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

Tenth Meeting
Montreal, 28–30 June 1993

COUNTRY PROGRAMME: JORDAN

This document consists of:

(a) Country Programme Evaluation Sheet (prepared by the Fund Secretariat)

(b) Country Programme Cover Sheet (prepared by the Fund Secretariat)

(c) Transmittal Letter from Government of Jordan

(d) The Country Programme

JORDAN COUNTRY PROGRAMME
EVALUATION SHEET

The Jordan Country Programme is submitted to the Tenth Meeting of the Executive Committee as document UNEP/OzL.Pro/ExCom/10/25. The document is consistent with the format indicated in the Procedures for Presentation of Country Programmes and Project Proposals to the Executive Committee (UNEP/OzL.Pro/ExCom/5/16).

It consists of:

- Letter of Transmittal
- Country Programme Cover Sheet (Prepared by the Secretariat)
- Executive Summary
- Introduction
- ODS Use and Alternatives
- Forecast Demand for the Controlled Substances by Sector
- Institutional Framework
- Policy Framework
- Response to the Montreal Protocol
- Phase-out Planning including Incremental Costs for Jordan
- Action Plan
- Activities, Project Proposals and Project Concepts

The total ODS consumption in Jordan in 1991 was 789 ODP tonnes. The consumption of CFC-11, CFC-12, CFC-114 and Halon 1211 constituted 12.2, 28.1, 20 and 231 ODP tonnes respectively. Distribution of consumption per sector for the same year was estimated as follows:

- 26.3% in the refrigeration sector
- 15.1% in the foam sector
- 28.9% in the aerosol sector
- 29.7% for fire extinguishers

The predicted ODS consumption following the unconstrained demand is estimated at 980 ODP tonnes by the year 2010.

Incremental cost for the phase-out of controlled substances have been estimated for two scenarios:

(a) Accelerated phase-out through the implementation of this Country Programme which targets the phase-out over the period 1993-1998. The incremental costs are estimated based on the planned activities under the Action Plan.

(b) Phase-out in the year 2010 in accordance with the requirements of the Montreal Protocol for countries operating under paragraph 1 of Article 5.

The incremental costs for the accelerated phase-out scenario and phase-out in accordance with the Montreal Protocol are US $8-13 million and US $14-19 million respectively.

To achieve the accelerated ODS phase-out the Government has developed the national strategy including Government policies and the Action Plan based on Government and industry actions. The national ozone policies outlines measures which support ODS phase-out activities in Jordan. They envisage in particular:

- to expedite the implementation of activities of reduction of ODS use and adoption of substitute chemicals and technologies;
- to enhance public awareness of the ozone issue through media attention;
- if required, to increase prices of ODS to levels where the ODS substitutes become financially attractive;
- when required, to establish a licensing system for ODS users;
- to establish ODS import monitoring procedures;
- to create Project Implementation Unit.

The Action Plan is based on the optimum phase-out scenario which is between the accelerated and allowable scenarios. According to this scenario, the phase-out of ODS consumption will be accomplished at the least economic cost as soon as is technically feasible. Actions are to be initiated in 1993. The phase-out will be mostly completed by 2000, while some ODS uses will continue until 2010. Over 13,000 tonnes of ODSs will be eliminated during the 1992-2010 period. Government actions consist of a broad scope of specific policy and legislative measures. They are listed under the Country Programme Cover Sheet. The action plan outlines the following activities and projects:

Technical assistance

- creation of a Project Implementation Unit;
- training/demonstration workshops in commercial air-conditioning, domestic refrigeration and industrial refrigeration;
- training in the refrigeration industry. This is to introduce recovery/recycling in the servicing sector and the use of new technologies;

Investment Projects

- deodorization of LPG for use as aerosol propellant;
- retrofit of aerosol filling plants;

- phase-out of halon use;
- phase-out in the flexible foam sectors;
- phase-out in the rigid foam sector;
- phase-out in the refrigeration sector.

The Country Programme does not outline the total budget of the Action Plan. However, the Seventh Meeting of the Executive Committee has already approved US $1.5 million allocation to the World Bank for Technical Support and Investment Project for the reduction of ODS consumption in Jordan. These allocations cover the following components:

- technical and organizational assistance component aimed at provision of technical and logistic support to the Government of Jordan, to develop its institutional capabilities to deal with the ozone issue (US $100,000);
- investment project on deodorization of LPG (US $700,000)
- Line-of-grant for development of demonstration and investment projects in aerosols, foams and refrigeration. (US 700,000)

These allocations have been used by the Word Bank for preparation of six projects in the aerosol and the foam sectors for a total cost of US $1,854,107. These projects are attached to the country programme. The World Bank is designated by the Government of Jordan as the implementing agency.

The Government of Jordan has requested in its letter of transmittal the approval of additional allocations of US $354,107 covering the additional cost of projects.

Recommendations

The following recommendations are made for consideration by Executive Committee:

1. The Country Programme be approved with the exclusion of specific projects attached, since some of these projects have already been approved by the Executive Committee.
2. The World Bank be requested to submit project proposals for funding at the next meetings of the Executive Committee.
3. Deferral of approval of the balance (US $354,107) requested in the letter of transmittal pending the submission of new proposals.

COUNTRY PROGRAMME COVER SHEET

Country : Jordan

Date Received : May 1993

Period Covered : 1993-2010

Lead National Agency : Ministry of Municipal and Rural Affairs and the Environment

1. Phase-out schedule

Substances	Current Consumption (Tonnes X ODP) in 1991	Planned Total Consumption till Phase-out Tonnes X ODP		Planned Year of Phase-out	
		Article 5 schedule	Optimal Schedule	Article 5 schedule	Optimal Schedule
CFC-11	153				
CFC-12	375				
CFC-115	20				
Halon-1211	231				
TOTAL	779	15,600	6,700	2010	2010

2. Government Action Plan

Item	Description of Actions	Commencement/Duration
Management and Monitoring System	• Establish a Project Implementation Unit (PIU) to manage and monitor ODS phaseout Projects	1993
	• Collect ODS import data	1993
	• Continued operation of the PIU.	1994-2010
	• Develop system to record ODS import and consistent with GATT classification.	1994-1995
	• Continue data collection	1994-2010
Public awareness System (Enhance Public Awareness)	• Direct media attention to ODS problems and potential recycling programs.	1993
	• Continue to develop support for public awareness campaign.	1994-2010
Policy	Draft policy statement and necessary legislation:	1994-1995
	• Formally announce phaseout timetable to enable industry to plan accordingly.	
Levies and Bans	• If needed, establish levies on ODS.	1994-1995
	• Ban on use of CFC in new central air conditioning units.	1994-1995
	• Ban on use of CFC for the manufacture of flexible polyurethane foams (excluding refrigerator foams)	1994-1995
	• Increase restriction on use of Halons.	1994-1995
	• Ban use of Halons in applications where alternatives are available.	1994-1995
	• Ban us of CFC in electronic cleaning.	1996-2010
	• Ban on use of CFC in rigid polyurethane foam comes into effect	1996-2010
	• Ban on use of CFC refrigerants in new domestic refrigerants and new domestic refrigerators and new mobile air conditioning.	1996-2010
	• Ban on all imports of virgin ODS comes into effect.	1996-2010
Projects	Implementation of projects to phaseout ODSs	1993-2010

3. Project Summary

Project Description	Commencement/ Duration	Use Sector	Tonnes ODP Phased Out	Implementing Agency	Incremental Cost US$
1. Purification of LPG to manufacture hydrocarbon aerosol propellant	1993/ 24 months	aerosols		World Bank	860,750
2. Conversion of Arab Pharmaceutical & Chemicals aerosol filling plant to hydrocarbon propellants	1993/ 12 months	aerosols	27	World Bank	279,157
3. Conversion of Households & Toiletries Manufacturing Co. to hydrocarbon propellant	1993/ 12 months	aerosols	30	World Bank	135,300
4. Conversion of Haddad aerosol filling plant to hydrocarbon propellant	1993/ 12 months	aerosols	85	World Bank	337,000
5. Conversion of flexible foam production operation at International Foam Inc. Co. from CFC-11 to methylene chloride	1993/ 9 months	foams	18	World Bank	100,000
6. Conversion of flexible foam production operation at Kolaghassi Foams and Mattress Factory from CFC-11 to methylene chloride	1993/ 9 months	foams	20	World Bank	141,900
TOTAL			180		1,854,107

4. Cost

Cost of activities and projects in the Country Programme of Jordan is US $1,854,107.

بسم الله الرحمن الرحيم

THE HASHEMITE KINGDOM
OF JORDAN
Ministry of Municipal & Rural
Affairs & The Environment
AMMAN

المملكة الأردنية الهاشمية
وزارة الشؤون البلدية والقروية والبيئة
عمان

الرقم ....
التاريخ 1993/5/
الموافق ....

سعادة الدكتور عمر العريني

يسرني ان اعلمكم بأن مجلس الوزراء في المملكه الاردنيه الهاشميه قد وافق على (البرنامج القطري لخفض المواد المستنزفه للأوزون) بصيغته المرفقه اليكم باللغه الانجليزيه .

واذ نرفع اليكم هذا البرنامج فاننا نرجو من سعادتكم تقديمه الى اللجنه التنفيذيه في اجتماعها العاشر (٢٨ - ٣٠ حزيران ١٩٩٣) للحصول على موافقتها عليه .

وكما تعلمون فان الاردن قد حصل في حيزيران ١٩٩٢ على موافقة نهائيه من اللجنه التنفيذيه بمبلغ (١,٥) مليون دولار . وعلى ضوء الزيارات الميدانيه التي قام بها الخبراء من البنك الدولي فان وثائق المشاريع المرفقه مع البرنامج القطري تشير الى ان الكلفه المطلوبه حاليا هي ١,٨٥٤,١٠٧ دولار امريكي . وعليه فاننا نأمل الحصول على موافقة اللجنه التنفيذيه لتغطية التكاليف الاضافيه والبالغه ٣٥٤,١٠٧ دولار امريكي . علما بأننا الان نقوم ببلورة مشاريع اخرى نأمل تقديمها الى اللجنه التنفيذيه في اجتماعاتها القادمه .

وبهذه المناسبه اتقدم اليكم بالشكر الجزيل على جهودكم القيمه في ادارة صندوق مونتريال . كما نشكر البنك الدولي على مساعدته لنا في اعداد البرنامج القطري .

وتفضلوا بقبول فائق الاحترام ،،،،

الدكتور / عبد الرزاق طبيشات

وزير الشؤون البلدية والقروية والبيئة

THE HASHEMITE KINGDOM
OF JORDAN

Ministry of Municipal & Rural
Affairs & The Environment

AMMAN

Date May 1993

Dr. Omar E. El Arini,

We are pleased to inform you that the Cabinet of Ministers of the Hashemite Kingdom of Jordan has approved Jordan's Country Programme (for the ozone depleting substances) as sent to you in the English version.

We are kindly requesting your assistance to submit the Country Programme to the Executive Committee at its 10th meeting (28-30 June 1993) for its approval.

As you already know Jordan received in June 1992 a final approval from the Executive Committee for an amount of US $1,500,000. Subsequent to visits of the World Bank's experts, the project documents attached to the Country Programme show an actual request of US $1,854,107. We hope to get the approval of the Executive Committee to cover the additional cost of US $354,107. We are also in the process of preparing other projects to be presented to the Executive Committee at their next meetings.

I would like to seize this opportunity to thank you very much for the great effort you put in managing the Secretariat and to thank the World Bank for their help in preparing the Country Programme.

Sincerely yours,

(signed)
Dr. Abdel Razak Tabishat
Minister
Ministry of Municipal & Rural
Affairs & The Environment

JORDAN

COUNTRY PROGRAM

PHASEOUT OF
OZONE DEPLETING SUBSTANCES

April 1993

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EXECUTIVE SUMMARY

Background

Jordan ratified the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) on 31 May 1989 and qualifies under paragraph 1 of Article 5 of the Montreal Protocol for a ten year delay in the phaseout of ODS. Jordan also qualifies for assistance from the Interim Multilateral Fund for the Implementation of the Montreal Protocol. At the request of the Government of Jordan, the World Bank assisted with the preparation of a Country Program, a requisite activity for assistance from the Multilateral Fund for the Implementation of the Montreal Protocol (MLF).

ODS use in Jordan

Jordan does not produce Ozone-Depleting Substances (ODS), but there are numerous users of ODS in the country. The bulk of the demand is concentrated in the industries that manufacture and service domestic refrigerators and air conditioning systems, in the foam industry which produces cushioning, building insulation and packaging, in aerosols, in fire suppression systems, and very small amounts in solvents. These industries contribute to a higher standard of living and, in recent years, have experienced growth exceeding that of the population. Total ODS consumption is estimated to have been 625 tones in 1991 (about 0,15 kg/capita), equivalent to 779 ODP (Ozone Depleting Potential) tones. The consumption in fire suppression applications which use ODS was estimated to be 77 tones in 1991.

Methodology for Country Program

The methodology for the preparation of the Country Program for Jordan involved a data collection and analysis mission during which data on the supply and demand for ODS, which were collected by the Government of Jordan, were updated; the institutional and policy framework was discussed with industry leaders and Government officials; ODS phaseout problems and plans were discussed with major consumers of ODS; and the availability of ODS substitutes was investigated. Activities which may qualify for MLF grants were identified. A set of ODS phaseout scenarios which spanned a range of probable activities were identified and costed. The optimum scenario was selected from the cost analysis and was used as a foundation for a phaseout strategy and action plan.

Alternative scenarios for ODS phase out

Two alternative scenarios were constructed to aid identification of the "Optimum" phase out strategy for Jordan through determination of net incremental economic costs. These scenarios were:

- Scenario 1 - **Allowable** (under the Montreal Protocol) - in which the transition to ODS substitutes is not undertaken in Jordan until 2000 but is completed by 2010 as required by the Montreal Protocol;

- Scenario 2 - **Accelerated** - in which the transition to ODS substitutes is accomplished at a rate consistent with the availability of technology and is accomplished over the period 1993-1998.

Within each scenario, the starting date of phase out was varied to verify the impact and to establish a probable range within which to expect actual results.

Cost analysis of the scenarios provided the identity and estimates of the magnitude of the various categories of costs associated with the phase out (capital, operational and administrative and early replacement of refrigerators) and the identifiable savings associated with a prompt ODS phase out.

The following table gives indicative values for the different costs associated with the optimum and the allowable scenarios that were studied.

	Optimum Accelerated Phaseout	Allowable Phaseout
	Scenario (1993-98)	Scenario (1993-2010)
	US$ Million	US$ Million
Net Incremental Capital Costs	5-10[1]	7-12[1]
Net Incremental Operating and Administrative Costs	0.5	0.1
Net Forced Early	2.4	6.8
TOTAL	8-13	14-19

Economic Cost to Jordan of Phase out

The net incremental economic cost to Jordan for the phase out of ODS ranged from US$ 8-13 Million to US$ 14-19 Million (expressed as the net present value in 1991 US dollars) depending on the speed of the phaseout and economic growth conditions through to the year 2010.

The primary conclusion drawn from this analysis is that a prompt ODS phaseout will be beneficial to the Jordanian economy. The determination of reimbursement of costs of financing the activities proposed in this country program and of net incremental costs is an issue for the Executive Committee of the MLF to decide in accordance with the terms of the Montreal Protocol.

In order of importance to the economic cost to Jordan, the following conclusions were also reached:

- in addition to the incremental capital costs, one of the significant net incremental costs to Jordan are those associated with the potential forced early replacement of domestic refrigerators when virgin CFC-12 is no longer available for recharge. This stems from the fact that there will be roughly 0.6 million refrigerators in service of Jordan in 2010, but replacement costs only apply to those continuing to use CFC-12. An early transition to refrigerant HFC-134a for domestic refrigerators will reduce the population of CFC-12 refrigerators in 2010, and hence reduce early replacement costs. The average age of the CFC-12 refrigerator population in 2010 was also a factor. In the accelerated cases, the absence of recycling of CFC-12 refrigerant substantially lowered the average age of CFC-12 refrigerators;

- net incremental operational costs ranged from US$ 0.1 Million with delayed phaseout to US$ 0.5 Million with accelerated phaseout. A significant proportion of these related to the incremental production costs for HFC-134a domestic refrigerators;

- the incorporation of recycle/recovery (or availability of a drop-in substitutes) into any phaseout case has the effect of directly reducing ODS consumption. Its primary benefit is to assure local supplies of CFC-12 for recharging refrigerators. Additional savings (not considered in the analysis) may be expected from applying recycle/recovery technology to the conservation of HFC-134a.

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[1] This has been estimated on the basis of present knowledge of non-ODS technologies and the present pipeline of projects which has been identified and which is anticipated over the next 2-3 years.

Recommended ODS Phaseout Strategy

The optimum strategy for the Government of Jordan is to adopt a set of policies and implement a series of projects in a comprehensive program that supports a phaseout of ODS consumption as soon as is technically feasible. This strategy will accomplish the complete phaseout of ODS at the least economic cost to the country and provide the basis for an officially recognized National Ozone Policy (NOP) to which industry and Government leaders are committed for phasing out ODS and which should be integrated in the national environmental strategy and policy framework.

Policies

The following set of integrated policies are proposed to form the National Ozone Policy (NOP) for Jordan:

- announce proposed phaseout schedule;
- expedite the implementation of activities directed at reduction of ODS use and adoption of substitute chemicals and technologies (including recycling and recovery activities) with imported equipment and technologies funded by the MLF being exempt from customs duties, sales taxes, etc.;
- enhance public awareness of the "ozone issue" through media attention. The emphasis should at first be placed on the conservation aspects of ODS and subsequently on substitution;
- if required, increase prices of ODS to levels at or below which ODS substitutes become financially attractive by applying a levy on imported ODS. It is expected that the medium to long term prices of some of the key ODS substitutes (such as HFC-134a) would be three to five times the present price of CFCs (such as CFC-12). Such policies will require further analysis before being adopted;
- when required, establish a licensing system for ODS users which encourages environmentally responsible handling practices and restricts distribution to registered users;
- establish ODS import monitoring procedures (as raw chemicals and in finished or semi-finished products) which account for all ODS as required under the Montreal Protocol and from which progress in reducing ODS consumption are tracked to guide appropriate adjustments in programs and policies; and
- create a "Project Implementation Unit" within the Ministry of Municipal, Rural Affairs and Environment (with Ministry of Planning support) to act as a focal point that will provide guidance in the formulation and promulgation of specific policies consistent with the NOP.

Proposed Projects

The Country Program is being submitted to the MLF which may provide financial assistance for selected activities. An initial list of projects has been prepared. Additional projects will be prepared and submitted to the Multilateral Fund as they are identified and evaluated.

Investment Projects

Investment projects have been (and will be) prepared for the key sectors. Projects will focus on the following activities:

- LPG purification for CFC replacement in the aerosol sector;
- Phaseout of Halon use;

- Aerosol plant retrofits;
- Phaseout in flexible foam sector;
- Phaseout in rigid foam sector; and
- CFC recovery and recycling.

Technical Assistance

- Training/demonstration workshops in commercial air-conditioning, domestic refrigeration and industrial refrigeration;
- Training in the refrigeration industry. This is to include recovery/recycling in the servicing sector and the use of new technologies;
- Workshop on flexible and rigid foams and Halon.

The projects being presented with the Country Program should be considered as a first step in Jordan's ODS phaseout program. As the phaseout proceeds, there will be other projects which will be identified and which could be presented to the MLF.

Action Plan

Objectives and Coordination. The objective of the Action Plan is to effectively, efficiently and as fairly as possible, phase out the consumption of ODS in Jordan in compliance with the Montreal Protocol, as ratified by the Government of Jordan and in accordance with the proposed optimum strategy.

The Action Plan comprises the investments, policies and implementation actions needed to ensure compliance. The principal agent is the Government which is responsible for the specific policies, referred to here as "National Ozone Policy".

This action plan is consistent with the principles for evaluating and financing incremental costs for ODS phaseout as detailed in the "Indicative List of Categories of Incremental Costs" adopted by the Second Meeting of the Parties to the Montreal Protocol.

The action plan proposed for Jordan is based on the optimum phaseout scenario where action is initiated in 1993. The phaseout will be mostly completed by 2000, while some ODS uses will continue until 2010.

Summary of proposed actions. The Action Plan Summary table outlines the key steps included in the action plan. Further discussion of this plan and the factors which have a significant impact on the phaseout program are included in Section 8 of the detailed report. The principal organization with responsibility for the action plan is the Ministry of Municipal, Rural Affairs and Environment, with the support of the Ministry of Planning.

ACTION PLAN SUMMARY

ITEM	1993	1994-1995	1996-2010
Management and Monitoring System	• Establish a Project Implementation Unit (PIU) to manage and monitor ODS phaseout Projects. •Collect ODS import data (DOS).	•Continued operation of the PIU. • Develop system to record ODS import and consistent with GATT classification, Department of Customs. • Continue data collection (DOS).	• Continue operation of the PIU. • Continue data collection (DOS).
Public Awareness Campaign	Enhance public awareness: • Direct media attention to ODS problems and potential recycling programs.	Continue to develop support for public awareness campaign.	Continue to develop support for public awareness campaign.
Policy		Draft policy statement and necessary legislation: • Formally announce phaseout timetable to enable industry to plan accordingly.	Enforcement.
Levies and Bans		• If needed, establish levies on ODS. • Ban on use of CFC in new central air conditioning units. • Ban on use of CFC for the manufacture of flexible polyurethane foams (excluding refrigerator foams). • Increase restriction on use of Halons. • Ban use of Halons in applications where alternatives are available.	• Ban use of CFC in electronic cleaning. • Ban on use of CFC in rigid polyurethane foam comes into effect. • Ban on use of CFC refrigerants in new domestic refrigerants and new domestic refrige-rators and new mobile air condi-tioning. • Ban on all imports of virgin ODS comes into effect.
Projects	Initiate projects that will decrease the use of ODS.	Continue projects that will decrease the use of ODS.	Continue projects that will decrease the use of ODS.

MMRAE: Ministry of Municipal, Rural Affairs and Environment
DOS: Department of Statistics
CD: Customs Department
CDD: Civil Defense Department
MOP: Ministry of Planning
MOF: Ministry of Finance
COI: Chambers of Industry

I. INTRODUCTION

Jordan has prepared a Country Program for the Phaseout of Ozone-Depleting Substances. This report encompasses all items needed to qualify as a Country Program which is a prerequisite for assistance from the Multilateral Fund for the Implementation of the Montreal Protocol.

The Montreal Protocol on Substances that Deplete the Ozone Layer

The initial discovery of chlorofluorocarbons (CFC) over 60 years ago led to the development of applications capable of improving the quality of life for most people in the world. In recent years, concern has increased about the accumulation of these compounds at the interface of the troposphere and stratosphere layers of the atmosphere known as the ozone layer.

Concerns were first raised in 1970 when a new, highly sensitive, electron capture detector was invented for the gas chromatograph. Measurable quantities of CFC were detected in the atmosphere as a result of this new development. In 1974, Molina and Roland proposed that the ultimate fate of CFC in the atmosphere was ultraviolet photodecomposition in the stratosphere with release of chlorine atoms. They suggested that these chlorine atoms might cause a reduction in the total amount of stratospheric ozone through a series of chemical reactions. As technology did not exist at that time to prove this hypothesis, the scientific community, led by Government funded agencies, undertook the development of a body of science required to measure trends and predict future ozone amounts in the stratosphere.

In 1978, the United States took the first step to stop the continued growth of CFC emissions to the atmosphere by banning so-called "non-essential" uses of CFC such as in aerosol propellants. The United Nations Environment Program (UNEP) became the focal point for international attention with the formation of the Coordinating Committee on the Ozone Layer (CCOL). UNEP published scientific assessments and initiated the formation of a global convention culminating in the Vienna Convention for the Protection of the Ozone Layer (adopted on 22 March 1985).

Concurrent scientific evidence that changes were occurring in the atmosphere was inconclusive until significant temporary changes in ozone over Antarctica were discovered by British scientists in late 1985. World attention then focused strongly on the CFC/ozone issue.

