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FINAL CONFIDENTIAL REPORT

ON

TECHNO ECONOMIC ASSESSMENT OF THE FINANCIAL VIABILITY OF THE COLLECTION AND SAFE DISPOSAL OF REFRIGERANT GASES AND RELATED MATERIALS IN AFRICA

(Project No. US/RAF/90/173)

VOLUME-II: KENYA COUNTRY STUDY

FOR

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
VIENNA, AUSTRIA
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SYNOPSIS

This report presents the background analysis that is intended to facilitate the UNIDO Secretariat to advise the Governments of Egypt, Kenya and Nigeria to enable them to launch an efficient system of collection/recovery and recycling of refrigerant gases and to develop regional guidelines for Africa as a whole.

The report is presented in four volumes, as described below :

VOLUME I : EGYPT COUNTRY STUDY
VOLUME II : KENYA COUNTRY STUDY
VOLUME III : NIGERIA COUNTRY STUDY
VOLUME IV : REGIONAL GUIDELINES & DATA BANK

Volumes I, II & III are structured similarly as under :

- The first part deals with a national economic audit on the pattern of import, demand and utilisation of CFCs in each of the countries based on an extensive primary survey. The audits, in turn, provide an assessment of the potential quantity of CFCs that can be recovered from various subsectors over the period allowed for complying with the Montreal Protocol.

- The second part looks at various feasible technical options and an analysis of the techno-economic viability of setting up nation-wide systems for recovery and recycling along with calculations of the net national economic benefits for each country for implementing such systems.

- The next part looks at the framework required for implementation, taking into account the technical, economic, socio-political and legislative environments in each of the countries.

Volume IV provides regional guidelines for Africa as a whole and the structure for a regional policy making oriented data bank. This volume reviews the analysis of the three countries on a comparative basis to evolve a generalised set of guidelines that could be used for implementing collection/recovery and recycling programmes throughout Africa to strengthen environmental and industrial policy and strategy in the region.

The findings of the study indicate that given adequate financial support from multilateral agencies and with appropriate legislation and institutional strengthening for implementation, viable programmes for collection/ recovery and recycling of refrigerant gases can be set up in each of the project countries and policy guidelines can be established for Africa as a whole.

VOLUME II - KENYA COUNTRY STUDY

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EXECUTIVE SUMMARY

I BACKGROUND

Ozone depletion and its after effects on the life on earth have become a matter of global concern. With the signing of the Montreal Protocol, the international community has come together for taking the necessary steps to stop the damage to the stratospheric ozone layer. This study has been commissioned by UNIDO, as part of an ongoing project, to cover the techno-economic assessment of the financial viability of collection, recycling and/or safe disposal of refrigerant gases and related materials. The field survey has been carried out in Egypt, Kenya & Nigeria, the project area countries to serve as a basis for recommending policy guidelines for Africa as a whole.

II CFC AUDIT & DEMAND FORECAST

A comprehensive survey was carried out in the three project countries, covering in detail the airconditioning and refrigeration sector, for assessment of the present levels of consumption of CFCs in various sub-sectors.

The survey involved contacting manufacturers, importers of CFCs, service agencies, commercial installations as well as professional bodies, associations and government agencies such as Egyptian Environment Affairs Agency (EEAA) in Egypt, National Environment Sectt.(NES) in Kenya & Federal Environment Protection Agency (FEPA) in Nigeria.

The total consumption of CFC-11 & CFC-12 in 1991 in Egypt, Kenya & Nigeria is shown below in Table I.