While the ban on the use of CFC in aerosol in many countries initially decreased worldwide use of CFC, rapid growth resumed in the early 1980s. Computer projections of ozone depletion resulting from sustained growth in CFC emissions at these levels led industry to advocate international efforts to limit long-term growth of CFC emissions. Negotiations of an international agreement began in December 1986 with the support of all of the world's leading CFC producers.

Ensuing negotiations led to the drafting of the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) in September 1987. This historic agreement addressed the need to reduce emissions of controlled substances (i.e. CFC and Halons) to a "safe" level in a way that was acceptable to all countries, including those who were seeking the economic and societal benefits of CFC enjoyed in developed countries.

The Montreal Protocol went into effect in 1989; over 80 countries have ratified the agreement to date. Jordan ratified the Protocol on 31 May 1989 and qualifies under paragraph 1 of Article 5 of the Protocol for assistance from the Multilateral Fund. The principal features of the original Montreal Protocol were:

- a set of control measures with scheduled reductions in consumption of controlled substances in each member country based on the country's use of these substances in 1986. The use is also based on an Ozone Depletion Potential (ODP) weighted basis (consumption was defined as production plus imports minus exports);

- a 10-year grace period for developing countries to comply with the Montreal Protocol control measures, provided their annual consumption of controlled substances is less than 0.3 kilograms/capita. Developing countries conforming to this condition are classified as paragraph 1 of Article 5 countries;

- restriction on trade of controlled substances with non-parties to the Montreal Protocol; and

- a requirement to reassess control measures at least once every four years.

A key provision in the Montreal Protocol requiring reassessment of the treaty's control measures was evoked when mounting scientific evidence showed that CFC were further damaging the ozone layer. The Second Meeting of the Parties in London in June 1990 produced an agreement to completely phase out CFC consumption in developed countries by the year 2000. Controlled substances were expanded to include 1,1,1-trichloroethane (methyl chloroform), carbon tetrachloride, and most fully halogenated CFC. The parties declared their intent to phase out hydrochlorofluorocarbons (HCFC) at some time in the future. The London agreement also established a technology and financial assistance resource for developing countries, the Interim Multilateral Fund. The recent Copenhagen Amendments further tightens the phaseout schedule.

For the purpose of this report, ozone depleting substances (ODS) are defined as substances currently regulated by the Montreal Protocol as revised in London in June 1990. The ODS most widely used in developing countries are CFC-11 and CFC-12. Methyl chloroform, carbon tetrachloride, CFC-113, CFC-114, CFC-115, Halon 1211, and Halon 1301 are also used but to a significantly lesser extent.

The Multilateral Fund

The Executive Committee of the Multilateral Fund, composed of seven parties operating under paragraph 1 of Article 5 of the Protocol, Jordan being a member of that committee, and seven parties not so operating, has been developing policies, guidelines and administrative arrangements for the Multilateral Fund since its formation in 1991. The critical responsibility of the Executive Committee is to consider and, where appropriate, approve Country Programs for compliance with the Montreal Protocol and approve project proposals and net incremental costs for implementation of such programs.

Jordan's Country Program

Implementation Guidelines and Criteria for Project Selection were approved by the Executive Committee at its Third Meeting in April 1991. In these guidelines, paragraph 1 of Article 5 Parties were invited to develop Country Programs (CP) and projects leading to a complete phaseout of ODS.

At the request of the Government of Jordan's Ministry of Municipal Rural Affairs and Environment, the World Bank fielded missions to Jordan in October 1991, May 1992 and February 1993. This mission had the following mandate:

- to collect/confirm basic information and statistics on ODS use;
- to visit industrial plants with significant ODS use and assess their performance and needs;
- to develop strategy options which would assist Jordan to decrease its ODS usage;
- to assist Jordan in developing a Country Program; and
- to develop investment projects; and
- to finalize the Country Program.

To accomplish the objectives of the Country Program, the elements identified in the Terms of Reference for Country Programs established by the Parties to the Montreal Protocol were evaluated.

Methodology for Phaseout Planning

The methodology used in developing the phaseout planning process for Jordan was structured to identify the least cost phaseout option to the country. The study team undertook to:

- review and study previous reports and studies;
- update the data for ODS demand and supply obtained by the Jordanian Government;
- develop forecasts of ODS demand unconstrained by the Montreal Protocol through the year 2010. This provided a base level demand profile to be serviced by ODS and their alternatives throughout the transitional period;
- identify probable substitutes (alternative chemicals and technologies) for ODS in order to estimate future availability: probable timing patterns for introduction of substitutes, and probable unit costs or investments to accomplish the substitution;
- identify the current institutional and policy framework as well as the industry structure and industry's phaseout plans and actions already taken;
- develop scenarios which span a full range of actions open to Jordan for compliance with the Montreal Protocol as a framework for comparison of costs;
- identify necessary projects for accomplishing a phaseout of ODS in coordination with each phaseout scenario;
- construct a mathematical model with which to estimate net incremental and other economic costs to Jordan for select scenarios over a range of economic growth rates, and with internal options such as recycle-recovery, and alternative rates of transition to ODS substitutes; and
- identify a preferred strategy to be adopted and an Action Plan to implement the chosen strategy.

The anticipated rate of transition to alternatives was estimated based on interviews with industry leaders in Jordan, other Article 5 Parties, the United States as well as Europe.

Phaseout Scenarios

Two principal scenarios were developed to cover the limits of the range of options that Jordan has to comply with the Montreal Protocol. An optimum scenario was then identified. The scenarios were:

- **allowable phaseout scenario under the Montreal Protocol** - All transitions to ODS substitutes are delayed until the last possible moment without violating the phaseout requirements of the Montreal Protocol; and
- **accelerated phaseout scenario** - The transition to ODS substitutes is accomplished sector by sector within 1-2 years of the technology and/or substitutes becoming commercially available.

At or between the accelerated and allowable phaseout scenarios there is an **optimum phaseout scenario** that minimizes the net incremental costs of phaseout to the Jordanian economy.

Methodology for Evaluating the Cost of ODS Phaseout

Evaluating the cost to Jordan for phasing out ODS required development of a set of optional phaseout scenarios from which costs could be evaluated. In the current climate of rapid change within the ODS user industries, such forecasting is at best an inexact science. The knowns are where we are today, and the limits to be imposed on ODS use are those established in the Montreal Protocol. The largest forecasting problems are estimating the most probable course for the market to follow between these two points. In order to make a forecast, assumptions must be made regarding: (1) the growth of demand for products currently produced with the aid of ODS; and (2) the timing and rate at which ODS are replaced with alternative chemicals and technologies over the forecast period (1990-2010).

Constraints on demand estimates were those of the Protocol limits. One point to note is that the constraint is partly determined by the plan adopted -- an accelerated phaseout actually reduces the 1995-1997 baseline from which paragraph 1 of Article 5 Parties derive their phaseout targets.

An approximation of overall country cost was made by using an approach based on the major identifiable economic costs. For Jordan, these costs and related assumptions were:

- the net incremental cost to the economy in compliance with the Montreal Protocol is defined as the difference between the costs that will be incurred in meeting demand unconstrained by any requirement to phaseout CFCs and those incurred in meeting the same level of demand for products but within the constraints of the Protocol. This will take into consideration both increases in costs in some sectors and cost savings in other sectors;
- net incremental costs to industry may be capital costs and/or operating costs. A best estimate of the unit costs in each category for each industry sector are set out in Chapter 6;
- the unit costs are multiplied by the projected number of units at any given time to give a total cost;
- the costs are included on a cash flow basis with the timing of the cash flow to match the assumed phaseout timing;
- the identified incremental cash flows in each industry sector (in 1991 prices) are calculated for the years 1991 to 2010 inclusive for each phaseout scenario;
- the cash flows associated with the early replacement of domestic refrigerators which cannot be recharged once virgin CFCs are no longer available are calculated. As the early replacements run on after the 2010 cut-off date, these cash flows are included through to the year 2015. This will still exclude some further early replacements that may occur after 2015 in the allowable scenario;
- all prices for CFC are included at 1991 US$ levels. Predictions about possible increases in the price of CFC as supply becomes scarce have not been made. Also, the prices of substitutes are included at the expected long run price, as obtained from the producers in Europe and the USA. This does not take into account the higher current prices of these;
- for each scenario studied, the annual cash flows are discounted to 1991 to give the net present value. This enables the comparison of costs incurred at different points in time by reference to the equivalent cost today, taking into account the time value of resources; and
- a discount rate of 10 per cent is used in the analysis.

II. ODS USE AND ALTERNATIVES

This chapter provides a review of current uses of ODS in Jordan and available options in preparing for and implementing the complete phaseout of ODS in accordance with the requirements of the Montreal Protocol

Background

Jordan imports all of its CFC and Halon. The bulk of the demand is concentrated in the industries that manufacture and service domestic refrigerators as well as in the foam and aerosol industries.

Details on ODS consumption in Jordan are presented in Table 2.1. ODS consumption by sector for 1991 is illustrated in Figure 2.1 while consumption in ODP tones is illustrated in Figure 2.2. The 1991 ODS consumption is estimated at 625 tones or 779 ODP tones.

Industry Structure

This section briefly describes each industry sector that uses or handles ODS in Jordan. The businesses involved are importers and distributors, manufacturers of products that contain or are made using ODS, and companies servicing refrigeration and air conditioning equipment as well as users of fire extinguishing equipment. Most companies involved with ODS in Jordan are in the private sector.

Table 2.1: ODS Consumption in Jordan

	1990		1991	
	Tones	ODP Tones	Tones	ODP Tones
CFC-11	162	162	163	153
CFC-12	400	400	375	375
CFC-114	18	18	20	20
Total CFC	**580**	**580**	**548**	**548**
Halon 1211	85	255	77	231
Total Halons	85	255	77	231
TOTAL	665	835	625	779

Refrigeration

Manufacturers of Domestic Refrigerators - There are three domestic refrigerator manufacturers in Jordan: National Refrigeration, Household Appliances Manufacturing, and Middle East Electrical. All these companies import the compressors which are assembled in the refrigerators. They also blow rigid polyurethane foam as insulation into the cavity between the inner and outer skins of the refrigerator cabinets.

Each of the three manufacturers is briefly described below:

- National Refrigeration has been in business for approximately ten years. Until 1989, it was one of two refrigerator manufacturers in Jordan, producing 6,000 to 7,000 units a year, and supplied about half of the market. It produced cycle defrost refrigerators with components imported from Italy, and a frost-free model with components imported from White Consolidated Industries in the USA. It is somewhat dependent on its suppliers for alternative technologies to eliminate the use of CFC;

- Household Appliances Manufacturing has been in business for about ten years, using the brand name Hamco. The company initially had a technical licensing agreement with Zanussi of Italy. Components are now purchased primarily from Italy. In 1991, they had a special contract to supply 10,000 upright freezers to the USSR as part of an arrangement between the Governments of Jordan and the USSR whereby Jordan was repaying a loan by supplying products. Hamco has the most integrated manufacturing facilities of the three Jordanian refrigerator manufacturing companies. They are also somewhat dependent on the component suppliers for the new CFC-free technologies; and

- Middle East Electrical (MEE), using the ACMA brand name, started operations in 1989 and has been very successful in penetrating the Jordanian market, currently supplying approximately 50 per cent of all refrigerators. Under the same arrangements as Hamco, it had an order for 10,000 refrigerators for the USSR. The company is partly owned by the ACMA company based in Singapore which provides most of the components. It produces duplicates of the Singaporean models. MEE produces outer cabinets and doors, plastic cabinet liners and door liners. All its refrigerator models are frost-free. It receives all its technical know-how from Singapore and the switch to new CFC-free technology will depend on their supplier.

Refrigerator Repair Workshops - There are a large number of small workshops repairing refrigerators. There is no definitive figure as to how many there actually are, but estimates are in the range of a few hundreds countrywide. These seem to be small, often family-run businesses. In all cases, 13.5 kg disposable cylinders of CFC 12 are purchased, typically from local distributors,

and used in recharging. Most recharging is required after compressor replacement, during which all the CFC-12 in the system is vented to the atmosphere and must be replaced.

Commercial Refrigeration - There are three companies involved in the manufacture and assembly of commercial refrigeration which includes walk-in coolers, refrigerated display cases and drinking water coolers. These companies are: Ihsan & Tahseen Balbaki, Arab Refrigerators Industries and Petra Engineering. The companies are primarily importers of finished products and components which they supply to the service industry. However, they fabricate the housings or cabinets for a few walk-in coolers and display cases, and install imported refrigerator system components. Arab Refrigerators Industries is switching its new systems to HCFC-22 under guidance from the U.S.-based firm Copeland.

Central Air Conditioning - Central air conditioning systems based on centrifugal chillers and using CFC-11 are all imported through local agents from such firms as Carrier or York in the USA. These are mainly used in hotels, office buildings and banks. They may be serviced by the engineering team associated with individual buildings or by the manufacturer's agent.

Mobile Air Conditioning Imports and Servicing - All mobile air conditioning equipment is imported already installed in the vehicles. Servicing is typically undertaken by the vehicle manufacturer's servicing centers, especially when the vehicles are relatively new.

Foam

Rigid Polyurethane Foam Manufacturers - Apart from the rigid polyurethane foams produced by the refrigerator manufacturers for insulation of the refrigerators, rigid polyurethane foam which uses CFC-11 as the blowing agent is also produced for building insulation by Fathi Abu Arja Industrial.

The formulation is imported from ICI in ready mixed form, including the CFC-11 component. Fathi Abu Arja Industrial does not make foam board, but undertakes custom spraying of the insulation onto the interior and exterior of buildings. They operate approximately six months of the year during the warmer weather. They are well aware of the ozone issue and constraints on CFC availability. They will shift to alternatives when these come available from their suppliers.

Flexible Polyurethane Foam Manufacturers - Flexible polyurethane foams are manufactured by about five companies: National Foam, Jordan Plastic, International Foam, Khola Gasi Foam and Arab Foam. Each produces three different densities of foam:

- low density (about 16 kg/m^3);
- medium density (about 21 kg/m^3); and
- high density (about 29 kg/m^3).

CFC-11 is only used in the manufacture of the low density foams. Carbon dioxide/water is used as the blowing agent in the others.

The low density foams are generally sold as low quality mattresses.

Aerosols

There are two principal (and several smaller) producers of cosmetic aerosols in Jordan: Household and Toiletries Manufacturing, and Methyeb Haddad & Sons:

- **Household Toiletries Manufacturing** is a major manufacturer of aerosol products using about 100 tones of CFC-12 per annum. They were operating under a license from Hans Schwarzkopf of Germany, which recently terminated this agreement because HTM was still using CFC-12 as the propellent. The company is therefore well aware of the ozone problem and will switch to LPG as soon as a local source becomes available;

- **Haddad** is a major Jordanian company in which aerosols are just one of a wide range of products they produce. They sell perfumes, hairsprays, deodorants and shaving cream in aerosol form, mostly using CFC-12 as the propellent, but with CFC-114 for some high quality perfumes. They are aware of the opportunity to use LPG as a way of cutting their costs and are actively seeking an unstenched supply, either from the local refinery, or from abroad;

Other companies manufacturing pesticide aerosols have already switched to the use of LPG propellants instead of CFC as this is cheaper for them and they do not need completely unstenched LPG.

Fire Extinguishers

There are four small firms selling Halon fire extinguishers. They all supply a range of portable extinguishers utilizing various extinguishing media:

- water, as a general purpose extinguisher;

- foam, for petrol/liquid fires;

- carbon dioxide for electrical fires;

- powder, the most popular general purpose extinguisher, but which leaves a residue; and

- halon (called BCF 1211), a good general purpose extinguisher which leaves no residue, but which is expensive, and therefore sales are limited.

All the Halon is imported from Europe, either in cylinders or in bulk for filling and refilling of cylinders locally.

It is not clear whether the same companies are also importing halon 1301 for fixed flooding systems, or whether these are purchased directly by the owners or occupants of the buildings where they are installed.

There is also substantial use of halon by the Civil Defense which has main responsibility for fire fighting and public safety.

Forecast Demand for ODS by Sector

Demand projections in each CFC user sector have been made to the year 2010, the cut off date for CFC consumption by paragraph 1 of Article 5 Parties. These forecasts assume that the Montreal Protocol does not exist and therefore there are no supply constraints. This defines demand with no substitution. The analysis does not take into account any possible product development or other changes in manufacturing practices as a result of normal progress. This projection is termed unconstrained demand. It is the starting point for determining the demand for substitutes.

Figures 2.3 and 2.4 set out the forecast for unconstrained demand for CFCs in Jordan between 1991 and the years 2000 and 2010, first showing projected use in the different sectors and secondly distinguishing between CFCs being used in manufacturing and those being used to recharge refrigerators and air conditioners in service. Overall, unconstrained CFC consumption is projected to increase from 548 tones in 1991 to approximately 1000 tones in 2010. This corresponds to an annual growth rate of about 3%.

These figures have been built up from forecasts for each sector, taking into account the different demand drivers in consumer and industrial markets. These projections can only be approximate, especially given their long range, but are indicative of the likely patterns of growth in Jordan.

Underlying Growth Assumptions

The underlying growth assumptions made in preparing the forecast are summarized in Table 2.2. The assumptions were made with regard to:

- population growth;
- GDP growth;
- domestic refrigerator manufacturing, usage and failure rates;
- central air conditioning;
- mobile air conditioning;
- polyurethane foam manufacturing;
- aerosols;
- solvents; and
- fire extinguisher.

Table 2.2: Summary of Growth and Other Underlying Assumptions

AREA	GROWTH AND OTHER ASSUMPTIONS	PERIOD
Population	° 3.4% annual growth	1992-2000
GDP	° 3.4% average annual growth	1991
	° 4.5%	1992-1998
	° 3%	1999-2010
Domestic Refrigerator Manufacturers	° 5% average annual growth	1992-2000
	° 0.5 million refrigerators in use	in 1990
	° 630,000 refrigerators in use	by 2000
	° 1 million refrigerators in use	by 2010
	° Average life of refrigerator	20 years
	° 0.3 kg of refrigerant per refrigerator	
	° 1.0 kg of refrigerant for the foam	
Households	° 525,000	in 1991
	° 1 million	by 2010
Refrigerator Failure	° 3% fail	in first year
	° 10% fail	in 13-20 years
Central Air Conditioning Units (Chillers)	° Units use HCFC-22	
Mobile Air Conditioners	° 3% of motor vehicles have air conditioning units	in 1991
	° 250,000 vehicles in use	
	° 500 new MAC purchased	in 1991
	° 2% annual growth rate	1992-2010
	° Average life	10 years
Polyurethane foam	° 3% average growth rate for rigid and flexible foams	1992-2010
Solvents	° Used in small quantities	
Fire Extinguishers	° 3% Growth Rate	1991-1993
	° 5% Annual Decrease	1993-1995
	° 3% Growth Rate	1995-2010

III. INSTITUTIONAL FRAMEWORK

This chapter of the report evaluates institutional capabilities available for implementing the ODS phaseout in Jordan.

Government Agencies. There are several links between the different organizations under the Prime Minister and the Ministries that have an interest in the Ozone Issue in Jordan.

Prime Minister. The Prime Minister is appointed by H. M. the King. Several of the ministries which report to the Prime Minister have an interest and responsibilities in the ozone issue.

Ministry of Municipal, Rural Affairs and Environment. The Ministry of Municipal, Rural Affairs and Environment is the principal ministry in the Jordanian Government with responsibilities in environmental affairs. Other ministries and organizations have staff dealing with the environment on an as needed basis. The main duties of the Department of the Environment within this ministry are: legislation, policy development and enforcement of the environmental protection regulations. The specific duties related to the ozone issues are to supervise and coordinate international and national activities related to the Montreal Protocol. This ministry would be responsible for the enforcement of the Action Plan for Jordan.

Ministry of Planning. The policies concerning such matters as the Ozone Issue are established in committees with all parties concerned. This Ministry receives data covering issues of interest to the Government. The Ministry analyzes this data, makes projections and reports to the other Government agencies that together establish policies. Figures for GDP, discount rate for project evaluation and population growth up to the year 2005 were obtained from this Ministry. On the Ozone Issue, this Ministry will play a key role in analyzing data and studying the effect of actions to be taken by the Government in implementing the Country Program.

Ministry of Industry and Trade. This Ministry has the responsibility for establishing norms and standards to be followed by the industry. It is presently establishing norms, standards and regulations governing the use of propellants in aerosols. The Ministry will advise the Government on the course of action to be taken which will minimize negative impact on industry. It will play a key role in establishing the norms and regulations governing the use of ODS and the phaseout of these substances according to the Action Plan established by the Government of Jordan.

Ministry of Health. The Public Health Law gives the Ministry of Health the authority to issue licenses, to monitor the industries which were issued licenses and to issue fines. This Ministry also has the authority to revoke licenses and close establishments that disobey the terms of the issued licenses. All chemicals going into Jordan must be approved by the Ministry of Health. This ministry is one of the required signatories of licenses. In the context of the Montreal Protocol, the Ministry of Health will enforce the license system agreed to in the action plan.

Ministry of Finance/Customs Department. The Customs Department is responsible for establishing the procedures for enforcing regulations relating to the entrance of goods into Jordan. This Department is also responsible for the classification of these goods and for the collection of levies as required by law. This department does not presently have the classification and monitoring systems for ODSs entering and leaving Jordan as required by the Montreal Protocol. Upon implementation of the Action Plan by the Government of Jordan, the Customs Department will record the quantities of ODSs entering and leaving the country, as required by the Montreal protocol. It will also apply the levies established and approved by the Government of Jordan Action Plan.

Civil Defense Department. In addition to its civil defense responsibilities, this Department issues permits for building and the use of all premises. The building permits include references to fire codes and the use of fire extinguishing equipment.

Amman Chamber of Industry. The Amman Chamber of Industry provides guidance to industrialists on the introduction of new technologies to Jordan. It also collects the views and complaints of industrialists regarding issues of interest to its members. In the transition period towards total ODS phaseout, the Chamber will provide assistance and advice to its members. It will invite specialists to individually address each sector of the industry that is involved with ODSs.

The Higher Council for Science and Technology and the Royal Scientific Society. The Royal Scientific Society can also provide valuable guidance to both Government and industry on ODS-related issues.

IV. POLICY FRAMEWORK

The policy framework within Jordan is presented in this Chapter of the report with the emphasis on those issues which may be relevant for implementing ODS phaseout.

Background

The general policies and the timing of the actions taken in Jordan will affect ODS phaseout costs at both the country level and at the individual enterprise level. An understanding of existing policies and available policy options is therefore needed to estimate net incremental costs. The cost to Jordan (or minimum adjustment cost given the existing economic policy and industrial strategy of Jordan) depends on the implementation plan, which to a certain extent, is constrained by policies which are institutionally feasible for the country. The net incremental financial costs to individual enterprises also depend on overall economic policy, especially tax provisions, and eligibility rules of the Multilateral Fund.

This report considers Jordan's overall economic policy and the general economic situation of the country and reflects industry's strategy, including investment and imported components and materials.

Political System and Trends

Legislative power is vested in H. M. the King and the National Assembly, consisting of a Senate and a House of Representatives. H. M.the King appoints the Prime Minister, the President and members of the Senate.

Economic Conditions

Before the Gulf crises, Jordan had a population of approximately 3,453,000. Since then between 500,000 to 1,000,000 people have returned. This sudden increase in population is having a toll on the infrastructure of the country. The present cost of living index in Jordan is 155.4 (1986=100). The GDP Growth Rate which fell from 5.4 in 1986 to -3.5 in 1988 had reached 0 in 1989. This figure is expected to grow in 1992 and 1993. Prior to the Gulf crises, large expenditures had been made to develop the country's infrastructure and to the development of industrial parks outside the main cities.

Existing Policies and Precedents

Parliament has enacted laws that authorize ministries to ban the entrance and ban the use of some chemicals into or within Jordan. By doing so the country has created precedents on the issue of bans and permits. One such ban is that of owning a diesel powered vehicle by residents of Jordan. This ban has been enforced since the early 1960s.

Incentives and Taxation Systems

There exist in Jordan several laws governing investments. "Favored Industry" projects, authorized under the Investment Law, may be granted exemptions from corporate, social security and income taxes for up to ten years; from loan repayment for up to seven years; and from customs levies on plant and raw materials. Tax holidays have also been granted for "Favored Industry" projects.

Business Regulations and Incentives

The Government of Jordan encourages the spirit of free enterprise. However, some controls and incentives have been applied to discourage or encourage, depending on the case, those sectors the Government views as requiring such actions.

The Government can thus apply a number of actions to encourage industry to use non ODS. It can also take measures to discourage the use of ODSs in compliance with its action plan and with the requirements of the Montreal Protocol. These are discussed below.

Incentives. Incentives are granted by the Government in key sectors. These take the form of allowance on capital investment, accelerated depreciation, exemption from customs levies, and low interest loans.

Customs Levy Exemption. In order to encourage the import of certain goods, the Government can exempt these goods from customs levies. In the application of the action plan, the Government also has the authority to apply bans on ODS.

Finance and Interest Subsidies. Interest rates in Jordan in recent years have been relatively high. For specific projects the Government may grant, as an incentive, permission to obtain loans at subsidized rates of interest.

V. RESPONSE TO THE MONTREAL PROTOCOL

This chapter of the report describes the actions taken to date by the government of Jordan as well as by industry in response to the Montreal Protocol.

Government Responses to the Protocol to Date

The Government of Jordan was one of the first Parties to ratify the Montreal Protocol. Jordan is in fact one of the Members of the Executive Committee of the MLF since its creation at the Second Meeting of the Parties.

Jordan has created within the Ministry of Municipal, Rural Affairs and Environment, a division which deals with matters related to the Montreal Protocol. This division has completed a survey on the consumption of ODSs.

The legal department of the Ministry of Municipal, Rural Affairs and Environment is preparing a draft law on the environment. Once agreed upon by the departments and the ministries concerned, the proposed law is expected to be presented to parliament.

Industry Responses to the Protocol to Date

Industry's response to the Montreal Protocol has varied from industry to industry within each sector using ODS. For example, the aerosol industry is fully aware of the requirements to phaseout ODS in the future. Other industrialists have superficial knowledge of these requirements.

In the refrigeration sector, some companies are obtaining information on the available technologies and are investigating the costs of production of non-ODS refrigerators. Others will wait until ODS are banned before they spend funds investigating and evaluating the costs of production of non-ODS refrigerators.

In the **aerosol industry** - market forces have influenced the changeover from ODS to LPG for insecticides and pesticides. However, in the cosmetics sector, the switch has not been made due to the unavailability of destenched LPG in Jordan. Such cosmetic quality LPG presently has to be imported.

The foam industry has not yet switched to CFC substitutes because of costs and, in the case of rigid foams, the lack of experience in the use of alternate blowing agents.

VI. PHASEOUT PLANNING

Careful planning of ODS phaseout will minimize the economical impacts on the Jordanian economy. This chapter describes alternative substances and technologies and their net incremental costs to the economy. The optimum phaseout scenario is also identified.

Background

The planning of a cost effective ODS phaseout policy requires the determination of net incremental costs for substitution to alternative chemicals and technologies in processes currently using ODS. Availability of alternative technologies was considered along with the capabilities of local industries. Scenarios which provide a framework upon which overall costs can be compared serve as an analytical tool over a range of timings considered to be within the realm of probability. The discussion which follows covers the details of the planning process used to provide a cost basis for recommendations incorporated in the phaseout strategy.

Availability of Technology

With the exception of some rigid insulating foams, certain Halons applications, and specific medical devices using CFCs, developed technology exists today to accomplish a complete phaseout of ODSs over a period of 2 years.

The Costs of Substitution

Incremental costs of substitution to non-ODS comprise:

- capital costs (such as development costs and the costs of modifying existing facilities, where necessary);
- additional operating costs; and
- costs associated with the early replacement of some domestic refrigerators once no further CFCs are available for recharging.

The likely costs, quoted in US dollars at 1991 prices, that will be incurred in each sector are discussed below. These are by no means definitive, but indicate our best estimate on the basis of information currently available.

Basic Assumptions

For the purpose of outlining and costing a phaseout program in Jordan, a single substitute has been identified for each application. For many applications, this is based on the substitutes that Jordanian industries are selecting. Current uses and likely substitutes are listed in Table 6.1, together with an estimate of the earliest point in time at which they are assumed to be commercially available and used in Jordan. This list is not to be interpreted as a set of recommendations for particular substance to be adopted for particular applications. Where the choice is still not clear cut, it reflects no more than a judgement as to the likely choices of substitutes. Companies are making their own commercial decisions as to which substitute or alternative to adopt.

Domestic Refrigerators

The phaseout of CFC-12 as the refrigerant and of CFC-11 as the blowing agent for the insulation foam are two separate and independent processes. Each is considered in turn below.

Refrigerant - The new refrigerant HFC-134a requires a redesigned compressor for which there are associated development costs. However, in Jordan, the manufacturers of refrigerators will purchase the required compressors from abroad since they do not have compressor manufacturing facilities.

Based on the experience of compressor and refrigerator manufacturers in the USA and Brazil, there will be net incremental production costs for the new cooling systems. These are expected to be:

- the additional cost of the new lubricant at about US$ 2.30 per compressor;
- a more expensive drier costing an extra US$ 0.50 per refrigerator; and
- improved enamel insulation on the motor wiring, costing about US$ 0.50 extra per refrigerator.

As compressors are imported, these are expected to cost US$ 1.20 in addition to the extra costs listed above, to reflect development costs.

The estimated long-term sale price of HFC-134a is taken to be five times the current international CFC-12 bulk sale price of about US$ 3,000 per tone (net of any import or other duties imposed by the Government of Jordan). This estimate is reported by companies currently developing HFC-134a. However, the new refrigeration systems will use about ten per cent less refrigerant. The additional cost of the first charge will therefore be about US$3.50 per refrigerator.

Incremental cost of a CFC-free refrigerator - Contacts with industry have indicated that additional production costs of about US$ 8 per refrigerator. A typical mid-range of 350 liters (approx. 12.5 cu ft) currently sells in Jordan for about US$ 600. Therefore, the projected additional cost is about 1% of the current selling price.

The latest evidence from development is the USA and Europe indicate that non-CFC refrigerators will be at least as energy efficient as current refrigerators. Although HFC-134a is thermodynamically less energy efficient than the existing CFC-12, the combination of redesigned compressors and new, less viscous lubricants is considered by European refrigerator manufacturers likely to result in energy savings. No consideration is given to incremental energy consumption in this analysis.

	CURRENT USE	SUBSTITUTE ASSUMED	ASSUMED EARLIEST USE IN JORDAN
Domestic refrigerators			
°refrigerant	CFC 12	HFC 134a	1995
°polyurethane insulating foam	CFC 11	50% CFC 11	1993
		HFCs	1995
Commercial refrigeration			
°refrigerant	CFC 12	HCFC 22 ammonia	1993
Mobile air conditioning			
°refrigerant	CFC 12	HFC 134a	1995
Polyurethane foam			
°rigid	CFC 11	50% CFC 11	1993
		HFCs	1998
°flexible	CFC 11	Methylene chloride	1993
Aerosols	CFC 11, 12,114	LPG	1994

Early Replacements of Domestic Refrigerators - There will be costs associated with the forced replacement of domestic refrigerators when the equipment fails and cannot be recharged given that CFCs are no longer available. The number of units likely to be affected is estimated based on the number of refrigerators that would have been recharged in any year if CFCs were still available. The cost to the consumer of forced replacement is represented by the timing difference between the actual early replacement and normal replacement. The cost of a new refrigerator is therefore included in the cash flow as the net timing effect, equivalent to including the full cost

Practical Considerations for Phaseout Timing

The Montreal Protocol prescribes the latest possible timing for the phaseout of CFC. However, there are also a number of practical considerations for the Government of Jordan in deciding on the phaseout timing it will adopt. These are as follows:

- some of the major users of CFC in Jordan (principally aerosol fillers) are already formulating plans to change to substitutes, independently of Government directives. International market forces will drive at least some phaseout of CFCs. The Government may wish to follow a strategy that is consistent with these forces;

- the future availability of CFC from producers in Europe and the USA will decline over the next three years. Many of the world's largest producers have announced complete phaseout of ODS production by 1995, with many having already reduced their production by 50% or more. Although the Protocol allows for some continued production to meet the needs of paragraph 1 of Article 5 Parties, it is not yet clear that this will be a commercially viable option for the producers. Jordan may be able to secure supply from other paragraph 1 of Article 5 Parties, or may choose to phaseout its consumption within the known supply pattern.

These issues indicate that phaseout well in advance of the deadlines set in the Protocol may be most likely and most desirable in Jordan.

Incremental Costs To Jordan

Key Assumptions

There are many uncertainties inherent in making forecasts of the sort entailed in developing a country program. Therefore, any cost calculations can only be indicative and the figures presented here should not be taken as any more than order of magnitude indications of possible outcomes.

The cost calculations are based on the demand forecasts and phaseout scenarios already described. In addition, a number of further fundamental assumptions underlie the incremental costs calculations. These are set out below:

- the net incremental cost to an economy of compliance with the Montreal Protocol is defined as the difference between the costs that will be incurred in meeting demand unconstrained by any requirement to phase out CFC and those incurred in meeting the same level of demand for products but within the constraints of the Protocol. This will take into account both increases in costs in some sectors and cost savings in other sectors;

- net incremental costs may be capital costs and/or operating costs;

- the costs are included on a cash flow basis with the timing of the cash flow to match the assumed phaseout timing;

- the identified incremental cash flows in each industry sector (in 1991 prices) are calculated for the years 1991 to 2010 inclusive for each phaseout scenario;

- the cash flows associated with the early replacement of domestic refrigerators which cannot be recharged once virgin CFC is no longer available are calculated. As the early replacements run on after the 2010 cut-off date, these cash flows are included through to the year 2015. This will still exclude some further early replacements that may occur after 2015 in the delayed scenario;

- all prices for CFCs are included at 1991 US$ levels. Predictions about possible increases in the price of CFC as supply becomes scarce have not been made. Also, the prices of substitutes are included at the expected long run price, as reported by industry in Europe and the USA;

- for each scenario, the annual cash flows are discounted to 1991 to give the net present value. This enables the comparison of costs incurred at different points in time by reference to the equivalent cost today, taking into account the time value of resources; and

- a discount rate of 10 per cent real is used.

Results

The estimated economic costs to Jordan of compliance with the Montreal Protocol vary according to the timing of phaseout. Based on all the assumptions about projected demand, a set of phaseout measures and likely costs of substitution, the economic costs of phaseout to Jordan may be summarized as follows:

	Optimum Phaseout Scenario (1993-98) US$ Million	**Allowable Phaseout** Scenario (1993-2010) US$ Million
Net Incremental Capital Costs	5-10[1]	7-12[1]
Net Incremental Operating and Administrative Costs	0.5	0.1
Net Forced Early	2.4	6.8
TOTAL	8-13	14-19

It is worth re-emphasizing here that these are only indicative figures given all the uncertainties inherent in their calculation. The total costs are dominated by the potential costs associated with forced early replacement of domestic refrigerators.

An early phaseout will prevent the emission of over 13,000 tones over the 1992-2010 period compared to the unconstrained demand. The allowable phaseout results in about 9,000 tones of ODP emissions avoided over the 1992-2010.

A variety of phaseout timings intermediate between the two extremes of the accelerated and delayed scenarios were analyzed. This analysis showed that any timing later than the accelerated scenario increases the total cost, since the reduction in incremental production costs is more than offset by the additional early replacement costs. This is not taking into account the effects of any potential recycling, since this seems unlikely to occur to any great extent in Jordan.

Most Likely Phaseout Scenario

In the light of these practicalities, the most likely timing scenario in Jordan is one in which phaseout occurs as early as possible consistent with technology availability. This takes into account the state of development of any new technology in North America, Europe and elsewhere, reflects a realistic timetable for the transfer of such technology to Jordan and broadly accords with the plans of Jordanian industry. It is likely to require Government actions to ensure that everyone is working to a similar schedule and therefore recognizes the lead times required by the Government

[1] This has been estimated on the basis of present knowledge of non-ODS technologies and the present pipeline of projects which has been identified and which is anticipated over the next 2-3 years.

incurred at the time of early replacement and an equal and offsetting credit at the projected time of normal replacement.

This additional demand for replacement of refrigerators will increase the required supply of refrigerators and will therefore impact on refrigerator manufacturers. For simplicity of presentation, the costs are included at the full cost (US$ 600) of a replacement refrigerator.

The scale of these early replacement costs can be reduced by the use of recovery and recycling and/or stockpiling, which can extend the period of time for which CFCs are available for recharging.

Insulation

As stated above, changes to CFC-11/water with addition of polyol requires no significant changes in production facilities. This adds approximately 2 to 3% to the overall cost of the raw material formulation compared to the existing formulation. This information was provided by companies selling the new formulations.

Chillers/Central Air Conditioning Plants

There are no capital costs associated with the conversion of manufacturing facilities since chillers/central air conditioning plants are imported into Jordan. The only incremental cost will be the additional cost of the substitute refrigerant, HCFC-22. This is US$ 100/tones, based on current prices before import and other duties imposed by the Government.

Mobile Air Conditioning

Since Jordan does not manufacture mobile air conditioning units, the only incremental cost as far as Jordan is concerned is the additional cost of the new refrigerant, HFC-134a.

Foams

Flexible foams will switch from CFC-11 to methylene chloride as a blowing agent and will have minor costs to modify the blowing nozzles and flow lines. They will eliminate the low density foams available. This will be replaced by a slightly higher density foam which adds about 5% to the cost of foam due to increased usage of the raw material. There is, nevertheless, a saving in the incremental operating costs equivalent to $ 705 per tone of CFC-11 replaced, given the lower cost of the replacement blowing agents.

Solvents

The use of aqueous cleaning systems as based on experience in Europe, will require capital cost expenditures estimated at US$ 20,000 (based on a batch operation equivalent to an existing unit with an annual consumption of 10 tones of CFC-113). It is estimated that operating costs will decrease by US$ 1,500 per tone of CFC-113 replaced, although this will be offset by the additional cost of the surfactant equivalent to US$ 5,820 per tone of CFC-113 replaced.

Halons

The Government of Jordan is presently evaluating the possible alternatives to using halons restricting the use of such substances to where alternatives cannot be used. Active project development is underway.

Aerosols

As the changeover from CFCs to LPG as propellants in aerosols is expected to be substantially complete in Jordan for non-cosmetic applications by 1994, the associated cost savings have not been included in the calculations made in this document. A local or imported supply of destenched LPG is required. However, there will be some capital costs associated with increased fire proofing and equipment retrofits. These are likely to amount to $100,000/filling facilities.

Alternative Strategies

The following elements are addressed in this section:

- identification of the most likely CFC phaseout scenario in Jordan based on current industry plans and market forces. This describes likely phaseout timings in each industry sector and builds these into the aggregate profile for the country;

- constructs a hypothetical scenario that leaves CFC phaseout as late as possible whilst keeping Jordan within the Protocol consumption limits.

These scenarios provide the basis for an assessment of the incremental cost of phaseout to Jordan (discussed in the next section), in order that the optimum (least economic cost) option can be identified.

ODS according to the Montreal Protocol - The Montreal Protocol phaseout profile for paragraph 1 of Article 5 Parties for the CFC contained in Annex A is set out in Figure 6.1. The base which defines the 100% ceiling is the average of consumption in 1995, 1996 and 1997, or 0.3 kg per capita if this is lower. Each country must ensure phaseout in all sectors of its economy in order to stay within these limits.

Unconstrained Demand in Jordan and the Protocol Limits

The starting point for developing phaseout scenarios is the forecast of unconstrained demand as described earlier. This is illustrated in Figure 6.2, which shows unconstrained demand in ODP tones and compares the demand forecast to the Protocol phaseout limits. The 100 per cent ceiling is based on the average consumption in the years 1995, 1996, and 1997. This is well below the 0.3 kg per capita allowance for countries operating under paragraph 1 of Article 5.

Accelerated Phaseout Scenario

Figure 6.3 illustrates the accelerated phaseout profile in Jordan. The 100% Protocol ceiling is based in the average 1995, 1996, 1997 consumption and is therefore lower than the ceiling based on unconstrained demand, as CFC demand has already begun to decline before 1995. The small residual demand for CFC post 1998 relates to recharging needs: it is assumed that there is a continuing supply to satisfy this within the Protocol limits.

Construction of this most likely scenario allows analysis to ascertain whether this is optimal, in the sense of incurring the least economic cost to Jordan. The graph in Figure 6.3 represents the most likely aggregate phaseout profile for Jordan as a whole, but is actually built up sector by sector.

Allowable Phaseout Scenario

Theoretically, phaseout could be delayed as long as possible so as to just meet the Protocol limits for paragraph 1 of Article 5 Parties, referred to here as "allowed" phaseout. This scenario, which assumes (unrealistically) that there will not be any phaseout independent of Government measures, is illustrated in Figure 6.4. It also assumes that there will continue to be a supply of CFC available for Jordan to import, even though many of its current suppliers may have terminated production this century.

Although this option is hypothetical, it is described here in order to assess the cost implications for Jordan of delaying phaseout. The aggregate phaseout profile for Jordan as a whole is illustrated in Figure 6.4, and the individual sector responses that it assumes are described in Annex F.

to introduce the necessary control measures. The most likely phaseout scenario is the one that represents the optimum in terms of least economic cost to Jordan.

Recovery and Recycling

There is an opportunity to avoid some of the early replacement costs if CFC are recycled and are therefore available for recharge after virgin CFC are no longer available. However, this would seem to be unlikely in Jordan, given the very small quantities of CFC involved.

Based on the phaseout scenarios examined, recharge with virgin CFC is constrained from 2007 (assuming that there is continuing CFC supply after complete phaseout in developed countries) and none is possible from 2010 (the date at which paragraph 1 of Article 5 Parties' consumption must be zero).

A recycling program might be introduced in, say, 1996. The extent to which the early replacement costs are reduced depends on the effectiveness of the recycling program. This reduction is partly offset by the costs of recycling, which are discussed in the section on the costs of substitution.

For illustration, two recycling cases are considered:

- **limited recycling**, where it is assumed that about 50 per cent of the CFC is recovered from refrigerators being repaired. In this example there will only be sufficient volumes of recycled CFC to recharge a proportion of the refrigerators that would otherwise have to be replaced early; and

- **substantial recycling**, where it is assumed that about 75% of the CFC is recovered from refrigerators being repaired, and about 25% of the CFC from refrigerators reaching the end of their useful lives.

The effect of these programs on the net present value of the early replacement costs, taking into account the costs of the proposed recycling schemes, are estimated as follows:

Early Replacement Costs
(US $ million)

	Optimum Phaseout	Allowable Phaseout
No recycling	2.4	6.8
Limited recycling	1.7	4.7
Substantial recycling	0.6	3.0

There is a strong argument for the introduction of recovery and recycling schemes in advance of these suggested timings to supply CFC for recharge if virgin supply becomes restricted sooner, as phaseout proceeds in developed countries.

Recycling schemes could technically be introduced immediately. This would reduce demand for virgin CFC and thus reduce overall emissions to the atmosphere. However, this is an expensive process, especially in Jordan where there is likely to be a very low utilization of recovery machines since the number of refrigerator repairs per workshop is quite low. This is exacerbated by the relatively low cost of virgin CFC-12 in Jordan. The cost savings associated with the reduced purchases of virgin CFC if recycled CFC is available are unlikely to be sufficient even to cover the operating costs of the recovery/reclaim process. If the capital costs are also taken into consideration, the process is even less economically viable.

Conclusions

The incremental costs to Jordan of phaseout of CFC vary with the timing of the introduction of substitutes and alternatives. Phaseout as soon as technically possible represents both the least cost option for Jordan and is most in tune with prevailing international market forces and the plans of Jordanian industries. It therefore is in everyone's best interest and is the preferred option.

A significant incremental costs to Jordan are those associated with the potential forced early replacement of domestic refrigerators when virgin CFC are no longer available for recharge. Perhaps stockpiling could provide CFC for recharging after virgin CFC is no longer available and thus could significantly reduce the number of forced early replacements.

VII. PROPOSED STRATEGY STATEMENT BY THE GOVERNMENT

As a requirement of the Montreal Protocol, the Government of Jordan has to define a strategy in which it will explain how the country will phaseout ODS. This chapter proposes such a strategy statement.

It is proposed that the Government of Jordan adopts a phaseout strategy which is in tune with current Jordanian industry plans and prevailing international market forces. This corresponds to an ODS phaseout as soon as is technically feasible and is the option that incurs the least economic costs to the economy. The Government should introduce phaseout measures in order to ensure that industries in Jordan are working to the same schedule. The strategies and policies which will be adopted by the Government of Jordan should be outlined in a National Ozone Policy.

The recommended policies are compatible with the existing institutional and policy framework of Jordan. These policies utilize the introduction of regulations, market forces and negotiated agreements with industry to accomplish phaseout goals in a cost effective and equitable manner.

Public acceptance of the costs and inconveniences accompanying the ODSs phaseout is an essential ingredient in achieving a prompt and effective ODS phaseout. It is recommended that the Government of Jordan actively support programs directed at elevating public awareness and provide early announcement of its intentions to both the public and to industry in order to encourage appropriate action.

It is recommended that the following set of policies be part of the National Ozone Policy (NOP):

- strengthen the Ministry of Municipal, Rural Affairs and Environment by increasing technical and financial resources to a level consistent with growing environmental needs within Jordan;

- create a "Project Implementation Unit" within the Ministry of Municipal, Rural Affairs and Environment as a focal point that will provide a guiding role in the formulation and promulgation of specific policies consistent with the NOP. The "Project Implementation Unit" would also function to develop voluntary agreements within industry to establish specific end-use bans consistent with the overall objectives of the ODS phaseout program;

- establish a licensing system for ODS users which encourages environmentally responsible handling practices and restricts distribution to users who qualify through approved programs;

- establish ODS import monitoring procedures which account for all ODS as required under the Montreal Protocol, and from which progress in reducing ODS consumption can be tracked to make appropriate adjustments in programs and policies;

- expedite implementation of activities directed at reduction of ODS use and adoption of substitute chemicals and technologies. All imported equipment and technologies relating to ODSs substitutes should be exempted from customs levies, duties, sales taxes, etc.;

- public awareness of the "ozone issue" should be enhanced through media attention for ODS reduction technologies;

- if require and when appropriate, introduce a levy on ODS to level which will provide a stimulus for:

  - the substitution of CFC-11 by HCFC-22 in new central air conditioning plants;

  - the use of only 50 per cent of the current amount of CFC-11 in blowing rigid polyurethane foams (for those that haven't implemented the change); and

  - the use of methylene chloride or other agents in the manufacture of flexible and rigid polyurethane foams.

- If required and when appropriate, introduce a levy on CFC-12 to increase its cif price to the prevailing cif price of HFC-134a to promote the use of alternative refrigerants in new equipment and to provide an incentive for recycling CFC-12 for recharge; and

- a further increase in the tax on CFC-11 to provide a stimulus to introduce a completely new blowing agent for rigid polyurethane foams.

Separate bans could then be introduced for use of ODS in each application:

- new central air conditioning units;

- polyurethane foams, excluding refrigerator insulation;

- CFC refrigerants in new refrigerators and air conditioners;

- electronics cleaning;

- refrigerator insulation foams; and

- fire extinguishers.

The proposed strategy would allow for the continuing import of CFC for recharging purposes until 2010.

VIII. ACTION PLAN FOR THE IMPLEMENTATION OF PHASEOUT

The Action Plan defines the specific actions, policies and institutional responsibilities towards supporting project activities by the Government of Jordan to achieve complete and optimum phaseout of ODS use within the time constraints imposed by the Montreal Protocol.

Plan Development

The objective of the Action Plan is to effectively, efficiently and as fairly as possible phaseout the consumption of ozone depleting substances in Jordan earlier than its obligations towards the Montreal Protocol.

The Action Plan comprises the investments, policies and implementation actions needed to ensure compliance. The principal agents are the Government of Jordan which is responsible for the specific policies, referred to here as "National Ozone Policy".

This action plan is consistent with the identified optimum phaseout timing and the principles for evaluating and financing net incremental costs for the ODS phaseout as detailed in the

"Indicative List of Categories of Incremental Costs" adopted by the Second Meeting of the Parties to the Montreal Protocol. In summary these are:

- cost-effective and efficient strategy;
- analysis which credits saving and avoids double accounting; and
- features early adoption of ozone protecting technologies.