TABLE - I

CFC UTILISATION BY SUB-SECTOR IN 1991

(MT)

	EGYPT		KENYA		NIGERIA	
	CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12
1. Refrigeration & Airconditioning						
- Domestic refrigerators & deep freezers	264	321	10.5	20.7	60.5	77.8
- Commercial& industrial refrigeration	50	25	6	51.7	6.5	3.5

Table-I (Contd..)
(MT)

	EGYPT		KENYA		NIGERIA	
	CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12
- Domestic & commercial airconditioning	31	-	-	-	4.7	7.3
- Mobile airconditioning	-	89	-	6.5	-	382.7
Sub-Total	345	435	16.5	78.9	71.7	471.3
2. Aerosols	90	360	5	4	-	150
3. Plastic Foams	640	50	-	-	280	-
Total	1075	845	21.5	82.9	351.7	621.3
	1920		104.4		973	

There is no significant consumption of CFCs in the solvent sector as CFC-113 has been substituted by Carbon Tetrachloride and Methyl Chloroform which are also controlled substances as per the amended Montreal Protocol.

The major proportion of CFC consumption in all countries has been in the air conditioning & refrigeration sector (41%, 91% and 56% in Egypt, Kenya & Nigeria respectively) due to the partial or complete switchover to substitutes in the other sectors. The per capita consumption of CFCs in Egypt, Kenya and Nigeria was 33.7 gms, 4.15 gms and 8.5 gms respectively in 1991.

The demand forecast for CFCs in the various sub-sectors of refrigeration and airconditioning, based on industrial growth rates, is summarised below in Table II, for the benchmark years of the Montreal Protocol.

TABLE - II

PRESENT & PROJECTED DEMAND FOR CFCs IN THE PROJECT COUNTRIES

COUNTRY		1991		1996		2005		2007		2010	
		CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12
EGYPT	- New	1055	497.0	179	43.1	0.0	0.0	0.0	0.0	0.0	0.0
	- Recharging	20	348.0	25.0	411.6	19.0	276.7	17.9	229.8	16.3	156.0
	- Total	1075	845	204.0	454.7	19.0	276.7	17.9	229.8	16.3	156.0

Table-II (Contd.)

COUNTRY		1991		1996		2005		2007		2010	
		CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12
KENYA	- New	21.5	39.5	6.7	4.8	0.0	0.0	0.0	0.0	0.0	0.0
	- Recharging	0	43.4	0.0	49.9	0.0	[illegible]	0.0	29.7	0.0	18.3
	- Total	21.5	82.9	6.7	54.7	0.0	37.0	0.0	[illegible]	0.0	18.3
NIGERIA	- New	347	216	43.2	42.5	0.0	0.0	0.0	0.0	0.0	0.0
	- Recharging	4.7	405.3	4.2	318.2	0.0	104.2	0.0	50.3	0.0	11.7
	- Total	351.7	621.3	47.4	360.7	0.0	104.2	0.0	50.3	0.0	11.7

After 1997 the CFC demand will only be for servicing of the existing population of CFC based equipment, as new equipment production will be based on substitutes rather than CFCs.. Inspite of the phasing out of equipment based on CFCs, the CFC requirement is still above the Montreal Protocol limits in the years 2005/2007.

As all the three countries are signatories to the Montreal Protocol, the above demand projections, when viewed in the context of compliance with the Protocol requirements, shows that these countries have no alternative but to plan, organise and implement programmes which will bring down the recharging requirements for CFC based products. This can only be achieved by putting in place, an effective national system for collection/recovery and recycling, as well as substitution of CFCs.

III EQUIPMENT FOR RECOVERY AND RECYCLING OF CFCs

Several manufacturers/users of these equipment were contacted and met by the project team experts, to understand the features and operations of the same. Based on this, a comparative evaluation of the technical features of various representative models of recovery and recycling equipment was carried out.

In view of the fact that the volumes of CFCs handled by typical individual enterprises in the project countries are very small as compared to those in developed countries, the low capacity portable models of the recovery and recycling equipment would be most appropriate for adoption in Egypt, Kenya and Nigeria.

The indicative price of a portable recovery equipment (capacity upto 0.5 lb per minute) is US $ 1000, while that of a recycling equipment (capacity upto 25 Kg per hour) is US$ 1400 only.

IV TECHNICAL OPTIONS FOR COLLECTION/RECOVERY AND RECYCLING OF CFCs

The various technical options for collection/recovery and recycling of CFCs from the refrigeration and airconditioning equipment were evolved taking into consideration the present practices for repair and maintenance of equipment in the four sub-sectors, viz domestic refrigerators and deep freezers, commercial and industrial refrigeration, domestic and commercial airconditioning, and mobile airconditioning.