The following section provides a summary of the Action Plan proposed for Jordan based on the optimum phaseout strategy. In this scenario, action is initiated in 1992 and the phaseout is completed by 2010.

Recommended Government Actions

The following is a summary of actions recommended for the various ministries and agencies with active roles in the implementation of an ODSs phaseout in accordance with the Montreal Protocol. These actions and their proposed timing are summarized in Table 8.1.

Management Action Plan

The Management action plan should include the establishment of a management unit for projects receiving assistance from the Multilateral Fund. It should also include the establishment of a monitoring unit for the phaseout program in order to implement the Action Plan.

Proposed Activities

The following activities are proposed as part of the Action Plan:

- training/demonstration workshops in commercial air-conditioning, domestic refrigeration and industrial refrigeration;
- training in the refrigeration industry. This is to introduce recovery/recycling in the servicing sector and the use of new technologies.

Proposed Investment Projects

- deodorization of LPG for use as aerosol propellant;
- retrofit of aerosol filling plants;
- phaseout of halon use;
- phaseout in the flexible foam sectors;
- phaseout in the rigid foam sector;
- phaseout in the refrigeration sector

Additional details on the proposed investment projects (prepared and concept) and other activities are provided in Annex A as they are prepared. Additional projects will be proposed and presented to the Multilateral Fund.

ACTION PLAN SUMMARY

ITEM	1993	1994-1995	1996-2010
Management and Monitoring System	• Establish a Project Implementation Unit (PIU) to manage and monitor ODS phaseout Projects. •Collect ODS import data (DOS).	•Continued operation of the PIU. • Develop system to record ODS import and consistent with GATT classification, Department of Customs. • Continue data collection (DOS).	• Continue operation of the PIU. • Continue data collection (DOS).
Public Awareness Campaign	Enhance public awareness: • Direct media attention to ODS problems and potential recycling programs.	Continue to develop support for public awareness campaign.	Continue to develop support for public awareness campaign.
Policy		Draft policy statement and necessary legislation: • Formally announce phaseout timetable to enable industry to plan accordingly.	Enforcement.
Levies and Bans		• If needed, establish levies on ODS. • Ban on use of CFC in new central air conditioning units. • Ban on use of CFC for the manufacture of flexible polyurethane foams (excluding refrigerator foams). • Increase restriction on use of Halons. • Ban use of Halons in applications where alternatives are available.	• Ban use of CFC in electronic cleaning. • Ban on use of CFC in rigid polyurethane foam comes into effect. • Ban on use of CFC refrigerants in new domestic refrigerants and new domestic refrige-rators and new mobile air condi-tioning. • Ban on all imports of virgin ODS comes into effect.
Projects	Initiate projects that will decrease the use of ODS.	Continue projects that will decrease the use of ODS.	Continue projects that will decrease the use of ODS.

MMRAE: Ministry of Municipal, Rural Affairs and Environment
DOS: Department of Statistics
CD: Customs Department
CDD: Civil Defense Department
MOP: Ministry of Planning
MOF: Ministry of Finance
COI: Chambers of Industry

Figure 2.1: ODS USE BY SECTOR IN JORDAN IN 1991
Total 625 tonnes

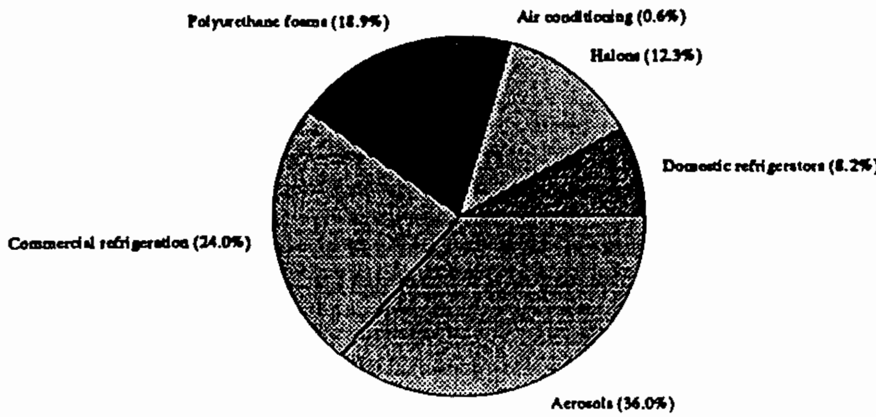


Figure 2.2: ODS USE BY SECTOR IN JORDAN IN 1991
Total 779 ODP tonnes

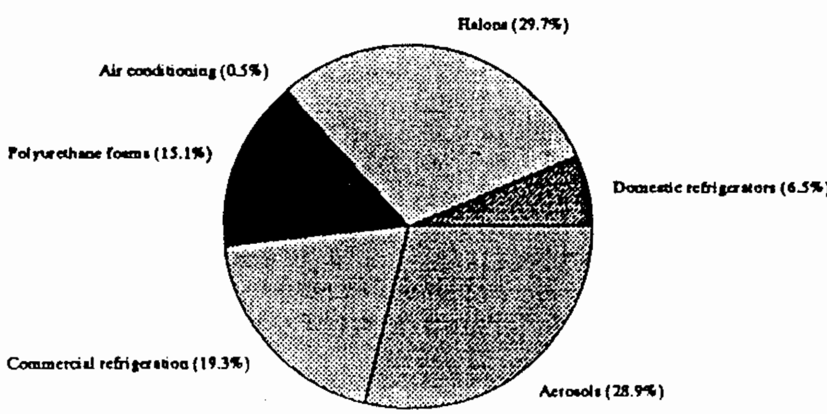


Figure 2.3: UNCONSTRAINED CFC USE FORECAST BY SECTOR IN JORDAN

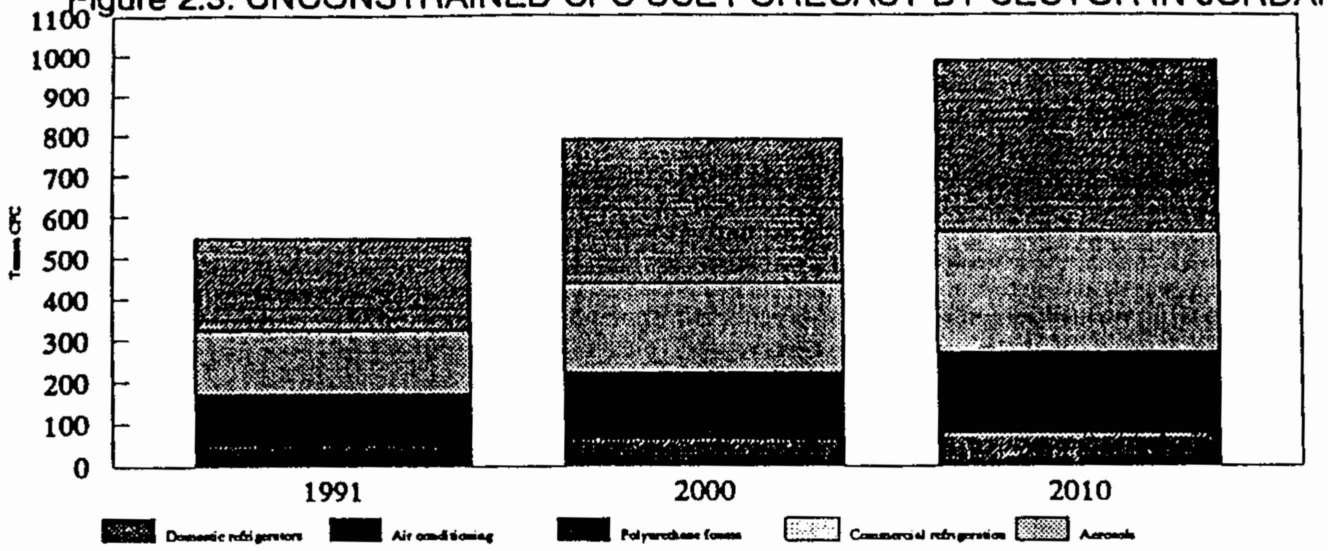


Figure 2.4: UNCONSTRAINED CFC DEMAND IN JORDAN

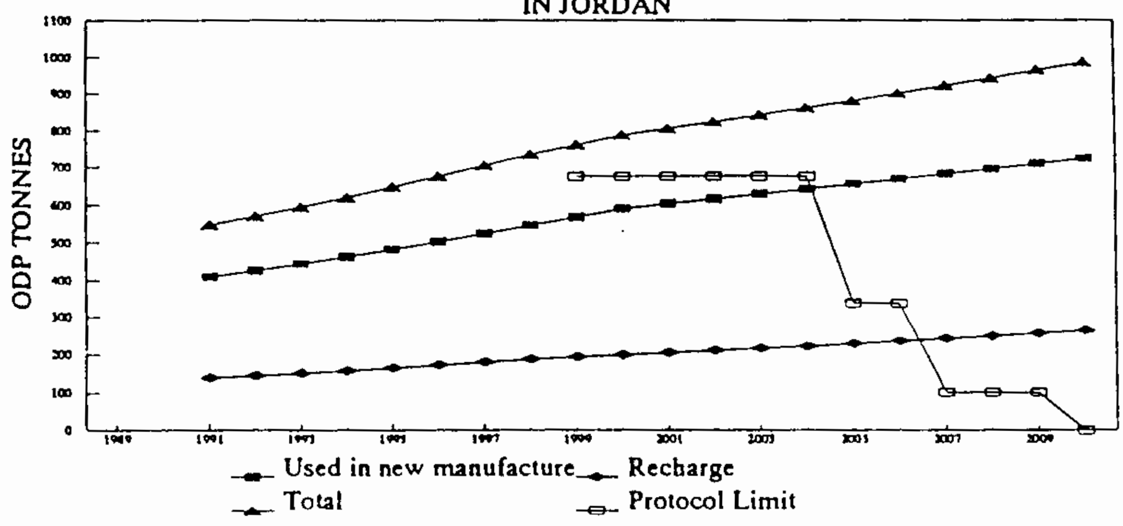
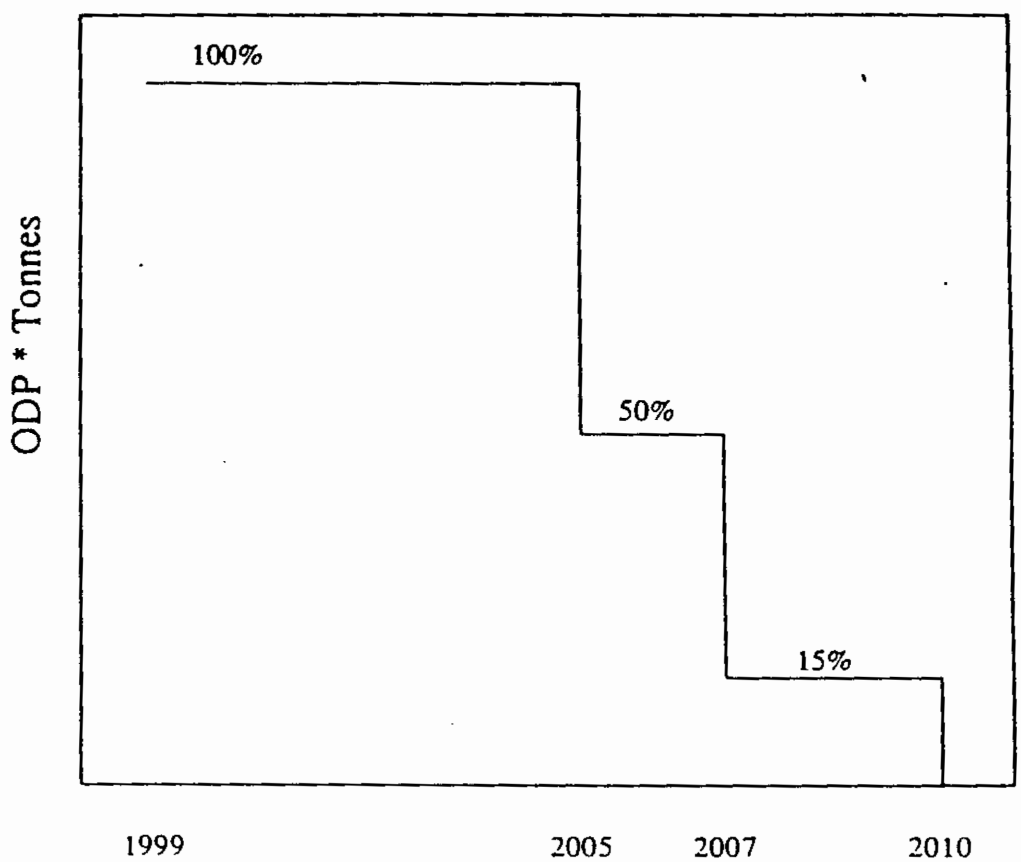


Figure 6.1
CFC PHASE-OUT PROFILE FOR ARTICLE 5 COUNTRIES
(as amended in June 1990)



Percentages are based on the lower of
average consumption in the years 1995 to 1997,
and 0.3 kilogrammes per capita

Figure 6.2: UNCONSTRAINED CFC DEMAND IN JORDAN

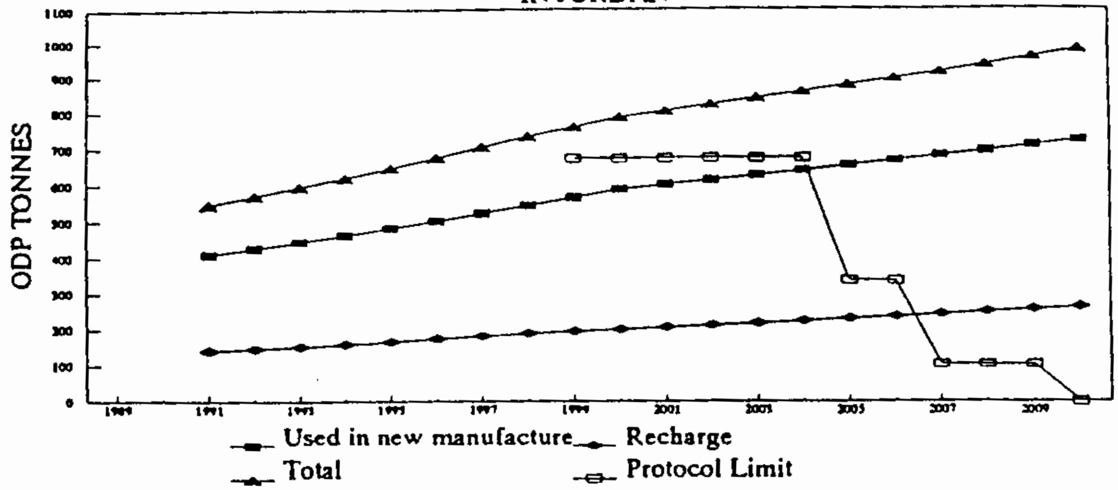


Figure 6.3: ACCELERATED PHASE-OUT OF CFCs IN JORDAN

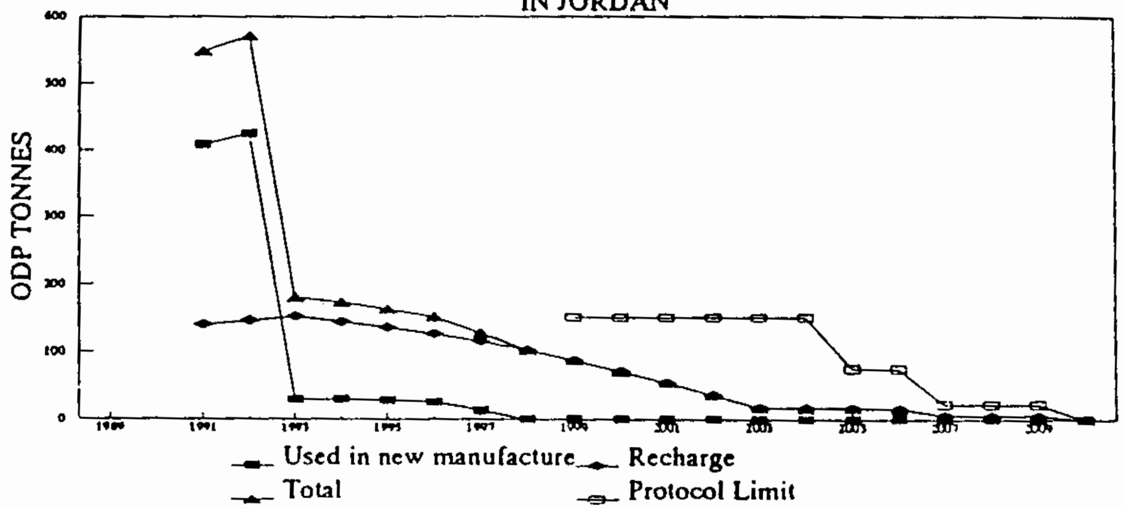
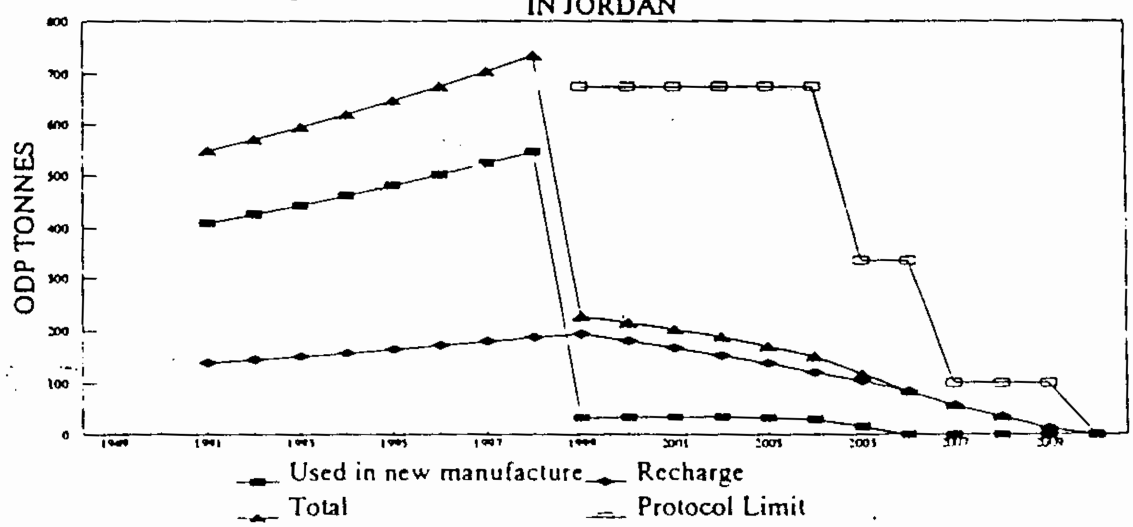


Figure 6.4: ALLOWED PHASE-OUT OF CFCs IN JORDAN



ANNEX A

ACTIVITIES, PROJECT PROPOSALS AND PROJECT CONCEPTS

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SUB PROJECT APPRAISAL REPORT

COUNTRY:	Hashemite Kingdom of Jordan
PROJECT TITLE:	Purification of LPG to manufacture hydrocarbon aerosol propellant (HAPs)
SECTOR COVERED:	Aerosols
ODS USE IN SECTOR:	225 tons CFC 12 (225 tons ODP - 28.8% of total ODP)
PROJECT IMPACT:	Facilitate the phase out of 225 tons per year of CFC 12 or mixtures of CFC 11/12 (225 tons ODP).
PROJECT DURATION:	31 months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	U.S. [$ 860,750]
PROPOSED OTF FINANCING:	U.S. [$ 860,750]
IMPLEMENTING ENTERPRISE:	Jordan Petroleum Refinery (JPR) Co. Ltd.
COORDINATING NATIONAL BODY:	Ozone Project Preparation & Implementation Unit (OPPIU)
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY:

This project will make available aerosol grade hydrocarbon (HC) propellants, so that the manufacturers of aerosols in Jordan can eliminate CFCs as propellants.

JPR is the only refinery in Jordan, ~~government owned~~ private company, and fortunately they have a high degree of technological knowhow. They are willing to purify the LPG to deliver pure propellant to Jordan's aerosol industry, even though the very low volume involved guarantees that they will lose money to do so.

JPR obtains their LPG from catalytic cracking, which means that this material is very high in olefins. The most common way of purifying LPG for use as aerosol propellants is with molecular sieves, but unfortunately this system does not remove olefins.

Some olefins have more natural odor than saturated hydrocarbons, and also they are very reactive, often destroying the perfumes used in aerosols. International standards for aerosol propellants limit olefins to 100 ppm.

Hydrogenation is a chemical process that converts unsaturated HC (olefins) into saturated HCs, and is the process that will be employed at JPR to produce HAPs.

PROJECT OBJECTIVES:

Phase out the use of 225 tons of CFC 12 or CFC 11/12 annually by supplying HAPs to the Jordanian aerosol industry.

SECTOR BACKGROUND:

Jordan imports all CFCs. Aerosols represented 36.0% of all ODS used in Jordan in 1991 (Jordan Country Program). There are 5 aerosol fillers that have been identified in Jordan, as follows:

COMPANY	CANS FILLED (YEARLY)
M. Haddad & Sons	1,000,000
Dajani International	500,000
Households & Toiletries	300,000
Arab Center for Pharmaceuticals	300,000
Jordan Antiseptics & Detergents	60,000
Total	2,160,000

Total CFC consumption (mainly CFC 12) in the aerosol sector in 1991 was 225 tons.

ENTERPRISE BACKGROUND:

Jordan Petroleum Refinery is a well established ~~government owned and operated~~ private company dedicated to refining basic petroleum products. Both the refinery plant and plant offices are housed in their own buildings in Zarka, Jordan.

JPR engineers are knowledgeable concerning the ozone depletion theory, and are aware that Jordan's aerosol industry must stop using CFC in the near future. They know that the HC propellant that comes out of their cracking unit at the moment is not acceptable for use in cosmetic or medicinal aerosols.

They can adjust the distillation process to produce the proper pressure of HC for use in aerosol, but it must be understood that this requires <u>that a petroleum refinery stop activities (this is normally a continuous process) until quality control indicates that the process controls have been so adjusted that the LPG being produced is of acceptable quality.</u>

Doing this 2,3, or 4 times a year is inherently a loosing proposition. For this reason, they are extremely reluctant to participate, and will do so only if the costs involved are covered by assistance from the OIF.

PROJECT DESCRIPTION:

Four major areas will be addressed by this project. First, sufficient storage must be available for unprocessed LPG (dirty gas) that JPR can change their refining process only 4 times a year maximum, and store feedstock for the following 3 months use.

Second, a very small hydrogenation unit (5 gallons per minute). This will be attached to a "heavies" separator, which will eliminate any C5 and C6 product that was not separated in distillation. Third, they must have a storage tank for processed HC (clean) where the HAPs is stored until it is approved by quality control.

Finally, a finished product storage tank connected to a dispatching area.

JUSTIFICATION FOR ALTERNATE TECHNOLOGY SELECTION:

Hydrocarbon aerosol propellants have been the principal alternatives to CFC 12 employed worldwide. They are approved by the 1991 UNEP Technical Options Report on Aerosols, Sterilants, and Miscellaneous Uses and Carbon Tetrachloride.

Jordan Petroleum Refinery currently produces a cut of liquefied hydrocarbon (80% butane, 20% propane) that is adequate for aerosols. JPR feedstock contains excessive quantities of olefins. All petroleum refineries use hydrogenation to remove undesirable olefins.

PROJECT COST:

The total project incremental cost of [$ 860,350] plus 10% contingency was calculated as the economic capital cost. Considering the benefit to Jordan's aerosol industry, JPR has been convinced to accept that incremental recurring costs and operational savings may be considered equal.

Capital Costs:

[$ 947,000] for the above specified equipment and training, plus 10% contingency

Recurring Costs/Savings:

Considering that to supply this product it will be necessary for JPR to interrupt normal operation of a rather large refinery, reoccurring costs must be truly sizable. It has been possible to convince JPR to accept that their costs are equal to the differential between the sale price of normal LPG and the sale price of HAPs.

LPG is subsidized (it is an important fuel for the general population) at Jordanian Dinars (JD) 160 per ton (U.S. $250). The HAPs that JPR will make will be sold at JD 600 per ton (U.S. $950. The difference, U.S. $700 per ton, multiplied by a probable use of 150 tons, indicates total direct savings of U.S. $105,000.00 per year.

Because of limited storage, this project is based on HAPs being produced 4 times a year. Quite possibly a realistic cost accounting of the indirect cost of stopping the production of a petroleum refinery 4 times a year would indicate reoccurring costs of several times the size of reoccurring savings.

Thus it was with considerable relief that the offer of JPR to consider savings and costs as equals was accepted.

UNIT ABATEMENT COSTS:

The calculated unit abatement costs for this project is [$0.685] per kilogram (see Annex #2).

IMPLEMENTATION:

Implementation should be possible in 18 months, although a formal period of 24 months is requested so as to have a reserve to properly debug the hydrogenation unit if any problems occur.

Task	Q1	Q2	Q3
Basic engineering	XXXXXX		
Obtain supplier quotations		XXXX	
Purchase all equipment and tanks & shipping of equipment			XXXXXXXXXXX

Task	Q4	Q5	Q6	Q7&8
Install Equipment and Tanks	XXXXXX			
Start up/Testing		X		
Initial production & debug of operation.			XX.	

PROCUREMENT:

The tanks, pumps and other general equipment are widely used in petroleum refining, and JPR undoubtable has numerous suppliers for them. Tank bases and piping must be done locally.

The hydrogenation unit is somewhat specialized, as are the molecular sieve towers for after processing. These supplier

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quotations should be extensively reviewed.

DISBURSEMENTS:

As negotiated with the suppliers.

REQUIRED REGULATORY ACTIONS:

No regulatory action can be taken at this time as HAPs are not available. Once JPR has made HAPs available, once all aerosol manufacturers have had an opportunity to convert, and once the technical expert contracted to do the training has certified that plant personnel are fully trained, the use of CFC in aerosols in Jordan should be prohibited.

RESULTS:

This project, in combination with sub projects for aerosol fillers, will result in the immediate reduction of 225,000 kilograms of CFC usage. If total aerosol packaging in Jordan grows as expected, the actual reduction will be greater.

ANNEX #1 Jordan Petroleum Refinery Purification of LPG to manufacture hydrocarbon aerosol propellant (HAPs) project costs:

The project costs are as follows:

1).	1 ea. 5 gal. per minute hydro-treating plant	* $ [250,000.00]
2).	1 ea. Heavies separator for above	[100,000.00]
3). **	5 ea. 20,000 gal storage tanks	200,000.00
4)	1 ea. Single tower molecular sieve	[20,000.00]
5).	3 pumps w/ "by-pass"	12,000.00
6)	Piping (lot)	1,000.00
7).	Bulkhead transfer assembly (lot)	4,000.00
8).	Laboratory equipment (lot)	20,000.00
9).	Fire protection system	5,500.00
10).	Gas detection system (lot)	10,000.00
11).	Transport trailer	60,000.00
12).	Engineering costs	50,000.00
13).	Start-up costs	50,000.00
	Sub Total	$782,500.00
14.	10 % Contingency	[78,250.00
	Total	[$860,750.00

* To be confirmed and adjusted later after receiving quotation.

** 3 TKs for untreated LPG (dirty LPG)
2 TKs for treated LPG.

ANNEX # 2 - UNIT ABATEMENT COSTS:

The unit abatement costs of the Households & Toiletries aerosol conversion project are calculated as follows:

Using the formula $A = \frac{C(F) + (OC-OS)}{W}$

where C = [$ 947,000]   OC = [$ 157,500]

(C)F = [$ 154,125]   OS = [$ 157,500]

W = 225,000

Doing the calculation, unit abatement cost = [$ 0.685]

ANNEX # 3 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

The substitute propellant, a mixture of butane and propane, does not damage the ozone layer. It does not contribute to acid rain, nor is it carcinogenic, mutagenic, or toxic. The butane/propane mix does not pollute the soil or ground water. This mixture is a volatile organic compound (voc) that contributes somewhat to ground level contamination. This mixture does have a global warming potential, albeit very low.

Hydrocarbons are extremely flammable, and explosive. The storage of the hydrocarbon propellants must be accomplished by strict adherence to the National Fire Protection pamphlet # 58 Standard for the Storage and Handling of Liquefied Gases.

The controlling concept for the proper handling of LPG is to minimize the risk of ignition to the vapor. Serious safety plans must be in place in the aerosol filling plant before beginning operations with this propellant.

SUB PROJECT APPRAISAL REPORT

COUNTRY:	Hashemite Kingdom of Jordan
PROJECT TITLE:	**International Foam Ind. Foam Conversion**
SECTOR COVERED:	Flexible Foam
ODS USE IN SECTOR:	118 tons CFC 11 (118 tons ODP - 15% of total ODP)
PROJECT IMPACT:	Phase out 18 tons per year of CFC 11 (18 tons ODP).
PROJECT DURATION:	9 months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	U.S. $100,000.
PROPOSED OTF FINANCING:	U.S. $100,000.
IMPLEMENTING ENTERPRISE:	International Foam Ind. Co.
COORDINATING NATIONAL BODY:	Ozone Project Preparation & Implementation Unit (OPPIU)
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY:

This project will support the conversion of flexible foam production operation at International Foam Ind. Co. from CFC 11 to methylene chloride (MeCl).

This company has one Laader Berg Ltd. A.s. (Norway)foam blowing machine, and uses 18 tons per year of CFC 11. They make all densities of polyurethane foam, but say that due to low cost 80% of their production is low density foam which requires CFC as a supplemental blowing agent.

They have studied what is required to change their machine to operate with MeCl, and have received the equipment supplier quotation. This project will provide necessary equipment retro-fits, and technical assistance for proper conversion to 100 % MeCl.

PROJECT OBJECTIVES:

Phase out the use of 18 tons of CFC 11 annually by modifying International Foam's Laader Berg machine for use with MeCl.

SECTOR BACKGROUND:

Jordan imports all CFCs. Within Jordan there are 5 large and some small companies using CFCs to manufacture polyurethane foam, as well as 3 manufacturers using CFC 11 to make rigid foam for the manufacture of refrigerators and one company using CFCs to produce rigid foam as insulation. Total use of CFC 11 in the foam sector in Jordan was 118 tons in 1991, which represents 18.9% of total ODS usage; or 15.1% of ODP usage.

The largest selling CFC blown foam products made in Jordan are low density (and low cost) mattresses. Experience has shown in many developed and developing countries around the world that this product can be made satisfactorily using MeCl as a blowing agent.

ENTERPRISE BACKGROUND:

International Foam is a well established company founded in 1969 to produce polyurethane foam, which uses about 18,000 kilograms of CFC 11 yearly in its operations, and is one of the five principal producers of flexible foam in Jordan. They are 100% Jordanian owned.

Their installed capacity is 15 tons of foam per hour. It is estimated that they currently have about a 13-18% share of the market in Jordan. Their machine is 1986 model, the most modern in Jordan.

PROJECT DESCRIPTION:

This project will purchase a new fallplate and trough, as well as other change parts to retrofit their Laader Berg machine for use with methylene chloride.

International has supplied an equipment list (see annex) and the cost of these materials has been established. Once equipment is purchased and arrives, it can be installed by International's personnel in about 15 days. Delivery time on the parts may be considered to be 90 days, so that the entire project can be completed in 105 days.

The required equipment list includes a substantial increase in plant ventilation, which is adequate to address safety requirements. No training components are required. Limited technical assistance is budgeted to help this technologically sound company master production with MeCl.

JUSTIFICATION FOR ALTERNATE TECHNOLOGY SELECTION:

No known drop-in substitute exists for CFC 11 in flexible foam applications. The <u>1991 UNEP Technical Options Committee Report on Flexible and Rigid Foams</u> (page ES 5) clearly indicates that methylene chloride is an immediate acceptable alternative material for flexible foams.

Further (page III-41), "In the U.S., approximately 70 per-cent of the auxiliary blowing agent currently being used is methylene chloride" and " Methylene Chloride can technically eliminate between 80 and 100 per cent of CFC 11 usage in flexible foam slabstock production".

PROJECT COST:

The total project incremental cost of $91,000 plus 10% contingency was calculated as the economic capital cost. It is estimated that the incremental recurring costs and operational savings for this project are about equal.

Capital Costs:

$91,000 for equipment to retrofit operations for use with MeCl and technical assistance, plus 10% contingency.

Recurring Costs/Savings:

The project will result in operational savings as the CFC-11 substitute material is about U.S. $0.30 cheaper per kilogram. However, this savings will be offset by increased scrap and maintenance as the production volume is low and the plant only runs occasionally (instead of continuous operation).

UNIT ABATEMENT COSTS:

The calculated unit abatement costs for this project is $0.90 per kilogram (see Annex #2).

IMPLEMENTATION:

This is a very simple project to implement, as it can be completed in 3 phases:

Task	Q1	Q2	Q3
Purchase change parts	XXXX		
Install change parts		XXXX	
Technical assistance visit and start up			XXXX

PROCUREMENT:

Spare parts must necessarily be purchased from the Laader Berg company or from a factory distributor. The technical assistance person selected must be fully knowledgeable about MeCl foam blowing, and capable of assisting International in producing high quality 15 kg/cubic meter density foam with MeCl.

DISBURSEMENTS:

As negotiated with the spare parts supplier. Normal terms are cash or irrevocable letter of credit in advance.

REQUIRED REGULATORY ACTIONS:

Once all foam manufacturers have had an opportunity to convert, and once the technical expert has demonstrated that MeCl blown foam is of an equivalent quality to CFC 11 blown foam, the use of CFC in foam blowing in Jordan should be prohibited.

RESULTS:

This project will result in the immediate reduction of 18,000 kilograms of CFC 11 usage in the first year. If this company's volume grows as expected, the actual reduction will be greater.

ANNEX #1 INTERNATIONAL FOAM IND. FOAM CONVERSION PROJECT COSTS:

The project costs are as follows:

1).	1 ea.	Fallplate and trough	U.S. $ 65,000.
2).		Other spare parts (lot)	6,000.
3).		Local modification of plant ventilation	10,000.
		Sub total equipment	81,000.
4).		Technical assistance	10,000.
		Sub Total	91,000.
5).		10 % Contingency	9,000.
		Total	$100,000.

ANNEX # 2 - UNIT ABATEMENT COSTS:

The unit abatement costs of the International Foam Ind. Foam Conversion project are calculated as follows:

Using the formula $A = \frac{C(F) + (OC-OS)}{W}$

where C = \$100,000. OC = \$ 5,400.

(C)F = \$ 16,275 OS = \$ 5,400.

W = 18,000

Doing the calculation, unit abatement cost = \$ 0.90

ANNEX # 3 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

To quote the 1991 UNEP Technical Options Committee Report on Flexible and Rigid Foams once again (page III-42), "The ozone depletion potential for methylene chloride is negligible because it has a very short atmospheric lifetime. The contribution of methylene chloride to acid rain is insignificant and it has negligible smog and global warming potentials."

The report further states "Short term health effects from repeated inhalation of excessive amounts of methylene chloride vapour include anaesthesia, possible organ injury or death. Permissible 8 hour exposure levels vary from country to country; the current range is 50-500 ppm, and, in general, regulation of methylene chloride exposure is becoming more stringent."

Also, "Therefore, worker exposures must be well controlled. This may require substantial capital investment in ventilation systems and materials handling equipment. In many countries, automatic block handling in the foam curing and initial storage areas means employee access does not occur."

Thus it is clear that while there is little or no environmental impact per se, great care must be taken to assure that safety requirements are properly considered.

ANNEX #4 SUB PROJECT APPRAISAL REPORT ( )

COUNTRY:	Hashemite Kingdom of Jordan
PROJECT TITLE:	**Kolaghassi Flexible Foam Conversion**
SECTOR COVERED:	Flexible Foam
ODS USE IN SECTOR:	118 tons CFC 11 (118 tons ODP - 15% of total ODP)
PROJECT IMPACT:	Phase out 20 tons per year of CFC 11 (20 tons ODP).
PROJECT DURATION:	9 months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	U.S. $141,900.
PROPOSED OTF FINANCING:	U.S. $141,900.
IMPLEMENTING ENTERPRISE:	Kolaghassi Foam & Mattress Factory Co.
COORDINATING NATIONAL BODY:	Ozone Project Preparation & Implementation Unit (OPPIU)
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY:

This project will support the conversion of flexible foam production operation at Kolaghassi Foam and Mattress Factory from CFC 11 to methylene chloride (MeCl).

This company has one Viking 2 meter wide machine, and uses 20 tons per year of CFC 11. They make all densities from 15 to 60 kilograms per square centimeter, but say that due to low cost the most popular densities are 15 and 18, which require CFC as a supplemental blowing agent.

They have tested foam production with methylene chloride, but since they have not modified their machine they have extreme maintenance problems. Thus this project will provide necessary equipment retrofits, and technical assistance for proper conversion to 100 % MeCl.

PROJECT OBJECTIVES:

Phase out the use of 20 tons of CFC 11 annually by modifying Kolaghassi's Viking foam blowing machine for use with MeCl.

SECTOR BACKGROUND:

Jordan imports all CFCs. Within Jordan there are 5 large and some small companies using CFCs to manufacture polyurethane foam, as well as 3 manufacturers using CFC 11 to make rigid foam for the manufacture of refrigerators and one company using CFCs to produce rigid foam as insulation. Total use of CFC 11 in the foam sector in Jordan was 118 tons in 1991, which represents 18.9% of total ODS usage; or 15.1% of ODP usage.

The largest selling CFC blown foam products made in Jordan are low density (and low cost) mattresses. Experience has shown in many developed and developing countries around the world that this product can be made satisfactorily using MeCl as a blowing agent.

ENTERPRISE BACKGROUND:

Kolaghassi is a well established company that has been in the foam business for many years, uses about 20,000 kilograms of CFC 11 yearly in its operations, and is one of the five principal producers of flexible foam in Jordan. They are 100% Jordanian owned.

Their installed capacity is 15 tons of foam per hour. It is estimated that they currently have about a 15-20% share of the market in Jordan.

PROJECT DESCRIPTION:

This project will finance a new storage tank and the necessary change parts to retrofit their Viking machine for use with methylene chloride.

Viking has supplied an equipment list (see annex) and the cost of these materials has been established. Once equipment is purchased and arrives, it can be installed by Kolaghassi's personnel in about 15 days. Delivery time on the parts may be considered to be 90 days, so that the entire project can be completed in 105 days.

Ventilation is adequate to address safety requirements, and no training components are required. Limited technical assistance is budgeted to help this technologically sound company master production with MeCl.

JUSTIFICATION FOR ALTERNATE TECHNOLOGY SELECTION:

No known drop-in substitute exists for CFC 11 in flexible foam applications. The <u>1991 UNEP Technical Options Committee Report on Flexible and Rigid Foams</u> (page ES 5) clearly indicates that methylene chloride is an immediate acceptable alternative material for flexible foams.

Further (page III-41), "In the U.S., approximately 70 percent of the auxiliary blowing agent currently being used is methylene chloride" and " Methylene Chloride can technically eliminate between 80 and 100 per cent of CFC 11 usage in flexible foam slabstock production".

PROJECT COST:

The total project incremental cost of $130,000 plus 10% contingency was calculated as the economic capital cost. It is estimated that the incremental recurring costs and operational savings for this project are about equal.

Capital Costs:

$130,000 for equipment to retrofit operations for use with MeCl and technical assistance, plus 10% contingency.

Recurring Costs/Savings:

The project will result in operational savings as the CFC-11 substitute material is about U.S. $0.30 cheaper per kilogram. However, this savings will be offset by increased scrap and maintenance as the production volume is low and the plant only runs occasionally (instead of continuous operation).

UNIT ABATEMENT COSTS:

The calculated unit abatement costs for this project is $1.16 per kilogram (see Annex #2).

IMPLEMENTATION:

This is a very simple project to implement, as it can be completed in 3 phases:

Task	Q1	Q2	Q3
Purchase change parts	XXXX		
Install change parts		XXXX	
Technical assistance visit and start up			XXXX

PROCUREMENT:

Spare parts must necessarily be purchased from the manufacturer of the Viking machine or from a factory distributor. The technical assistance person selected must be fully knowledgeable about MeCl foam blowing, and capable of assisting Kolaghassi in producing high quality 15 kg/cubic meter density foam with MeCl.

DISBURSEMENTS:

As negotiated with the spare parts supplier. Normal terms are cash or irrevocable letter of credit in advance.

REQUIRED REGULATORY ACTIONS:

Once all foam manufacturers have had an opportunity to convert, and once the technical expert has demonstrated that MeCl blown foam is of an equivalent quality to CFC 11 blown foam, the use of CFC in foam blowing in Jordan should be prohibited.

RESULTS:

This project will result in the immediate reduction of 20,000 kilograms of CFC 11 usage in the first year. If this company's volume grows as expected, the actual reduction will be greater.

ANNEX #1 KOLAGHASSI FLEXIBLE FOAM CONVERSION PROJECT COSTS:

The project costs are as follows:

1).	1 ea.	HCl resistant tank (2 cubic meters) complete with valves, cooling system, and gauges.	U.S. $ 40,000.
2).		Teflon piping and connections (lot)	3,000.
3).	1 ea.	Metering pump w/HCl resistant teflon seals	15,000.
4).	1 set	Mixing head complete w/seals and valves	19,000.
5).		Teflon type flowmeters	12,000.
6).		Ventilation improvements (lot)	30,000.
		Sub total equipment	119,000.
7).		Technical assistance in MeCl foam blowing	10,000.
			129,000.
8).		10 % Contingency	12,900.
		Total	$141,900

ANNEX # 2 - UNIT ABATEMENT COSTS:

The unit abatement costs of the Kolaghassi Flexible Foam Conversion project are calculated as follows:

Using the formula $A = \frac{\underline{C(F) + (OC-OS)}}{W}$

where C = $143,000.   OC = $ 6,000.

(C)F = $ 23,273   OS = $ 6,000.

W = 20,000

Doing the calculation, unit abatement cost = $ 1.16

ANNEX # 3 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

To quote the 1991 UNEP Technical Options Committee Report on Flexible and Rigid Foams once again (page III-42), "The ozone depletion potential for methylene chloride is negligible because it has a very short atmospheric lifetime. The contribution of methylene chloride to acid rain is insignificant and it has negligible smog and global warming potentials."

The report further states "Short term health effects from repeated inhalation of excessive amounts of methylene chloride vapour include anaesthesia, possible organ injury or death. Permissible 8 hour exposure levels vary from country to country; the current range is 50-500 ppm, and, in general, regulation of methylene chloride exposure is becoming more stringent."

Also, "Therefore, worker exposures must be well controlled. This may require substantial capital investment in ventilation systems and materials handling equipment. In many countries, automatic block handling in the foam curing and initial storage areas means employee access does not occur."

Thus it is clear that while there is little or no environmental impact per se, great care must be taken to assure that safety requirements are properly considered.

ARAB CENTER FOR PHARMACEUTICALS AND CHEMICALS

SUB PROJECT APPRAISAL REPORT

COUNTRY:	Hashemite Kingdom of Jordan
PROJECT TITLE:	**Arab Pharmaceuticals Aerosol Conversion**
SECTOR COVERED:	Aerosols
ODS USE IN SECTOR:	225 tons CFC 12 (225 tons ODP - 28.8% of total ODP)
PROJECT IMPACT:	Phase out 27 tons per year of CFC 12 or mixtures of CFC 11/12 (85 tons ODP).
PROJECT DURATION:	12 months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	U.S. [$ 279157]
PROPOSED OTF FINANCING:	U.S. [$ 279157]
IMPLEMENTING ENTERPRISE:	*ARAB CENTER FOR PHARMACEUTICALS AND CHEMICALS*
COORDINATING NATIONAL BODY:	Ozone Project Preparation & Implementation Unit (OPPIU)
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY:

This project will convert the Arab Pharmaceutical & Chemicals aerosol filling plant to hydrocarbon (HC) propellants. They are the only manufacturers of medicinal aerosols in Jordan, and all of their products are topical sprays, which can be converted to hydrocarbon aerosol propellants (HAPs).

The Arab Pharmaceutical's plant is vertical, and they fill on the 2nd story, which is not adequate for filling hydrocarbon aerosol propellants (HAPs). They are fortunately building a new plant, and the area where they will construct the new plant has adequate space for filling aerosols, although not for large storage tanks for HAPs.

They have an old Pharmacol machine which is adequate to fill CFCs, but not adequate for hydrocarbons. This project includes a small aerosol filling line and an enclosed explosion proof filling room to allow Arab Pharmaceuticals to fill HAPs safely.

Also, safety training done by a foreign expert is definitely necessary.

PROJECT OBJECTIVES:

Phase out the use of 27 tons of CFC 12 or CFC 11/12 annually by completing the conversion process from CFCs to HAPs.

SECTOR BACKGROUND:

Jordan imports all CFCs. Aerosols represented 36.0% of all ODS used in Jordan in 1991 (Jordan Country Program). There are 5 aerosol fillers that have been identified in Jordan, as follows:

COMPANY	CANS FILLED (YEARLY)
M. Haddad & Sons	1,000,000
Dajani International	500,000
Households & Toiletries	300,000
Arab Center for Pharmaceuticals	300,000
Jordan Antiseptics & Detergents	60,000
Total	2,160,000

Total CFC consumption (mainly CFC 12) in the aerosol sector in 1991 was 225 tons.

ENTERPRISE BACKGROUND:

Arab Pharmaceuticals & Chemicals Company is a large, well established company active in many areas. Both the plant and general offices are housed in their own buildings in the Sahab Industrial City, Amman, Jordan. Capital is 100% Jordanian.

They are very aware that they must stop using CFC in the near future, but they have other alternatives (such as not in kind substitution) and will not commit the capital that converting would require at this time. Also, they know that the HC currently produced by Jordan Petroleum Refinery (JPR) is not acceptable for use in medicinal or cosmetic aerosols.

They would like to eliminate CFCs, and will participate in the conversion process if they can receive assistance from the OTF.

PROJECT DESCRIPTION:

Four major areas will be addressed by this project. First, they need a new filling line, pneumatic and explosion proof, with the gassing head separated from the product filling and gassing stations.

Second, they need a well ventilated explosion proof room for filling HAPs, with simple gas detecting equipment. Third, they need storage racks for 50 kilogram HAPs cylinders.

Last, they need intensive safety training by an experienced foreign expert.

JUSTIFICATION FOR ALTERNATE TECHNOLOGY SELECTION:

Hydrocarbon aerosol propellants have been the principal alternatives to CFC 12 employed worldwide. They are approved by the <u>1991 UNEP Technical Options Report on Aerosols, Sterilants, and Miscellaneous Uses and Carbon Tetrachloride.</u>

Jordan Petroleum Refinery currently produces a cut of liquefied hydrocarbon (80% butane, 20% propane) that is adequate for aerosols, if hydrogenation is employed to remove undesirable olefins. Another investment sub project is addressing this need with JPR.

PROJECT COST:

The total project incremental cost of [$ 162870] plus 10% contingency was calculated as the economic capital cost. It is estimated that the incremental recurring costs and operational savings for this project are about equal.

<u>Capital Costs:</u>

[$ 162870] for the above specified equipment and training, plus 10% contingency.

<u>Recurring Costs/Savings:</u>

The project will result in operational savings as the HC substitute material is about U.S. $0.20 cheaper per kilogram than the CFC 12 it replaces. However, this savings (which amounts to $3,000.00 per year on 300,000 units) will be offset by increased maintenance cost (spare parts plus down time) which good manufacturing safety requires with HC propellants.

UNIT ABATEMENT COSTS:

The calculated unit abatement costs for this project is [$ 1.68] per kilogram (see Annex #2).

IMPLEMENTATION:

This is a very simple project to implement, as it can be completed in 3 phases during 4 quarters:

Task	Q1	Q2	Q3	Q4
Purchase all equipment and tanks	XXXX			
Install equipment/tanks			XXXX	
Training visit				XXXX

PROCUREMENT:

Aerosol equipment may be purchased from many sources. See Annex #1 "Suppliers of Aerosol Equipment" for the four pre-approved and recommended sources.

The person contracted for training must be fully prepared concerning aerosol filling plant safety, and tank and piping installation. Experience with HC aerosol formulations or with the purification of HCs would be useful.