Based on the findings of the field survey and evaluation of the equipment available for collection/recovery and recycling of CFCs, the technical options found relevant in the specific context of the three countries are as follows :

1. Widespread use of plastic bags for collection of CFC-12 during servicing of domestic refrigerators and deep freezers
2. Recovery equipment to be installed at the workshops of manufacturers/assemblers as well as large servicing agencies
3. Recycling of the collected/recovered CFCs would be ideally done by dealers/distributors/importers of CFCs, who already have a network for supply to the end users

The priorities for recovery and recycling of CFCs in the three countries are as follows based on the CFC consumption pattern and assessment of recoverable quantities for each sub-sector.

Country	Sub-Sector
Egypt	- Domestic refrigeration & deep freezers
	- Mobile airconditioning
Kenya	- Domestic refrigerators & deep freezers
	- Commercial & Industrial refrigeration
Nigeria	- Mobile airconditioning
	- Domestic refrigerators & deep freezers

Considerations for Adoption of Recovery & Recycling Equipment

Local manufacture/assembly of the recovery and recycling equipment in the project countries is technically feasible but not commercially viable due to low volumes. To make local manufacture/assembly in an African country viable, it would be necessary to club local requirements with the neighbouring countries' requirements. Therefore three or four projects can be considered for Africa as a whole.

However, the necessary technical skills and competence exist to operate and maintain the equipment, with necessary training inputs being provided initially.

Attainable Reduction in CFC Consumption

Recovery and recycling programmes in each country will help to reduce the CFC consumption substantially. The maximum reductions attainable, based on 1991 field survey data, are given in Table III below :

TABLE - III

MAXIMUM ATTAINABLE REDUCTION IN CFC CONSUMPTION BY RECOVERY & RECYCLING (1991 DATA)

	as % of recharging demand	as % of total demand for airconditioning & refrigeration sector
Egypt	58	28
Kenya	56	26
Nigeria	36	27

The maximum attainable reduction in Nigeria is the lowest, as a percentage of recharging demand, because in the mobile airconditioning sub-sector, which accounts for the largest share of recharging demand in Nigeria, most of the requirement is for leakage cases where the average recoverable quantity is low, as a percentage of total initial charge.

Recovery of CFCs from related materials (Insulation Foam)

The recovery of CFCs from insulation foam is logistically and economically not feasible in the project countries. Reported initial estimates from developed countries suggest that the overall cost of CFCs recovered from domestic refrigerators would be nearly twenty five times the cost of virgin CFC.

Safe Disposal of CFCs

Disposal of CFCs is not a practical proposition for any of the project countries as the facilities for thermal incineration require very high capital investment (over US$ 40 million) and hence can be justified only if the quantity of CFCs to be destroyed is of the order of 15,000 MT per annum. Even then the cost of destruction is about US$ 3000-3500 per MT of CFC making it economically unviable.

V ECONOMIC VIABILITY

The economic viability of the identified technical options

for recovery and recycling was done at

a) Venture (individual enterprise) level
b) National level

Viability Analysis at Venture level

The first step in venture level viability analysis was to establish the dimensions of the venture in terms of equipment required, based on which the project investment and means of financing were determined taking the current prevailing norms in each country. The number of ventures of each type for the three project countries were arrived at as follows :

TABLE - IV

MAXIMUM NUMBER OF RECOVERY & RECYCLING VENTURES IN THE PROJECT COUNTRIES

	EGYPT		KENYA		NIGERIA	
	Recovery only	Recycling	Recovery only	Recycling	Recovery only	Recycling
Max. annual qty feasible (average for 1993-2010)	57 MT	211* MT	16 MT	24* MT	60 MT	81* MT
Min economic qty @ per venture	261 Kg	1799 Kg	180 Kg	1266 Kg	256 Kg	1633 Kg
Max. number of ventures possible	218	117	90	19	234	50