DISBURSEMENTS:

As negotiated with the suppliers.

REQUIRED REGULATORY ACTIONS:

Once all aerosol manufacturers have had an opportunity to convert, and once the technical expert contracted to do the training has certified that plant personnel are fully trained, the use of CFC in aerosols in Jordan should be prohibited.

RESULTS:

This project will result in the immediate reduction of 27,000 kilograms of CFC usage in the first year. If this company's volume grows as expected, the actual reduction will be greater.

ARAB CENTER FOR PHARMACEUTICALS
AND CHEMICALS

ANNEX #1 ARAB PHARMACEUTICALS CONVERSION PROJECT COSTS:

The project costs are as follows:

1). 1 ea. Pneumatic automatic aerosol filling line with 1 crimper, 1 vacuum crimper, and 1 300 cc. gasser mounted on a separate table. U.S. $ [65,160]

2). 1 ea. Return 1 by 3 mtr. conveyor "L" shaped [6,460]

3). 1 set Racks for 20 50kg. propellant bottles [4,675]

4). 1 ea. Explosion proof gassing room complete with ventilating system, blow out walls, explosion proof electric, and simple gas detection system [74,575]

	Sub total equipment	[150,870]
5). Plant safety training		12,000.
	Sub Total	[162,870]
6). 10 % Contingency		[16287]
	Total	[$ 179,157]

Construction Cost	*$ 100,000*
Total area	*150 m²*
30 m²	*500 JD/m*
120 m²	*200 JD/m*
Grand Total	*279157 USD.*

ANNEX # 2 - UNIT ABATEMENT COSTS:

The unit abatement costs of the Arab Pharmaceutical's aerosol conversion project are calculated as follows:

Using the formula $A = \frac{C(F) + (OC-OS)}{W}$

where C = [$ 279157] OC = [$ 3000]

(C)F = [$ 45432.8] OS = [$ 3000]

W = 27,000

Doing the calculation, unit abatement cost = [$ 1.68]

ANNEX # 3 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

The substitute propellant, a mixture of butane and propane, does not damage the ozone layer. It does not contribute to acid rain, nor is it carcinogenic, mutagenic, or toxic. The butane/propane mix does not pollute the soil or ground water. This mixture is a volatile organic compound (voc) that contributes somewhat to ground level contamination. This mixture does have a global warming potential, albeit very low.

Hydrocarbons are extremely flammable, and explosive. The storage of the hydrocarbon propellants must be accomplished by strict adherence to the National Fire Protection pamphlet # 58 Standard for the Storage and Handling of Liquefied Gases.

The controlling concept for the proper handling of LPG is to minimize the risk of ignition to the vapor. Serious safety plans must be in place in the aerosol filling plant before beginning operations with this propellant.

SUB PROJECT APPRAISAL REPORT

COUNTRY:	Hashemite Kingdom of Jordan
PROJECT TITLE:	**Households & Toiletries Aerosol Conversion**
SECTOR COVERED:	Aerosols
ODS USE IN SECTOR:	225 tons CFC 12 (225 tons ODP - 28.8% of total ODP)
PROJECT IMPACT:	Phase out 30 tons per year of CFC 12 (30 tons ODP).
PROJECT DURATION:	12 months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	U.S. $135,300.
PROPOSED OTF FINANCING:	U.S. $135,300.
IMPLEMENTING ENTERPRISE:	Households & Toiletries Manufacturing Company
COORDINATING NATIONAL BODY:	Ozone Project Preparation & Implementation Unit (OPPIU)
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY:

This project will complete the conversion to hydrocarbon (HC) propellants at this company. They have a new (1992 model) Terco automatic filling machine, completely explosion proof, that is installed in the industrial zone of Irbid. The gassing is done in a special room that is ventilated and which contains gas detection equipment.

They began working with HC propellants last year, but they have had many problems due to the poor quality of the propellant that they are receiving from Jordan Petroleum Refinery (JPR). JPR cannot better the quality of the gas until they have installed the hydrogenation system recommended by Dr. Harry B. Mc Cain in the preappraisal mission.

Because of the large investment that this company has already made (over U.S. $500,000.), they have no capital to complete necessary investments to use hydrocarbon aerosol propellants (HAPs). This project will install permanent storage tanks and improve fire protection to improve overall plant safety. Some quality control equipment is necessary, as well as training done by a foreign expert.

PROJECT OBJECTIVES:

Phase out the use of 30 tons of CFC 12 annually by completing the conversion process from CFC 12 to HAPs.

SECTOR BACKGROUND:

Jordan imports all CFCs. Aerosols represented 36.0% of all ODS used in Jordan in 1991 (Jordan Country Program). There are 5 aerosol fillers that have been identified in Jordan, as follows:

COMPANY	CANS FILLED (YEARLY)
M. Haddad & Sons	1,000,000
Dajani International	500,000
Households & Toiletries	300,000
Arab Center for Pharmaceuticals	300,000
Jordan Antiseptics & Detergents	60,000
Total	2,160,000

Total CFC consumption (mainly CFC 12) in the aerosol sector in 1991 was 225 tons.

ENTERPRISE BACKGROUND:

Households and Toiletries is part of a major industrial and commercial consortium, the Sukhtian Group. Capital is 100% Jordanian.

This company has the license to fill the "Bac" deodorant and "Taft" hair spray from Schwartzkopf of Germany. They also hope to bring out new products of their own, as well as contract packaging for other Jordanian Companies.

Their plant in Irbid is new, as has an installed capacity of over 5,000,000 units per annum. Total plant costs including building modifications were above U.S. $700,000, which indicates the determination that this group has to participate in the aerosol business.

PROJECT DESCRIPTION:

Three major areas will be addressed by this project. First, they are currently receiving HCs in 50 kilo portable tanks, which is inherently unsafe. JPR has indicated a willingness to ship the propellant in bulk if the company has storage for 20 tons, which is the capacity of the truck. The company has sufficient space to install permanent storage tanks for this quantity.

Second, they require some laboratory equipment for quality control of the HAPs. The CFCs are manufactured chemicals that are delivered with consistent characteristics lot after lot. The HAPs are purified refinery materials that have wide variations in their physical and chemical properties. They cannot use HAPs without a laboratory to control them.

Third, although the plant was built for HAPs, not all of the safety provisions were implemented, and this project will complete the safety requirements.

JUSTIFICATION FOR ALTERNATE TECHNOLOGY SELECTION:

Hydrocarbon aerosol propellants have been the principal alternatives to CFC 12 employed worldwide. They are approved by the <u>1991 UNEP Technical Options Report on Aerosols, Sterilants, and Miscellaneous Uses and Carbon Tetrachloride.</u>

Jordan Petroleum Refinery currently produces a cut of liquefied hydrocarbon (80% butane, 20% propane) that is adequate for aerosols if hydrogenation is employed to remove undesirable olefins. Another investment sub project is addressing this need with JPR.

PROJECT COST:

The total project incremental cost of $123,000. plus 10% contingency was calculated as the economic capital cost. It is estimated that the incremental recurring costs and operational savings for this project are about equal.

<u>Capital Costs:</u>

$123,000. for the above specified equipment and training, plus 10% contingency.

<u>Recurring Costs/Savings:</u>

The project will result in operational savings as the HC substitute material is about U.S. $0.20 cheaper per kilogram than the CFC 12 it replaces. However, this savings (which amounts to $6,000.00 per year on 300,000 units) will be offset by increased maintenance cost (spare parts plus down time) which good manufacturing safety requires with HC propellants.

UNIT ABATEMENT COSTS:

The calculated unit abatement costs for this project is $0.73 per kilogram (see Annex #2).

IMPLEMENTATION:

This is a very simple project to implement, as it can be completed in 3 phases during 4 quarters:

Task	Q1	Q2	Q3	Q4
Purchase tanks/lab equipment	XXXX			
Install tanks			XXXX	
Training visit				XXXX

PROCUREMENT:

Tanks may be purchased anywhere in the world, but it must be noted that Jordan has regulations concerning tank characteristics. The person contracted for training must be fully prepared concerning aerosol filling plant safety, and tank and piping installation. Experience with HC aerosol formulations or with the purification of HCs would be useful.

DISBURSEMENTS:

As negotiated with the suppliers.

REQUIRED REGULATORY ACTIONS:

Once all aerosol manufacturers have had an opportunity to convert, and once the technical expert contracted to do the training has certified that plant personnel are fully trained, the use of CFC in aerosols in Jordan should be prohibited.

RESULTS:

This project will result in the immediate reduction of 30,000 kilograms of CFC 12 usage in the first year. If this company's volume grows as expected, the actual reduction will be greater.

ANNEX #1 HOUSEHOLDS & TOILETRIES CONVERSION PROJECT COSTS:

The project costs are as follows:

1).	2 ea.	6,500 gal isotainer tanks	U.S. $ 76,000.
2).		Laboratory equipment (lot)	15,000.
3).		Additional safety equipment (lot)	5,000.
4).		Tank farm preparation (tank bases, fencing, etc.)	15,000.
		Sub total equipment	111,000.
5).	Plant safety training		12,000.
			123,000.
6).	10 % Contingency		12,300.
		Total	$135,300.

ANNEX # 2 - UNIT ABATEMENT COSTS:

The unit abatement costs of the Households & Toiletries aerosol conversion project are calculated as follows:

Using the formula $A = \frac{C(F) + (OC-OS)}{W}$

where C = \$135,300. OC = \$ 6,000.

(C)F = \$ 22,020 OS = \$ 6,000.

W = 30,000

Doing the calculation, unit abatement cost = \$ 0.73

The substitute propellant, a mixture of butane and propane, does not damage the ozone layer. It does not contribute to acid rain, nor is it carcinogenic, mutagenic, or toxic. The butane/propane mix does not pollute the soil or ground water. This mixture is a volatile organic compound (voc) that contributes somewhat to ground level contamination. This mixture does have a global warming potential, albeit very low.

Hydrocarbons are extremely flammable, and explosive. The storage of the hydrocarbon propellants must be accomplished by strict adherence to the National Fire Protection pamphlet # 58 Standard for the Storage and Handling of Liquefied Gases.

The controlling concept for the proper handling of LPG is to minimize the risk of ignition to the vapor. Serious safety plans must be in place in the aerosol filling plant before beginning operations with this propellant.

SUB PROJECT APPRAISAL REPORT

COUNTRY:	Hashemite Kingdom of Jordan
PROJECT TITLE:	**Haddad Aerosol Conversion**
SECTOR COVERED:	Aerosols
ODS USE IN SECTOR:	225 tons CFC 12 (225 tons ODP - 28.8% of total ODP)
PROJECT IMPACT:	Phase out 85 tons per year of CFC 12 or mixtures of CFC 11/12 (85 tons ODP).
PROJECT DURATION:	12 months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	U.S. [$ 337000]
PROPOSED OTF FINANCING:	U.S. [$ 337000]
IMPLEMENTING ENTERPRISE:	M. Haddad & Sons Company
COORDINATING NATIONAL BODY:	Ozone Project Preparation & Implementation Unit (OPPIU)
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY:

This project will convert the Haddad company aerosol filling plant to hydrocarbon (HC) propellants. They are the largest manufacturers of aerosols in Jordan, filling about 1,000,000 units per year of their own brand (Contessa) and contract filling (J.B.Williams). They account for almost 40% of the CFCs used in the aerosol sector in Jordan.

The Haddad plant is vertical, about 6 stories high; and absolutely is not adequate for filling hydrocarbon aerosol propellants (HAPs). They are fortunately building a new plant, and where the new plant is there is adequate space for filling aerosols, although possible not for large storage tanks for HAPs.

They have very old Coster and Pamasol equipment which is adequate to fill CFCs, but not adequate for hydrocarbons. This project includes a small aerosol filling line and an enclosed explosion proof filling room to allow Haddad to fill HAPs safely. Also, safety training done by a foreign expert is definitely necessary.

PROJECT OBJECTIVES:

Phase out the use of 85 tons of CFC 12 or CFC 11/12 annually by completing the conversion process from CFC to HAPs.

SECTOR BACKGROUND:

Jordan imports all CFCs. Aerosols represented 36.0% of all ODS used in Jordan in 1991 (Jordan Country Program). There are 5 aerosol fillers that have been identified in Jordan, as follows:

COMPANY	CANS FILLED (YEARLY)
M. Haddad & Sons	1,000,000
Dajani International	500,000
Households & Toiletries	300,000
Arab Center for Pharmaceuticals	300,000
Jordan Antiseptics & Detergents	60,000
Total	2,160,000

Total CFC consumption (mainly CFC 12) in the aerosol sector in 1991 was 225 tons.

ENTERPRISE BACKGROUND:

M. Haddad & Sons Company is a large, well established company active in many areas. Both the plant and general offices are housed in their own buildings in Zarka, Jordan. Capital is 100% Jordanian.

They are very aware that they must stop using CFC in the near future, but do not wish to commit the capital that converting would require. Also, they no that the HC currently produced by Jordan Petroleum Refinery (JPR) is not acceptable for use in cosmetic aerosols.

They were invited on a UNDP study mission to Egypt to learn more about how to fill HAPs, but this mission has not yet taken place. Still, they have enough knowledge about the conversion process to be willing to participate if they can receive assistance from the OTF.

PROJECT DESCRIPTION:

Four major areas will be addressed by this project. First, they need a new filling line, pneumatic and explosion proof, with the gassing head separated from the product filling and gassing stations.

Second, they need a well ventilated explosion proof room for filling HAPs, with simple gas detecting equipment. Third, they need storage racks for 50 kilogram HAPs cylinders.

Last, they need intensive safety training by an experienced foreign expert.

JUSTIFICATION FOR ALTERNATE TECHNOLOGY SELECTION:

Hydrocarbon aerosol propellants have been the principal alternatives to CFC 12 employed worldwide. They are approved by the 1991 UNEP Technical Options Report on Aerosols, Sterilants, and Miscellaneous Uses and Carbon Tetrachloride.

Jordan Petroleum Refinery currently produces a cut of liquefied hydrocarbon (80% butane, 20% propane) that is adequate for aerosols, if hydrogenation is employed to remove undesirable olefins. Another investment sub project is addressing this need with JPR.

PROJECT COST:

The total project incremental cost of[$ 337000] plus 10% contingency was calculated as the economic capital cost. It is estimated that the incremental recurring costs and operational savings for this project are about equal.

Capital Costs:

[$ 337 000] for the above specified equipment and training, plus 10% contingency.

Recurring Costs/Savings:

The project will result in operational savings as the HC substitute material is about U.S. $0.20 cheaper per kilogram than the CFC 12 it replaces. However, this savings (which amounts to $17,000.00 per year on 1,000,000 units) will be offset by increased maintenance cost (spare parts plus down time) which good manufacturing safety requires with HC propellants.

UNIT ABATEMENT COSTS:

The calculated unit abatement costs for this project is [$ 0.65] per kilogram (see Annex #2).

IMPLEMENTATION:

This is a very simple project to implement, as it can be completed in 3 phases during 4 quarters:

Task	Q1	Q2	Q3	Q4
Purchase all equipment and tanks	XXXX			
Install equipment/tanks			XXXX	
Training visit				XXXX

PROCUREMENT:

Aerosol equipment may be purchased from many sources. See Annex #1 "Suppliers of Aerosol Equipment" for the four pre-approved and recommended sources.

The person contracted for training must be fully prepared concerning aerosol filling plant safety, and tank and piping installation. Experience with HC aerosol formulations or with the purification of HCs would be useful.

DISBURSEMENTS:

As negotiated with the suppliers.

REQUIRED REGULATORY ACTIONS:

Once all aerosol manufacturers have had an opportunity to convert, and once the technical expert contracted to do the training has certified that plant personnel are fully trained, the use of CFC in aerosols in Jordan should be prohibited.

RESULTS:

This project will result in the immediate reduction of 85,000 kilograms of CFC usage in the first year. If this company's volume grows as expected, the actual reduction will be greater.

ANNEX #1 M. HADDAD & SONS CONVERSION PROJECT COSTS:

The project costs are as follows:

1). 1 ea. Pneumatic automatic aerosol filling line with 1 crimper, 1 vacuum crimper, and 1 300 cc. gasser mounted on a separate table. U.S. $	[65160]
2). 1 ea. Return 1 by 3 mtr. conveyor "L" shaped	[6460]
3). 1 set Racks for 20 50kg. propellant bottles	[11805]
4). 1 ea. Explosion proof gassing room complete with ventilating system, blow out walls, explosion proof electric, and simple gas detection system	[74575]
Sub total equipment	[158000]
5). Plant safety training	12,000.
Sun Total	[170000]
6). 10 % Contingency	[17000]
Total	[$ 187000]
7) Building + Laboratory equipment	150000
Total	337000

ANNEX # 2 - UNIT ABATEMENT COSTS:

The unit abatement costs of the Households & Toiletries aerosol conversion project are calculated as follows:

Using the formula $A = \frac{C(F) + (OC-OS)}{W}$

where C = [$ 337000]   OC = [$ 34000]

(C)F = [$ 54846.75]   OS = [$ 34000]

W = 85,000

Doing the calculation, unit abatement cost = [$ 0.65]

ANNEX # 3 ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

The substitute propellant, a mixture of butane and propane, does not damage the ozone layer. It does not contribute to acid rain, nor is it carcinogenic, mutagenic, or toxic. The butane/propane mix does not pollute the soil or ground water. This mixture is a volatile organic compound (voc) that contributes somewhat to ground level contamination. This mixture does have a global warming potential, albeit very low.

Hydrocarbons are extremely flammable, and explosive. The storage of the hydrocarbon propellants must be accomplished by strict adherence to the National Fire Protection pamphlet # 58 Standard for the Storage and Handling of Liquefied Gases.

The controlling concept for the proper handling of LPG is to minimize the risk of ignition to the vapor. Serious safety plans must be in place in the aerosol filling plant before beginning operations with this propellant.

ANNEX B

Technological Alternatives for ODS Phaseout

ANNEX B

ODS PHASE-OUT ALTERNATIVES

Refrigeration and Air Conditioning

B.1 Chlorofluorocarbon refrigerants were developed in the early 1930s. They provided a safe alternative to ammonia, sulfur dioxide and isobutane, which at the time were the cooling fluids commonly used in home refrigerators and air conditioners for public buildings. While other applications have resulted from CFC development, cooling applications grew most rapidly. Today, the fluorocarbon family of compounds account for nearly all cooling fluids used by the refrigeration and air conditioning industry in the vapor compression systems which have become the industry standard.

B.2 For satisfactory performance in the vapor compression common to most units, a refrigerant must not only have favorable thermophysical properties but also be non-flammable, basically non-toxic, and inert to materials of construction. Fluorocarbons have achieved their prominence because they posses the unique combination of properties which best satisfies these sometimes conflicting requirements.

B.3 Refrigeration systems using fluorocarbons as the cooling fluid are common in all sectors of modern society. The most common units are the domestic refrigerators and freezers found in nearly all developed countries' homes and in a growing number of households in developing countries. At retail stores, food display cases are refrigerated to extend shelf life and prevent spoilage. At the wholesale level, large warehouses and transport vehicles (trucks, trains, and ships) are refrigerated to expand the market areas for their products. Industrial plants use refrigeration to sustain desired operating conditions and to prevent loss of volatile substances. Finally, air conditioning utilizes fluorocarbon refrigerants to cool air in a variety of environments, including most mechanical forms of human transportation, in many homes and most modern office buildings and hotels. Air conditioning is particularly important in the hotter regions of the world.

Market Segmentation

B.4 Due to the wide range of applications for fluorocarbon refrigerants, the industry ordinarily segments users as follows:

By the type of device utilizing fluorocarbons

By the end-use served by the device

By the servicing of the device.

B.5 Within each segment there are usually only one or two fluorcarbons with physical properties best suited to the application. These fluorocarbons naturally serve most of the users within the segment.

Commonly Used CFCs for Refrigerators and Air Conditioners

<u>Refrigeration</u>	
<u>Commercial Units</u>	
Food Storage	CFC-12; R-502
Industrial Machines	CFC-12
Transport Units	CFC-12; R-502
<u>Home Refrig/Freezers</u>	CFC-12
<u>Vending Machines</u>	CFC-12
<u>Air Conditioning</u>	
Large Buildings	CFC-11; CFC-12; HCFC-22
Mobile Units	CFC-12
Room and Package Unit	HCFC-22
Heat Pumps	HCFC-22

<u>Alternatives to Chlorofluorocarbon Refrigerants</u>

B.6 There are several options for replacing CFCs in the vapor compression systems commonly used in refrigeration and air conditioning equipment. The Technical Options Report prepared in May 1989 under the auspices of the United Nations Environmental Programme identified the following options described below for replacement of CFC cooling fluids:

Use HFC-134a.

B.7 This appears to be one of the best long term alternative refrigerants. Most equipment manufactures have based their long term plans on using HFC-134a to replace CFC-12 in new refrigeration systems. Compression equipment must be redesigned to optimize energy efficiency. More importantly, the standard lubricant used in CFC-12 systems must be replaced with one which is compatible with HFC-134a. Such lubricants are commercially available but are significantly more costly the CFC-12 lubricants. Alternative lubricants are polyester and polyalkaneglycol (PAG) oils. The polyester oils are the most stable as well as the most expensive. They are the lubricant of choice for long-service equipment such as domestic refrigerators. PAGs are the lubricant of choice for automotive air conditioners which have an average service life of only 5-7 years in the developed world.

Replace CFC-11 with HCFC-123.

B.8 Low pressure water chiller systems used for air conditioning in most large office buildings, hotels, and similar structures commonly employ CFC-11 as the refrigerant. These systems form an integral part of each building structure and represent a major investment component. Replacing such systems is not feasible. Retrofitting existing water chiller units to use an alternative refrigerant such as HCFC-123 is the most developed option for eliminating CFC-11 use at this time. Field testing of such retrofits has been underway by major manufacturers for several years. The technology for accomplishing the retrofit is readily available. Equipment modifications include minor changes in elastomeric and motor components; however, system capacity is reduced by up to 10 percent. Toxicity testing of HCFC-123 must be completed before this technology can be widely applied. Preliminary tests have indicated that exposure of workers to HCFC-123 vapors must be limited. An interim ALV of 10 ppm has been set as a precautionary measure pending completion of the tests.

Use "drop-in" ternary blends.

B.9 A series of ternary fluorocarbon mixtures (HCFC-22; HFC-152a; HCFC-124), referred to as "blends", have been designed as "drop-in" replacements for CFC-12. The primary feature of these "blends" is that they simulate quite closely the thermodynamic properties of CFC-12. They are also compatible with the same lubricant as is used with CFC-12. The "blends" have the potential to satisfy the long-term service requirements for equipment, such as domestic refrigerators and auto air conditioners currently using CFC-12. "Blends" are also considered to have potential as an interim substitute for HFC-134a in cases where equipment designs are retrofit for "blends" rather than redesigned for HFC-134a.

B.10 From the perspective of a developing country with limited technological resources, the primary disadvantages of "blends" include the following items.

- Most "blends" are proprietary mixtures patented by DuPont and are therefore not available from multiple sources.

- "Blends" tend to lose one component more rapidly than the others. Hence, there is a composition and performance drift with time. Restoring the system to an original composition can require chemical analysis and special metering of components.

- The "blends" require two components which although available are in short supply on the world market (HCFC-124 and HFC-152a).

- Life testing of equipment retrofitted with "blends" is at a relatively early stage. Such testing must be satisfactorily completed prior to global acceptance of this technology.

B.11 On balance, the economic advantages of "blends" outweigh the disadvantages primarily because of the large installed base of equipment (e.g. refrigerators) which can complete their useful life without requiring CFC-12 for servicing. "Blends" would offset this potential economic cost.

B.12 The future for "blends" in developing countries is one of gradual growth commencing about 1995 as supplies of CFC-12 become scarce. Growth, however, will be constrained by supply of technology and materials from the United States.

Conserve available CFC resources.

B.13 Significant quantities of CFC-12 are wasted during servicing of defective refrigeration equipment. Some of the wastage is the result of diagnostic procedures which use CFC-12 as a test gas. Additional wastage occurs when improper recharging equipment is used by inexperienced service personnel. Proper service procedures for devices such as domestic refrigerators have the potential to reduce CFC-12 imports in some countries by over 50 percent. While conservation practices which reduce wastage of CFCs are cost effective, traditional CFC prices will need to increase significantly to support the required changes within the equipment service community.