Note : * Includes additional quantity collected through plastic bags which is processed with the help of portable recolvery equipment installed at all the recycling ventures.
@ Taken as 25% higher than the break-even volume

Based on the above and taking into account the findings of the industrial field surveys carried out, the practical number of ventures for each country were determined. The viability analysis of ventures for the three countries is summarised in the Table V below :

TABLE - V

SUMMARY OF VIABILITY ANALYSIS AT VENTURE LEVEL

	EGYPT		KENYA		NIGERIA	
	Recovery only	Recy-cling	Recovery only	Recy-cling	Recovery only	Recy-cling
No. of ventures proposed (based on industrial survey)	100	12	40	5	150	10
Project cost per venture(US$)	1352	3224	1366	3244	1352	3223
Cost per kg of CFC processed (US $)	0.92	4.10	1.04	5.80	0.92	4.47
Break even quantity,kg	209	1439	145	1013	205	1306
Internal rate of return (IRR)						
- on project cost	23.5%	78.9%	27.9%	75.6%	47.2%	97.7%

The break-even quantity for recovery and recycling ventures in Kenya are the lowest as compared to Egypt and Nigeria, as the existing selling prices of CFCs in Kenya are the highest.

The promotion of these ventures will help each of the countries to comply with the Montreal Protocol. While this would be almost total in Nigeria, in Egypt and Kenya the recovery and recycling programme would have to be supplemented by CFC banks or perhaps use of a drop in substitute for recharging in the years after 2007.

At the enterprise level, the ventures for collection (by plastic bags), recovery (by portable equipment) and recycling will need to be supported with measures such as exemption of import duty and provision of capital subsidy on equipment, increase in import duty on virgin CFCs, and Government sponsored training and publicity compaign, for these venture to become economically viable.

Net National Economic Benefit

The venture level analysis has been aggregated at the national level for each country. The Net National

Economic Benefit has been worked out using the principles of social cost benefit analysis. The annual costs and benefits (at 1992 prices) have been assessed for the period 1993 to 2010. A discounting factor of 2% has been used to determine the "net present value" of the net national economic benefit for each country, as summarised in Table VI below.

TABLE - VI

NET NATIONAL ECONOMIC BENEFIT

	EGYPT	KENYA	NIGERIA
In local currency	(-) LE 19.69 Mn	(-) KSH 13.52 Mn	(-) N 17.44 Mn
In US $	(-) US$ 5.95 Mn	(-) US$ 0.48 Mn	(-) US $ 0.97 Mn

The net value for Egypt is particularly high owing to the subsidy on plastic bags which is the major medium for collection of CFCs from the largest sub-sector i.e. domestic refrigerators.

This further confirms the fact that recovery and recycling programmes in these countries have to be viewed as a requirement needing financial support from international agencies.

VI FRAMEWORK FOR IMPLEMENTATION

At present none of these project countries have an appropriate legislative and institutional framework, with respect to usage, recovery and recycling of CFCs.

The economies of these countries are characterised by low rate of growth, adverse balance of payments situation and dependence on imports in the manufacturing sector.

The public awareness and consumer pull is limited and at the present level cannot be counted on to drive a recovery and recycling programme. Further, the existing institutions are not geared up in terms of organisation or training for coordinating the total programme.

We recommend the following framework for implementing the recovery and recycling programme :

1. Command and control measures

   These measures are in terms of enactment of legislation on practices in the following areas which would be applicable in all the countries.

   - Sale of CFC and maintaining records of the same

- Accredition/certification of users of CFC
- Obligation on the part of large installations especially chillers and equipment manufacturers to install recovery equipment
- Obligation of service agencies to recover CFCs
- Obligation on sellers of CFCs to buy back recovered CFCs
- Obligation on service agencies to return a certain proportion of recovered CFCs to be able to purchase virgin CFCs

2. Financial Support Measures

These are -

- Making imported equipment and spares for the recovery and recycling ventures duty exempt

- Providing grants/subsidies to entrepreneurs for setting up ventures. The minimum subsidy to make the ventures viable is 20%. However higher subsidy of upto 50% can be considered by each country depending on the priority to be accorded for implementation.
- Increasing the price of virgin CFC by imposing higher duties so as to raise the price of 'recovered' CFC
- Free supply of plastic bags to accredited service agencies
- Meeting expenses for training and promotion
- Meeting the costs of setting up a CFC bank when required

It is recommended that these costs should be met out of a special fund created with the help of foreign aid.

3. Institutional Strengthening

We have recommended that in each of the project countries the existing agency dealing with environmental issues like EEAA in Egypt, NES in Kenya and FEPA in Nigeria, create a separate department to deal exclusively with the following in conjunction with manufacturers associations and other bodies.

- Evolving codes of practice
- Providing technical inputs through training
- Certification/accreditation of service agencies
- Assisting in start-up of ventures
- Collection and compilation of data on CFC supply and use
- Running demonstration centres for recovery and recycling equipment

- Setting up of CFC banks (e.g. Kenya & Egypt)
- Organising public awareness programs
- Intervention in pricing of 'recovered' CFC
- Overall coordination & monitoring with industry and multilateral agencies

While the measures suggested by and large are common for these countries, the differences in the environment and industrial situation in each of the countries, calls for some variations in approach.

While in Egypt legislation would be effective in many areas, in Nigeria it would be financial incentives that would evoke the stronger response.

The actual mix of measures and their timing in each of the countries would finally depend on the level of response and the speed at which the respective governments wish to implement the programme.

VII COMPARISON OF COUNTRY CASE STUDIES & FORMULATION OF REGIONAL GUIDELINES

The comparison of recovery and recycling programmes in the three project countries is summarised in Table-VII below.

TABLE - VII

CFC RECOVERY AND RECYCLING - A COMPARATIVE ANALYSIS

PARAMETERS	EGYPT	KENYA	NIGERIA
CFC consumption by sub-sector cumulative for 1993-2010 (MT)			
- Domestic Fridges	5876.2	278.2	923
- Commercial & Industrial Refrigeration	309	490.8	79
- Commercial Air Conditioning	412	-	90
- Mobile Air-Conditioners	1102	60.7	2826.2
Total cumulative Consumption (MT)	7699.2	829.7	3918.2

Table-VII (Contd..)

PARAMETERS	EGYPT	KENYA	NIGERIA
Cumulative total recharging requirement from 1993 to 2010 (MT)	6131	727.4	3339
- as a % of total consumption	79.6%	87.7%	85.2%
Max. CFC Recoverable by sub-sector from 1993 to 2010 (MT)			
- Domestic Fridges	3084	145	422.1
- Commercial & Industrial Refrigeration	133	233.5	23.4
- Commercial Air Conditioning	46	-	17.1
- Mobile Air-Conditioners	566	26	1005.7
Total	3829	404.5	1468.3
Practically recoverable quantity (including collection using plastic bags)from 1993 to 2010 (MT)	1764	253	817
- as a % of total consumption	22.9%	30.4%	20.8%
- as a % of recharging requirement	28.8%	34.7%	24.4%
Type of service set up in each sub-sector			
- Domestic Fridges	Small repair agencies	Manufacturers' service deptt. plus small agencies	Manufacturers' service deptt. plus small agencies

Table-VII (Contd..)

PARAMETERS	EGYPT	KENYA	NIGERIA
- Commercial & Industrial refrigerators	Manufacture-ra service network	Manufactur-ers' servi-ce deptt.	Manufactur-ers' service deptt.
- Mobile Air-conditioners	Garages of various sizes	Big Garages/ agencies	Garages of various sizes
Total Project Investment(inUS$)	173,888	70,860	235,030
Average annual value of CFC saved (in US$)	215,606	35,159	100,889

Further, the evaluation of the country case studies brings out the following :

a) The present industrial infrastructure is poor and manufacture of CFC based equipment is dependent on import of components as well as CFCs. Hence the substitution with non-CFC based equipment in manufaucture of new equipment would take place in line with the developed countries.