Retrofit Existing Equipment for HCFC-22

B.14 Specialty equipment, such as water coolers, use small CFC-12 refrigerant units which can be replaced with similar HCFC-22 units. Equipment redesign efforts are small, while the HCFC-22 technology is well proven in devices such as window air conditioners. The obvious advantage for such redesign is that HCFC-22 has an ODP of only 0.05. The added cost of the HCFC-22 compression system, and the added cost of the redesign are disadvantages which will be overcome as supplies of CFC-12 become short, and prices for CFC-12 escalate.

Use Ammonia.

B.15 This option is only a viable consideration for new installations, as ammonia will not function in existing equipment. Ammonia has good thermodynamic properties and good heat and mass transfer properties and is the lowest-priced refrigerant available today. Under specific operating conditions it has a high coefficient of performance. Ammonia is toxic and flammable, characteristics which are important safety concerns when public exposure to leakage is possible.

B.16 Application of ammonia as a significant replacement for CFC-11 or CFC-12 refrigerant is unlikely.

<u>Recovery - Recycle - Reclamation of CFCs</u>

B.17 Opportunities to conserve existing supplies of CFC by recapturing and reusing CFCs from existing facilities exist primarily in the refrigerant sector. Refrigerants are usually contained in a sealed systems and are amenable to recapture during routine repair or maintenance. Flexible foams release their contained CFCs during the first few days following manufacture. Closed-cell rigid foams slowly release their CFCs over a period of several years. Aerosol products release their CFCs immediately upon use.

B.18 Refrigeration and air conditioning equipment (e.g. home refrigerators, auto air conditioners, etc.) require periodic repair or maintenance during which it is usually necessary to remove the CFC refrigerant before the appropriate service procedure can be performed. A common repair is to locate and seal a leak thru which CFC escaped. Another common repair is to replace of the hermetically sealed compressor-motor unit because the motor is burned-out. Both repairs require discharging any residual refrigerant in the system before commencing the mechanical phase of the repair procedure. Large commercial and industrial system users employ periodic preventative maintenance to protect their investments. A common component of maintenance procedures is replacement of used CFC refrigerant with virgin material to remove contaminants (water, air, degraded oils, metal particles) from the system. The used CFCs are often discharged to the atmosphere.

B.19 Different types of equipment use different refrigerants; they must not be mixed. A refrigeration device must not be recharged with a refrigerant other than that for which it was originally designed without consultation with the manufacturer of the original equipment.

B.20 Conservation of refrigerants used in existing facilities requires: 1) isolation of the refrigerant within the system; 2) coupling the system to an external container; 3) conveying the refrigerant from the system to the external container; 4) purification of the recovered refrigerant, and 5) recharging equipment with pure refrigerant. There are three terms which best define the various phases of these activities in the refrigeration and air conditioning sector - recovery, recycle, reclaim.

> **Recovery:** To remove refrigerant in any condition from a system and store it in an external container without testing or processing.
>
> **Recycle:** To purify refrigerant for reuse by oil separation, filtration, drying, and/or chemical treatment. This procedure is usually (but not necessarily) performed on a job site or in a service shop and the purified CFC is returned to the equipment from which it was originally recovered.
>
> **Reclaim:** To reprocess recovered refrigerant by distillation and other means so that it meets new product specifications. Reclamation is usually performed in a large scale centrally located facility with extensive analytical capabilities.

B.21 Recovery is the essential first step that must be taken before the refrigeration system is opened to the atmosphere. By definition the quantity of refrigerant recovered will not exceed its initial charge (e.g. 150-300 grams for a home refrigerator). Recovery of small quantities of refrigerant is possible but is generally not cost effective at current CFC prices. One system uses evacuated bags into which the refrigerant is vented. The bags are then sent to a central facility where their contents are pumped into a storage tank for reclamation.

B.22 To recycle refrigerants, specially designed machines are directly coupled to the refrigerant system charging line; refrigerant is processed through a variety of purification devices in the machine; the system is evacuated of all residual gases; virgin refrigerant is added to replace system losses, and the recycled refrigerant is returned to the system. The recycle procedure can be interrupted prior to the evacuation step in order to inspect or repair system defects.

B.23 The recycle procedure is particularly useful for large systems which are pre-equipped with the necessary valves and recovery tanks (e.g. large centrifugal chillers). Special recycle machines are available for minimizing refrigerant loss during periodic maintenance. Owners of large systems are often reluctant to use recycle procedures because they believe the risk of inadequate purification is excessive. In such instances, it is feasible to recover the used refrigerant for reclamation and reuse in other facilities.

B.24 Reclamation of used refrigerant is a complex task requiring precise identification of all materials being handled to avoid cross contamination with other refrigerants and/or acceptance of dangerous substances in combination with the refrigerants. Purification generally requires large distillation facilities similar to those used during CFC manufacture.

FOAMS

B.25 CFCs are used in the foam sector for processes which expand plastic materials to create insulation, cushioning, packaging products, floatation devices, and shoe soles. Foams compete with fiberglass, paper, polyester fiberfill, and natural fibers for application in end-products. CFCs are used as blowing agents because they have suitable volatility and low toxicity, are non-reactive and non-flammable, and are cost effective. When retained in the foam cell structure, their low thermal conductivity imparts excellent insulation characteristics to the foam. CFCs in combination with other agents are also used to decrease foam density and increase softness of flexible foams. CFCs cool the exothermic reaction in the production process and protect the product against overheating and burning.

Market Segmentation and Alternatives

B.26 The primary plastic types and their respective CFC blowing agents are:

Polyurethane	CFC-11
Polystyrene	CFC-12
Polyolefins	CFC-11/12/114
Phenolic	CFC-11/113

Polyurethane

B.27 Polyurethane foam is produced by in-situ catalytic polymerization of a polyol and a reactive isocyanate [toluene diisocyanate (TDI) or diisocyanate-diphenylmethane (MDI)] in the presence of a blowing agent (CFC-11, methylene chloride, or CO2). The specific ingredients used depend on the foam characteristics desired. Flame retardants are added to meet end user specifications. Since the process is catalytic, exothermic, and initiates at ambient conditions, ingredients are mixed in their proper proportions at the point of their introduction into the process.

B.28 Polyol/blowing agent/catalyst systems are frequently premixed by suppliers so that reaction can be initiated simply by adding the isocyanate. Premixing reduces the need for storage and mixing facilities at the user's plant and usually improves quality control. Large manufacturers, however, prefer to mix their ingredients on site.

B.29 Foam products are classified as:

Flexible--Open cell structure--flexible and elastic foams for cushioning in home and office furniture, bedding, carpet underlay, and car seats.

Semi-Rigid--Open cell structure--moderate elasticity for safety padding in vehicle interiors (instrument panels, arm rests, door panels, etc).

Rigid--Closed cell structure for acoustic and thermal insulation--panels in housing and for insulation of home refrigerators.

Integral Skin--Compact outer skin with a gradual change over to a fine cellular core; high rigidity and surface hardness, low weight--desks, windows, electronic parts, and shoe soles.

B.30 CFC-11 requirements vary with the type of foam being produced. As an ingredient, CFC-11 accounts for 10-30 percent of the finished foam weight. Methylene chloride can be used to replace CFC-11 in most flexible foam applications on an equimolar basis; however, methylene chloride toxicity (suspect carcinogen) is a concern which must be delt with in the process environment by use of protective equipment to avoid worker exposure to fumes released during foam formation.

B.31 Polyurethane foams can also be expanded by carbon dioxide (CO2) which is generated in-situ by a reaction between water and isocyanate. These so-called "water blown" foams are not as soft as "CFC blown" foams and must be specially formulated to achieve acceptable product quality. Partial water substitution for CFC-11 has been demonstrated to reduce CFC requirements without significant loss of performance in rigid foams.

B.32 Home refrigerators contain significant quantities of rigid foam which is formed in place at the point of manufacture to insulate the interior compartment and to add stability to the external shell. Refrigerator manufactures usually mix their ingredients on site. CFC-11 requirements have been reduced at several locations by up to 50 percent by employing a combination of "water blown" and CFC-11 expansion methods with special polyols.

B.33 HCFC-22 has shown promise as a direct replacement for CFC-11 without major formulation adjustment. Although HCFC-22 is a gas (boiling point -40.8C) at ambient conditions, its extremely good solubility in polyols and polyurethane systems allows it to be used with only minor equipment modifications. On a weight basis, approximately 60-65% of the amount of CFC-11 is needed to reach

CFC-11 equilibrium free rise densities thereby reducing net cost of manufacture. HCFC-22 blown foam cell structures tend to be somewhat finer and may require formulation adjustment to stabilize the foam. However, the finer structure improves insulation value and partially offsets the higher thermal conductivity of HCFC-22 as compared to CFC-11. There could be some tightening of HCFC-22 production given that it does not have an ODP of zero but of 0.5.

B.34 HCFC-123 (ODP=0.02) and HCFC-141b (ODP=0.15) are also potential blowing agents for polyurethane foams. HCFC-141b must be handled as a flammable liquid. HCFC-123 has been assigned a 100 ppm AEL (Acceptable Exposure Level) and will require special handling. Both materials are being extensively tested for toxicity as part of the Program for Alternative Fluorocarbon Toxicity Testing (PAFT), sponsored by major global fluorocarbon manufacturers. Scheduled dates for reporting results of the PAFT two-year chronic inhalation exposure tests are:

PAFT Reporting Dates - Two-Year Tests	
HCFC-123	mid-1992
HCFC-141b	mid-1993

B.35 Application of HCFC-123 and HCFC-141b as commercial blowing agents, even on a small scale, prior to completion of the PAFT tests is unlikely. Early tests have indicated a need to establish an ALV of 10 ppm as a precaution. Also, world capacity for production of these materials will be limited until it is clear that toxicity is acceptably low and that there will be sufficient demand and justification for the required capital investment.

B.36 In summary, it is technically possible to reduce CFC consumption in the polyurethane foam industry by at least 80 percent using a combination of process modifications and currently available blowing agent/polyol systems. Complete elimination of CFCs will require development of new blowing agent systems, probably HCFC-based, or changes in design of the end-products as new technologies (e.g. vacuum panels) emerge.

Polystyrene

B.37 There are two types of polystyrene foam: rigid boardstock for insulation, and rigid sheet for disposable food service and packaging products. Both types of foam are produced by an extrusion process in which CFC-12 is dispersed in molten polystyrene under high pressure. As the mixture leaves the extruder, the CFC-12 vaporizes and causes the plastic to expand uniformly. The high moisture resistance of polystyrene makes it practical and cost effective for applications where water is present. Since polystyrene is thermoplastic, sheets can be molded into special shapes for packaging foods, meats and eggs. These applications are of environmental concern because they contribute to solid waste and are not biodegradable.

B.38 HCFC-22, in combination with hydrocarbons, can be substituted for CFC-12 in the manufacture of most extruded polystyrene sheet products. HCFC-22 has FDA approval in the U.S. for food packaging, provided HCFC-22 concentration is <5ppm at the time of food contact. Other HCFCs and HFCs are being considered as CFC-12 replacements. All must await completion of toxicity tests and all will need special approval for use in contact with foods. In the mean time, natural products and plastic sheets can and will displace most applications for polystyrene sheet.

B.39 HFC-152a is gaining acceptance as a blowing agent for polystyrene in facilities equipped for handling flammable gases, such as propane.

Other Foams

B.40 Polyolefin foams account for only five percent of all foams and include products made from polyethylene and polypropylene resins which occasionally include other resins as modifiers. The process technology for polyolefins is essentially the same as that used for polystyrene except that the blowing agent is usually a mixture of CFC-114, CFC-12, and/or CFC-11. Specific properties of polyolefin foams meet the requirements for packaging of high value goods such as furniture and electronic devices where the package must be designed to provide a high degree of product protection. Substitute packaging materials and systems do not usually meet the high performance requirements of these products.

B.41 Hydrocarbons, and HCFC-22/HCFC-142b mixtures are used today to replace CFC-12 in polyolefin foam manufacture. Some process modification is necessary because of and CFC-12 are commonly used. Replacement with LPG and inert gases such as CO_2, N_2O and N_2 has been effective in most cases with the exception of medical applications. The special characteristics of CFCs have made them essential and irreplaceable in this application.

B.42 Closed cell phenolic foams are produced by the acid-catalyzed polymerization of a phenolic resin using CFC-11 and CFC-113 as the blowing agent. These foams serve a speciality market in high performance insulation and as such account for less than one percent of all foams. They offer better insulating value than other materials due to the low thermal conductivity of the CFCs which are fully retained within the foam for extended periods of time. They also have improved fire resistance, low smoke generation, and high temperature resistance. End-uses are for roofing insulation and other high-end applications in the construction industry. HCFC-123 and HCFC-141b appear to be suitable alternatives to the CFCs currently used; however, their higher thermal conductivities may require process refinements, and use is unlikely until toxicity issues are resolved..

AEROSOLS

B.43 Aerosol propellants are defined as volatile fluids capable of expelling active ingredients from a sealed container at or below 105 degrees Fahrenheit. Propellants such as CO_2 have been used for over 100 years to dispense sodas and other food products, but as CFC supplies became abundant in the 1950s and 1960s, their unique properties led to the rapid growth of a large aerosol industry. By 1974, aerosol propellant applications accounted for about three-fourths of the world CFC consumption. The market was saturated with a wide variety of aerosol products 50-60 percent of which used CFCs as a propellant.

The major applications were shaving creams, hair sprays, antiperspirant sprays, perfumes, insecticides and repellants, polishes, paints, oven cleaners, air fresheners, and laundry aids.

Alternative Propellants by Market Segment

B.44 For the purposes of this study, the market for CFC aerosol propellants was segmented into Cosmetics, Household Products, and Other Aerosol applications.

Cosmetics

B.45 Major applications of CFCs in cosmetics include hair sprays, antiperspirants, perfumes and colognes, skin care products, shaving creams, and other personal products. These applications account for 30-50 percent of all aerosol production in most countries. Active ingredients can vary widely. Propellants must meet special requirements of compatibility with all components in the system.

B.46 Propellants must be non-toxic, inert, odorless, and preferably non-flammable. CFC-12 and CFC-114 are commonly used in combination with various alcohols and water. Alternative non-CFC delivery systems such as pumps and sticks have satisfied half of the cosmetic market needs, but most consumers still prefer aerosols. Propellants such as deodorized liquid petroleum gas mixtures (LPG) are one CFC substitute but are often flammable during use. Dimethyl ether (DME) is also flammable but is used because of its compatibility with water based formulations. There is no universal alternative for cosmetic applications, as each has its own specific requirements and preferences.

Household Products

B.47 Household products account for approximately 30-40 percent of the demand for aerosol propellants. These products include laundry aids, furniture polishes and cleaners, oven cleaners, air fresheners, insecticides, and insect repellants. They usually compete with similar non-aerosol products but are preferred based on the performance of their delivery system. The most commonly used CFCs are CFC-11 and CFC-12. Replacement with LPG has been satisfactory. One company, Johnson Wax, converted all of their CFC aerosols to LPG propellant in 1975 and has had satisfactory performance opposite competitive products ever since.

Other Aerosols

B.48 Miscellaneous aerosol propellant applications account for the balance of demand and include paints, coatings and finishes, lubrication products, automotive products, speciality insulation systems, food products, and medicines. CFC-11 and CFC-12 are commonly used. Replacement with LPG and inert gases such as CO_2, N_2O and N_2 have been effective in most cases with the exception of medical applications, where the special characteristics of CFCs have made them essential and irreplaceable.

SOLVENTS

Background

B.49 The unique solvent characteristics of chlorinated hydrocarbons and fluorocarbons has led to a wide range of solvent applications where cleaning efficiency and product quality are enhanced significantly as a direct result of using the solvent.

B.50 Three industries rely on solvents for sustaining product integrity.

Electronics - where residues must be removed from components (electronic chips, circuit boards, etc.) without damaging the substrate or the primary parts.

Metal Parts Manufacture - where heavy residues of oils, greases , and cuttings must be effectively removed before assembly, painting, or packaging.

Dry Cleaning (clothing) - often included in the scope of the solvent business because of the large volume used, but not included in this study because ODSs are not ordinarily used as solvents.

B.51 Major ODS solvents classified as controlled substances under the Montreal Protocol are trichlorotrifluoroethane (CFC-113), Carbon Tetrachloride (CTC), and 1,1,1 trichloroethane (methyl chloroform).

CFC-113

B.52 This chlorofluorocarbon solvent has been the solvent of choice for high-end electronics applications and has participated strongly in the growth of the computer business during the 1980s. It is also preferred for the cleaning of precision parts, machine tools, and other metal components. In these applications, the solvents often contain about 2% CFC-11.

Carbon Tetrachloride

B.53 While CTC has been widely used in the past as a solvent for general cleaning, its toxic properties have mitigated against it use. Today, it is only used as a solvent where low-cost is the only consideration and there is no human exposure. Other applications for CTC are as the primary raw material for CFC-11/12 manufacture, and as an ingredient for certain pesticides and pharmaceuticals.

Methyl Chloroform

B.54 First used as a solvent to replace carbon tetrachloride in cold cleaning, methyl chloroform is now used for both cold cleaning and vapor degreasing and is highly effective whether used hot or cold and the method is dip, spray, wipe, flush or ultrasonic. Additives are frequently used to enhance corrosion protection and solvent stability.

<u>Alternative Solvents</u>

B.55 With few exceptions, the "ozone issue" and the Montreal Protocol restrictions have prompted solvent users to seek and apply alternative non-ODS solvents to their operations. These efforts have been largely successful without sacrificing cleaning effectiveness. The attention directed at solvent containment and reclamation has paid cost dividends. One measurable result of the transformation to non-ODS solvents has been an 80% reduction in CFC-113 use in the United States since 1986. Methyl chloroform has displaced some of the CFC-113; in time, these applications will move to 1,1,1 trichlorethylene. Every application usually has one or more options that can be adopted. These include use of terpenes, organic and alcohol-based solvents, and longer range HCFC solvent blends if toxicity testing is completed with satisfactory results. In other instances, process changes which eliminate the need for solvent cleaning (e.g. no clean fluxes) are proving satisfactory.

<u>HALONS</u>

B.56 Halons are used extensively as effective fire extinguishants in hand-held units (Halon 1211) and in central systems (Halon 1301). Commercial aircraft and modern military equipment (tanks, aircraft, and ships) have all adopted Halon systems for fire protection.

B.57 Except for Halon consumed in equipment testing or during a fire event, all Halon is still contained in its original container. Because of its effectiveness in extinguishing fires without damaging electronic or other equipment or without toxic or other impacts on humans, Halons are strongly preferred over other extinguishants. There are other obvious fire extinguishants that users can adopt in place of Halons (water, dry chemical, CO_2) at the expense of effectiveness. A chemical substitute with all of the unique properties of Halons has not been identified; however, by using alternatives in applications where use of Halons is non-essential, the reduction in the consumption will be appreciable.

ANNEX C

DETAILED PHASEOUT SCENARIOS BY USER SECTOR

This Annex sets out the assumed phase-out pattern in each user sector for the two scenarios:

- accelerated phase-out;
- allowed phase-out.

1. Accelerated Phase-Out by Sector

This section presents diagrams illustrating the most likely responses of each industry sector to market forces and reflects their current plans where these exist. It assumes supporting government phase-out measures to ensure that all sectors respond in this timeframe. The speed of changeover in each sector is constructed in line with industry estimates where available.

Domestic Refrigerators

Figure F.1 illustrates unconstrained demand projections, Figure F.2 illustrates the most likely phase-out profile for domestic refrigerator manufacturers. There are separate lines on each graph for:

- the CFC-11 used in the insulating foam;
- the CFC-12 used in new refrigerators;
- the CFC-12 required for recharge; and
- the resultant total CFC demand in the sector.

There are four significant steps in the phase-out graph:

- the introduction of water blowing (50 per cent less CFC-11) of the foam in 1993. This is already technically possible and in widespread use in Europe and the USA, although there are some cost penalties that are delaying its adoption in Jordan;
- the complete phase-out of CFC-11 in the foam over a period of 2 years (starting in 1997) as it is replaced by HCFC-22. The exact technicalities of this are not yet fully resolved;
- a phase-in of HFC-134a refrigerant to replace CFC-12 in new refrigerators over four years beginning in 1995. This is broadly in line with Jordanian manufacturers plans. It allows time for its full commercial introduction in Europe, expected in 1993;

- a curtailment of recharge with virgin CFCs from 2007, as constrained by the Protocol 15 per cent limit. [Caroline to check]

Commercial Refrigeration

The graphs in Figure F.4 and F.5 illustrate unconstrained and accelerated phaseout profiles. There is a gradual reduction in the demand for CFC-12 for recharge as the population of units using CFC-12 declines over time with the introduction of new units using alternative refrigerants.

Mobile Air Conditioning

In this sector, there is also a distinction between CFC-12 consumption for new units and for recharge demand, as shown in Figures F.7 and F.8. Use of CFC-12 in new units decreases over four years (starting in 1995) as HFC-134a is introduced. The first HFC-134a air conditioners have already been introduced by Mercedes into their top range cars. It is likely to take some time for this to spread to most mobile air conditioners.

The demand for CFC-12 for recharge is not met from 2007, as virgin CFC supply is constrained by the 15 per cent limit in the Protocol.

Polyurethane Foams

The graphs in Figures F.10 and F.11 illustrate unconstrained and accelerated ODS phaseout for both rigid and flexible foams (excluding refrigerator insulation).

For flexible foams, there is a single phase-out step in 1993 when production of the low density foam ceases.

The use of CFC-11 in rigid foams decreases with the introduction of water blowing (50 per cent less CFC-11) in 1993. As was mentioned in the case of refrigerator insulating foam, water blowing is already common. CFC-11 in the foam is phased out completely over a period of 2 years starting in 1997.

Aerosols

The phase-out of CFCs from aerosols is likely to proceed rapidly once an unstenched supply of LPG is secured. This assumed to happen in 1993, as illustrated in Figure F.15.

2. Allowed Phase-Out by Sector

The responses that might be expected from each industry sector if they take no action in advance of government phase-out measures are essentially the same as those described for the most likely scenario, but occuring later. These are illustrated in the following series of graphs.