b) However, economic pressures would motivate extended use of existing CFC based equipment, resulting in continued requirement of CFCs for recharging.

c) In all cases, technical options identified are similar. These are

- Use of plastic bags for collection of CFCs from domestic refrigerators
- Recovery equipment for recovering CFCs from car airconditioners and commercial refrigeration systems

d) In all cases, recycling would be ideally undertaken by the CFC suppliers as they have the necessary infrastructure for collection, storage and distribution.

e) All countries would have to import the recovery and recycling equipment, hence the project cost for ventures is similar.

f) We have found that recovery and recycling ventures can be made viable by giving adequate financial

support and instituting an appropriate pricing mechanism for collected/recovered and recycled CFCs.

g) In all countries, the present organisation under respective environmental agencies requires to be strengthened for implementing and monitoring of the CFC recovery and recycling programmes.

h) Existing legislative framework in each of the countries is inadequate with respect to CFC utilisation. This calls for necessary legislation to be enacted to cover the following :

- Sale & purchase of CFCs
- Formulation and implementation of codes of practice in manufacturing as well as servicing
- Collection/recovery of CFCs by service agencies and purchase of the same for recycling and sale by the selling agencies

i) Need for emphasis on increasing public awareness to make the collection/recovery and recycling programmes successful.

VIII REGIONAL GUIDELINES FOR AFRICA AS A WHOLE :

Based on the above comparative assessment of country case studies, the regional guidelines for Africa as a whole have been formulated, as detailed in Volume IV of this report.

Some of the significant guidelines are :

1) As African countries do not manufacture CFCs, the only technical option to reduce CFC consumption/ emissions is through implementation of viable CFC collection/recovery and recycling programmes.

2) Each country would require to have an organisation identified or created to implement the collection/ recovery and recycling programmes. This can be achieved by Institutional strengthening of any existing agency involved in environmental issues.

3) Financial support by the concerned Government for making the recovery and recycling activity viable at venture level would be required.

The national Governments would in turn need support for funding this programme from external sources, i.e. multilateral fund created by the international community.

4) The number of recovery and recycling ventures and formulation of an overall National System will require a detailed audit of CFC consumption and a

study of manufacturing and servicing practices in each country.

5) The audit data would need to be analysed for prioritisation of sub-sectors for implementing the recovery and recycling programme. This would be based on the assessment of the quantities of CFC handled and geographical dispersion of users as well as servicing agencies.

6) A national data base would need to be created for each country which would comprise of data on enterprises, sub-sectors and sectors of industry using CFCs.

IX REGIONAL DATA BANK

The data base for each country can be integrated into a Regional Data Bank, the structure for which has been discussed in detail in Volume IV of this report, and summarised below :

Level 1 : Enterprise level - which would have data on the activity of individual enterprises and the particulars of CFC consumption and utilisation.

Level 2 : Sub-sector level - containing aggregation of enterprise level data and sub-sector specific data.

Level 3 : Sector level - containing an aggregation of sub-sector level data plus sector specific data

Level 4 : National level - in which the data will be aggregation of sector level data as well as country specific data.

From the experience of the project country studies it may be said that the one time audit of CFC supply and use in different African countries integrated into the Regional Data Bank can provide sufficient data at the enterprise, sub-sector and sectoral levels for assistance in formulating required policy measures.

VIII. CONCLUSIONS

The findings of the study indicate that given adequate financial support from multilateral agencies and with appropriate legislation and institutional strengthening for implementation, it is technically, economically and organisationally feasible to have viable programmes for recovery and recycling of refrigerant gases in Africa.

CHAPTER - 1

INTRODUCTION

1.1 BACKGROUND

There is overwhelming scientific evidence to indicate that damage to the ozone layer is being caused by chlorofluorocarbons (CFCs) which are used in refrigeration and airconditioning equipment, aerosols, plastic foams and cleaning solvents.

Ozone depletion can lead to increased high energy ultra violet radiations on earth which can result in major problems such as increasing human skin cancer, disrupting the aquatic food chain and adversely affecting food-crops production. In addition, CFCs are generally held to be responsible for some one fifth of global warming.

In response to worldwide concerns on depletion of the ozone layer, CFC control measures were agreed upon at Montreal in 1987 in an international agreement now commonly referred to as "Montreal Protocol". The Protocol came into force in 1989 and was further strengthened in London in 1990.

The 'Open ended working group of the parties to the Montreal Protocol' recommended that 'Country specific studies' be carried out in developing countries in order to understand their specific needs and to estimate the cost of assistance required to comply with the Montreal Protocol.

As a contribution to these efforts UNIDO has embarked upon a project - US/RAF/90/173 with the following 9 sub-programmes with specific reference to countries in Africa.

1. Industrial Country Studies

2. Industrial Sub-sector Background Analyses

3. Techno-economic Appraisal

4. Identification of Industrial Enterprises producing/ assembling CFC-based Products

5. Deployment of Methodology to Appraise Techno-economic Viability and Costs of Substituting Technology

6. Test Methodology to determine cost of replacement

7. Revise Methodology and Computer Software

8. Determine the Cost of Substituting Technologies

9. Funding the Technology Substitution

The first two sub-programmes have been completed and they have brought out that the greatest impact on reductions in CFC consumption in African countries can be made through adoption of efficient recovery and recycling systems of the coolant gases - CFC 11 and CFC 12 used in the refrigeration and airconditioning sector.

1.2 STUDY OBJECTIVES

1.2.1 The present project has been assigned to Mantec Consultants Pvt Ltd, India vide UNIDO letter dated 28th October, 1991. This forms the sub-programme no. 3 of the above project US/RAF/90/173 and is aimed at "Techno-economic Assessment of the Financial Viability of the collection and safe disposal of refrigerant gases and related materials". The aims of this assignment are.

- to carry out the background analysis required to allow the UNIDO Secretariat to provide the Governments of three (3) representative African countries : Egypt, Kenya and Nigeria, with policy advice to enable them to enact an efficient system of collection, recycling and/or safe disposal of refrigerant gases and allied materials;

- to provide the basis for the development of a generalised set of technical, economic, political and legislative guidelines valid for Africa as a whole and to strengthen environmental and industrial policy and strategy in the region.

In 1990, UNEP conducted a country study titled "Ozone Layer Protection : Kenya case study on costs and strategies" for Kenya.

This project takes off from this stage and concentrates on 3 countries - Egypt, Kenya and Nigeria to serve as a basis for development of a generalised set of guidelines for Africa as a whole. These three countries are signatories to the Montreal Protocol, and fall in the category of "Developing Countries" as defined in the Montreal Protocol as their per capita CFC consumption is far less than 300 gms. per annum.

1.3 STRUCTURE OF THE REPORT

1.3.1 The project report covering the studies related to Egypt, Kenya and Nigeria, is prepared in four volumes, as under:

Volume I	-	Egypt Country Study
Volume II	-	Kenya Country Study
Volume III	-	Nigeria Country Study
Volume IV	-	Regional Guidelines & Data Bank

Each of the volumes I, II and III are structured in such a way that it becomes a stand alone comprehensive report of that country, but yet carries with it the overall Executive Summary and Conclusions, which cover all three country studies. This arrangement permits each country to have its own report but also permits the policy makers of the country to have an overview of the variations from one country to another.

Volume IV carries the regional aspects and provides a set of guidelines and inputs for a policy-making oriented data bank to assist international agencies in formulating a regional policy for recovery, recycling and disposal of CFCs used in the refrigeration and airconditioning equipment.