DOMESTIC REFRIGERATORS

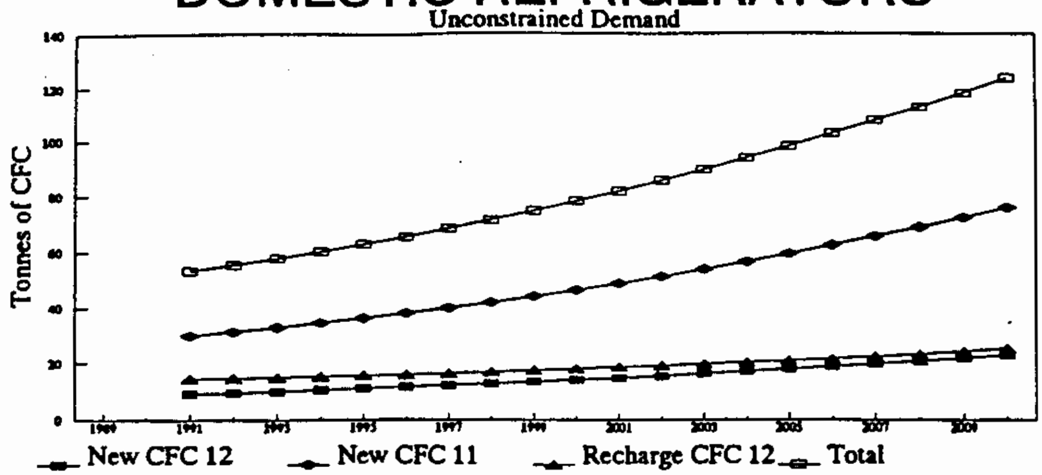

FIGURE F.1

DOMESTIC REFRIGERATORS

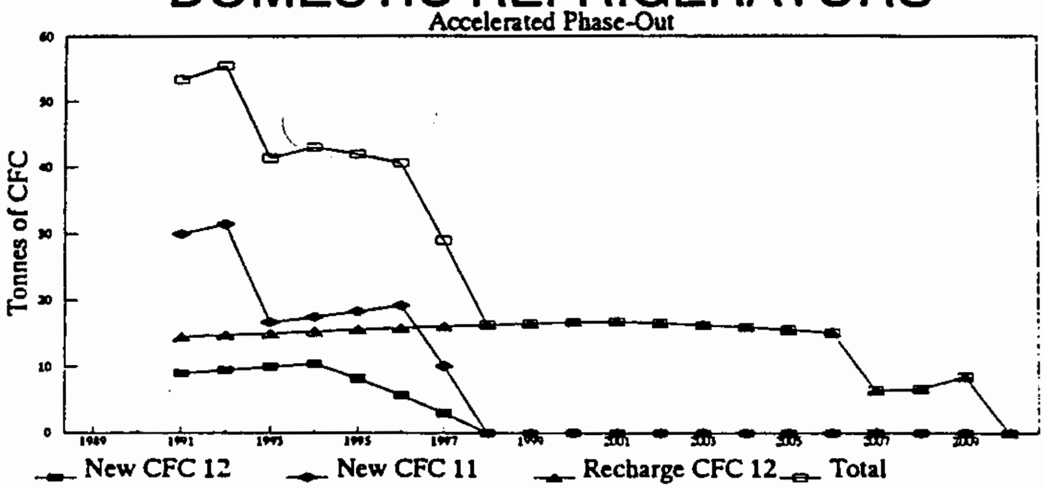

FIGURE F.2

DOMESTIC REFRIGERATORS

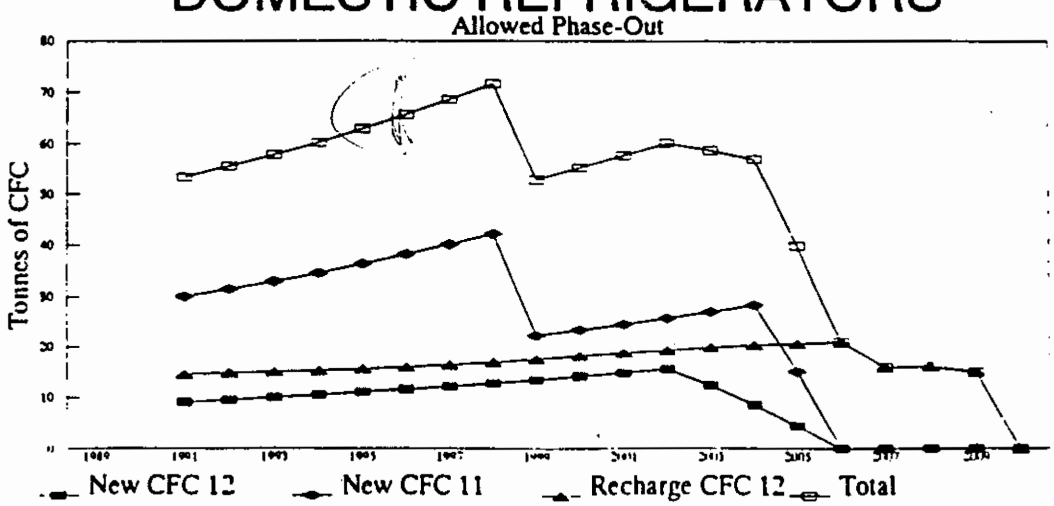

FIGURE F.3

COMMERCIAL REFRIGERATION
Unconstrained Demand

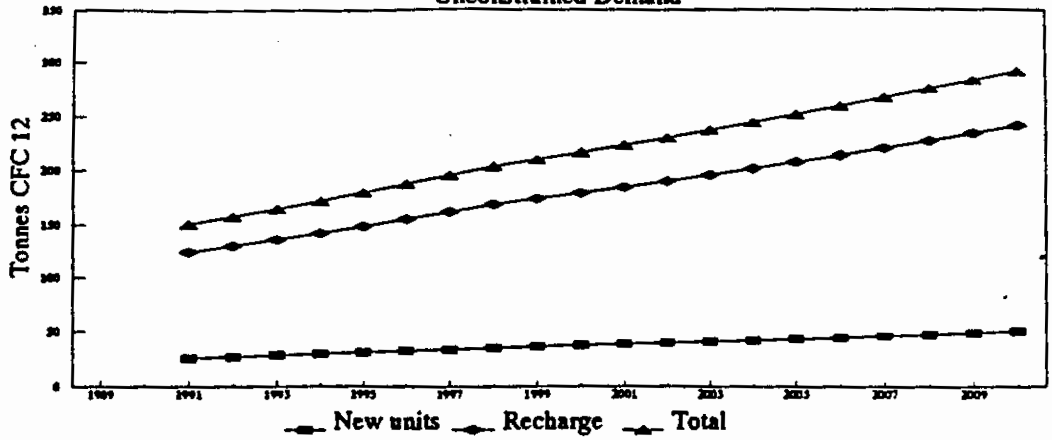

FIGURE F.4

COMMERCIAL REFRIGERATION
Accelerated Phase-Out

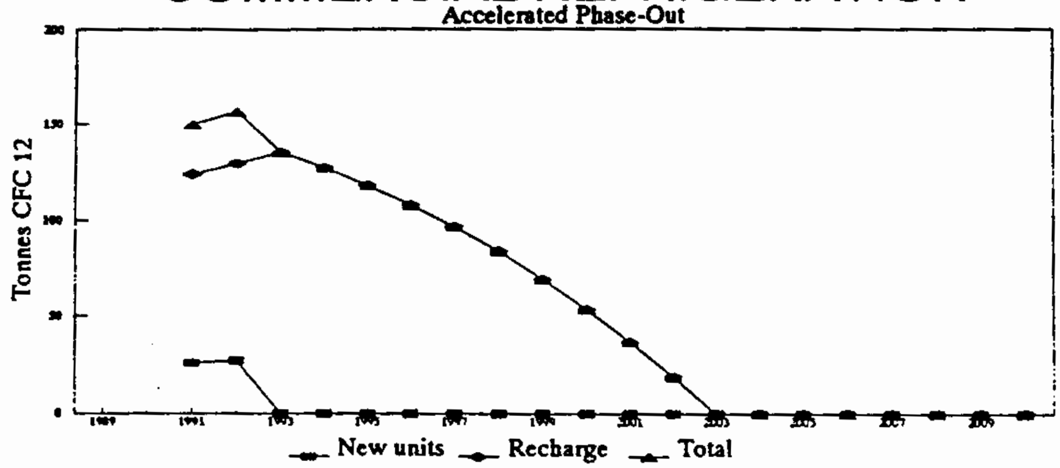

FIGURE F.5

COMMERCIAL REFRIGERATION
Allowed Phase-Out

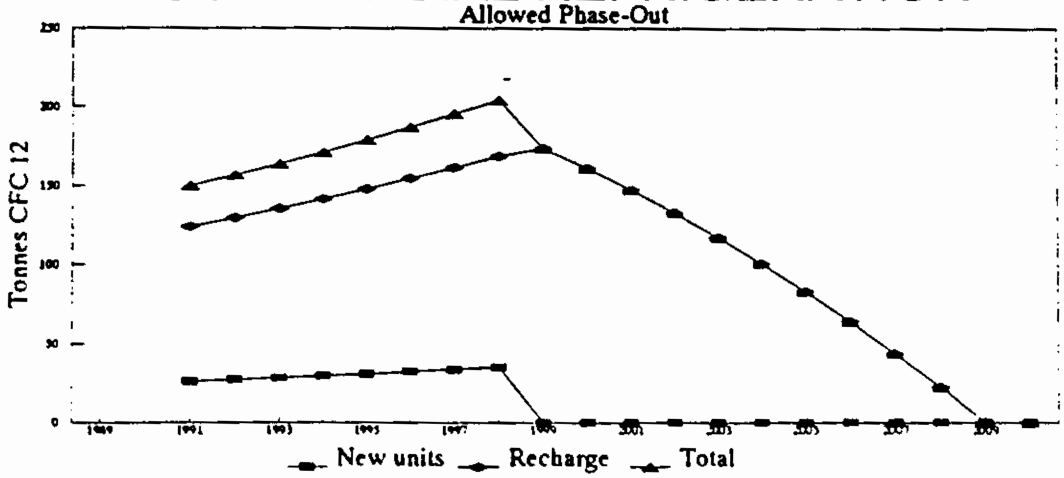

FIGURE F.6

MOBILE AIR CONDITIONERS
Unconstrained Demand

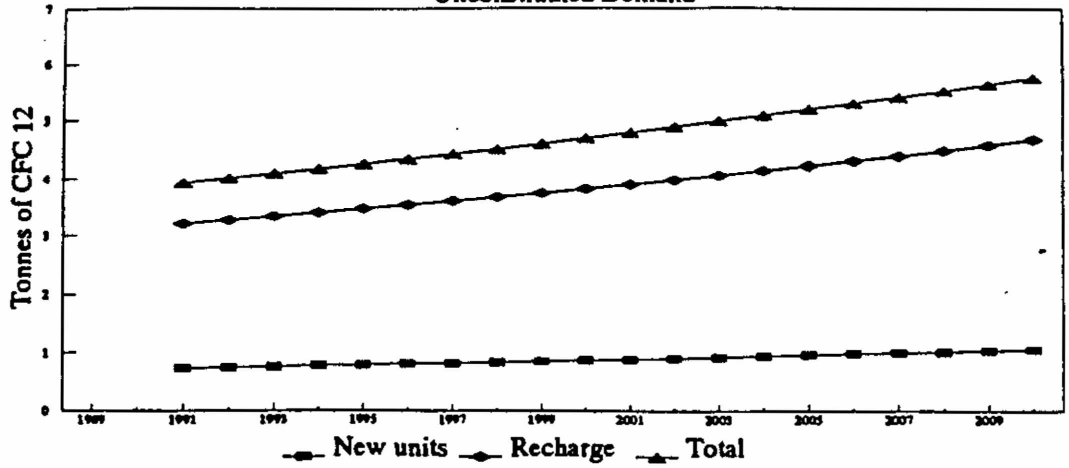

FIGURE F.7

MOBILE AIR CONDITIONERS
AcceleratedPhase-Out

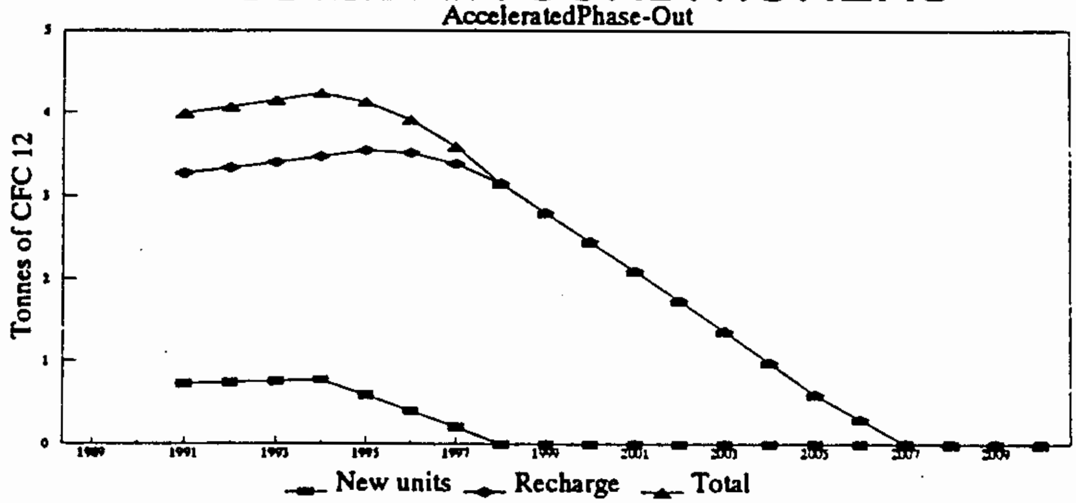

FIGURE F.8

MOBILE AIR CONDITIONERS
Allowed Phase-Out

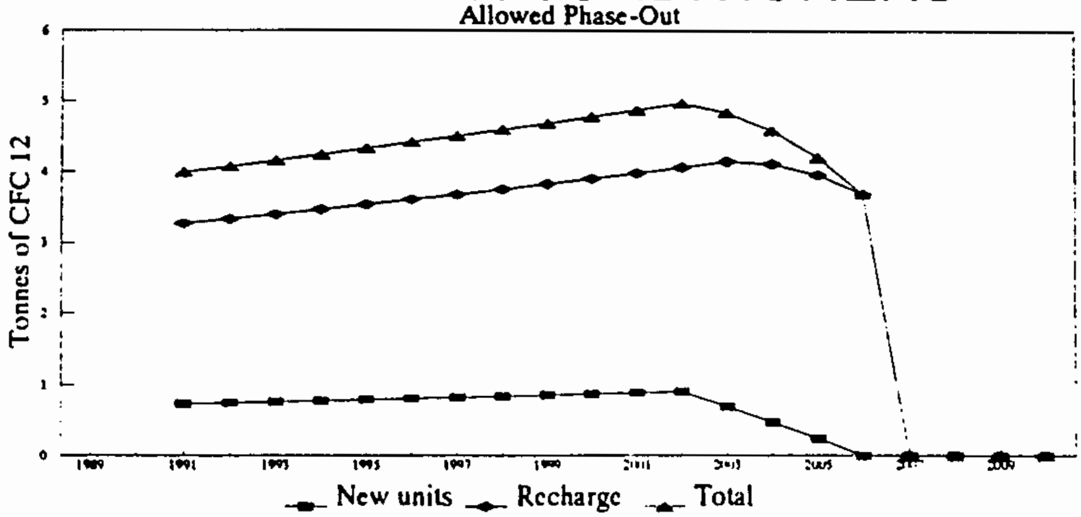

FIGURE F.9

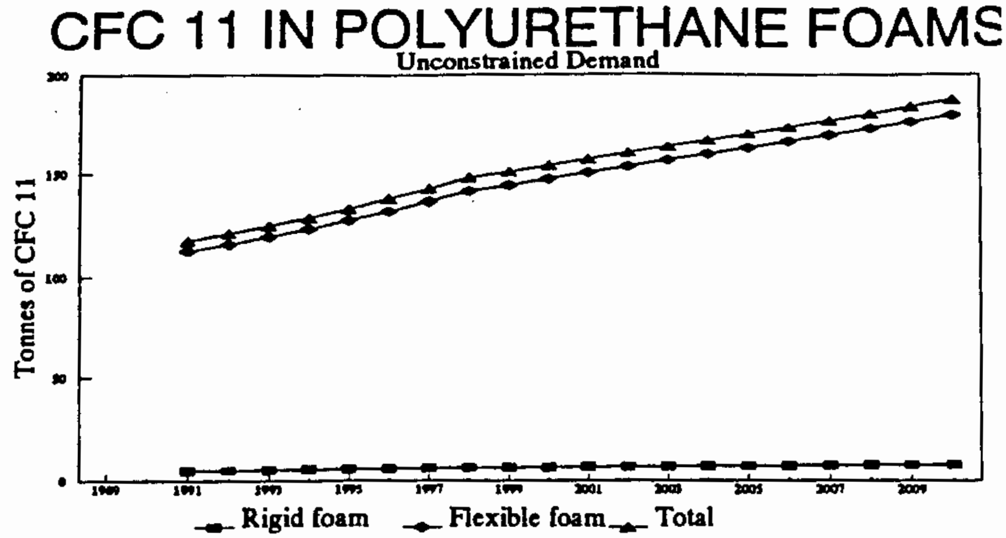

FIGURE F.10

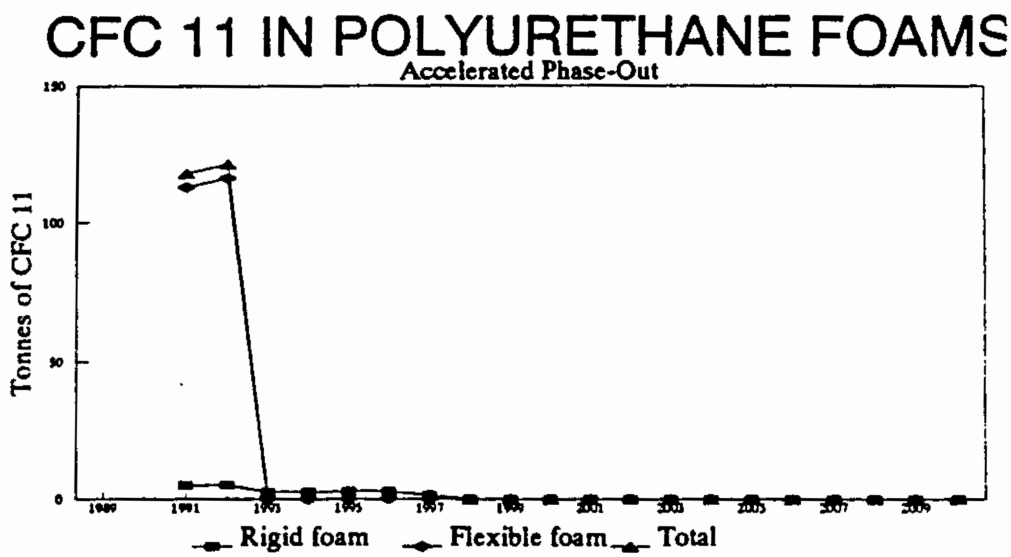

FIGURE F.11

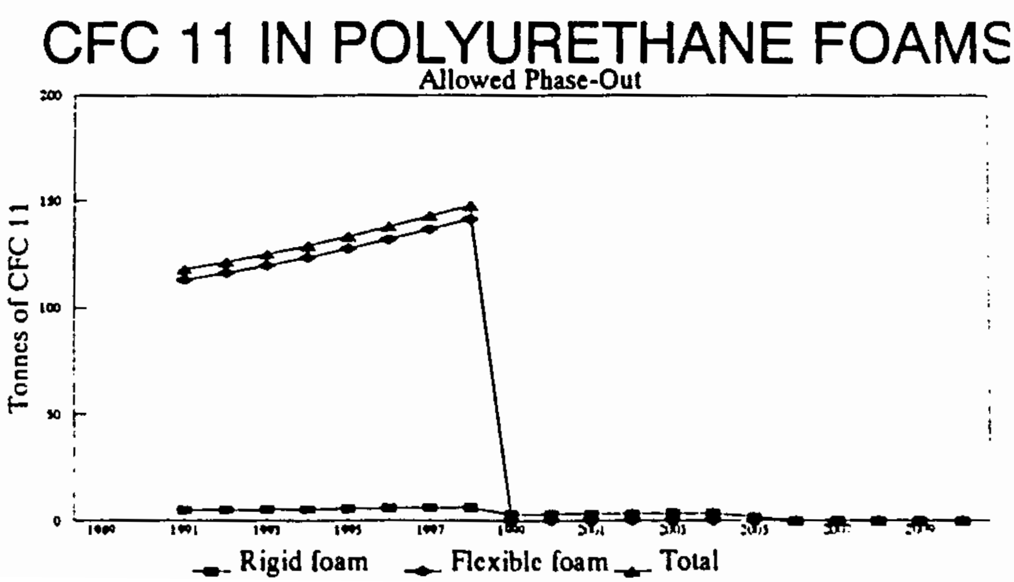

FIGURE F.12

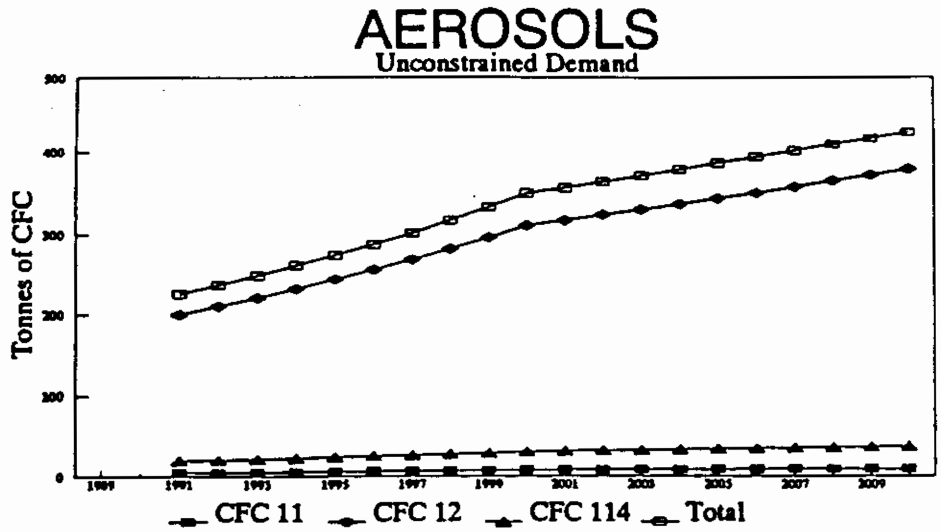

FIGURE F.13

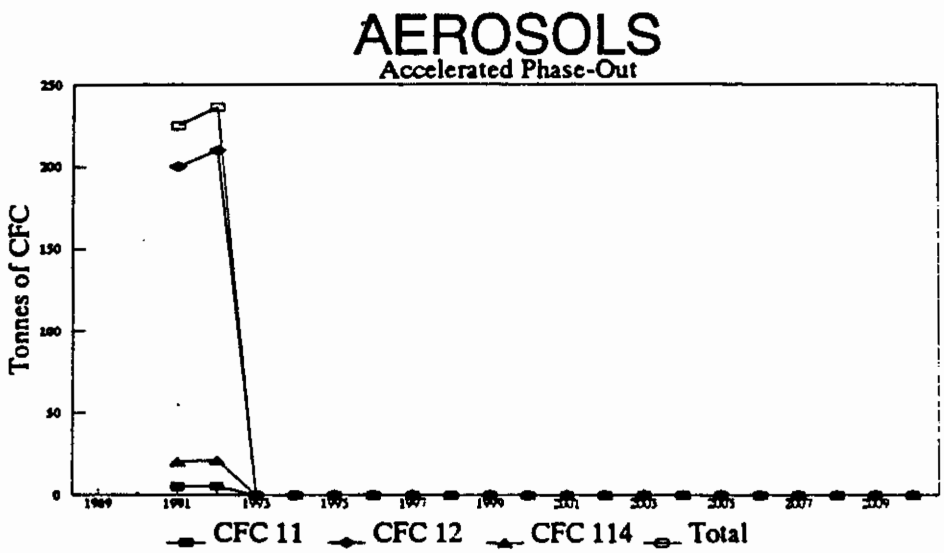

FIGURE F.14

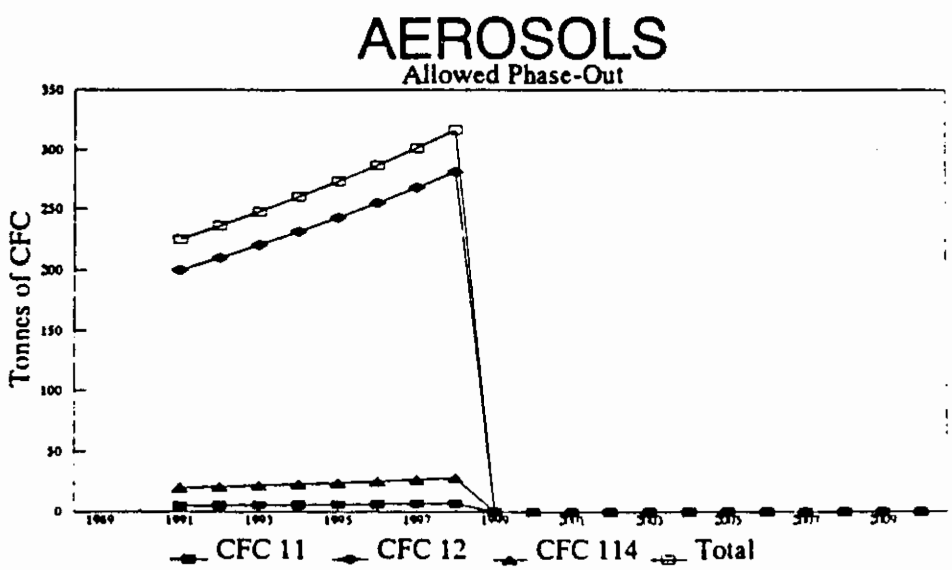

FIGURE F.15