1.4 APPROACH TO THE STUDY

1.4.1 The overall approach adopted is outlined below :

Step I : Comprehensive CFC Audit, to ascertain

- Total supply of CFCs
- CFC consumption pattern (by sub-sector)
- Unit CFC consumption norm (by equipment)
- Estimation of New and Recharging demand (by sub-sector)
- Physical distribution of suppliers/users

Step II : Demand Forecasting for airconditioning and refrigeration sector (upto year 2010)

- By equipment type and by sub-sector
- New and Recharging demand for CFCs
- Assessment of technically feasible quantities for recovery and recycling (by type of equipment)
- Practically Recoverable quantities
- Implications on compliance with Montreal Protocol

Step III : Technical options for Recovery, Recycling and Safe Disposal

- Schemes for recovery & recycling in various sub-sectors
- Equipment selection
- Logistics and other aspects of technical feasibility

- Identificatien of types of ventures & framework for national system for recovery & recycling

Step IV : Economic Viability Analysis

- At venture as well as national level
- Sensitivity Analysis

Step V : Framework for Implementation

- Present Scenario
- Proposed measures such as Legislative, Financial support, Market measures, Institutional framework

1.4.2 The basic collection of data has been based on a comprehensive field survey of industrial enterprises, professional bodies and associations, as well as government organisations etc.. Suitable questionnaires/check lists were used for obtaining the necessary information from various sources. Discussions were also held with relevant international organisations including UNEP, World Bank, etc.

Considerable effort was put in towards collection of secondary data from various sources. A list of various reports/documents specially collected and studied is enclosed at Appendix 1.1.

Besides the project team experts, nationals from the country were employed as sub-contractors, to facilitate the conduct of the study and to have local participation.

Based on the field survey, secondary data collection and useful discussions with key officials and country experts, this report analyses and presents the findings and recommendations in line with the objectives.

1.4.3 A brief resume of the coverage is given below :

a) Useful discussions were held with Mr Bjarne Larsen, Programme Officer and Mr Paul Mwake, Consultant, UNIDO; Mr Tore J Brevik, Chief, Information and Public Affairs and Mr Naigzy Gebremedhin, Chief, TAEB of UNEP as well as Mr K M Sarma, Coordinator Ozone Secretariat, and Mr Yusuf J Ahmad, Advisor, UNEP. Meetings were also held with Mr B O K'omudhu, Mr Mugo, Director, Mr F N Kihumba and Mr Mungai of the National Environment Secretariat.

The role and significance of NES and UNEP are given below :

National Environment Sectt.(NES)

NES is a Kenya Government Department under the

Ministry of Environment and Natural Resources. The Secretariat is mandated with technical matters related to the resolution of environmental and human settlements issues.

NES is instrumental in formulation and implementation of various policies, programmes and projects related to various environmental issues in Kenya. As Kenya is a signatory to the Montreal Protocol, NES is entrusted with the role of developing strategies and methodologies and plays co-ordinative and catalytic role in their implementation.

United Nations Environment Programme (UNEP)

Head-quartered in Nairobi, it is the apex co-ordinating body for implementing the Montreal Protocol. The OZONE SECRETARIAT set up under UNEP, has specifically the role of facilitating international co-operation in the protection of the ozone layer, while also monitoring the implementation of the Montreal Protocol.

b) A list of various organisations and persons contacted during the field survey is enclosed at Appendix - 1.2.

1.5 STRUCTURE OF THE VOLUME II - KENYA COUNTRY STUDY

This volume is set out as follows :

An executive summary is provided in the beginning giving an overview of the findings and conclusions of the overall study.

Chapter 2 provides description of the present supply and utilisation; future demand projections; and recoverable quantities of CFCs, upto the year 2010, which is the terminal year for complete phasing out of CFCs as per the Montreal Protocol. It also provides an overview of the physical distribution of the suppliers and users of CFCs in Kenya.

Chapter 3 provides details about the various types of equipment available for recovery and recycling of refrigerant CFCs.

Chapter 4 describes the relevant technical options and the feasible structure of the national level programme for recovery and recycling of CFCs.

Chapter 5 describes the Economic Analysis of the ventures for recovery and recycling, at the enterprise as well as the national level. This analysis includes computation of Net National Economic Benefit.

Chapter 6 deals with evolving a framework for implementation of the recovery and recycling programme in Kenya.

Chapter 7 presents the overall conclusions of the study.

CHAPTER - 2

CFC AUDIT AND DEMAND FORECAST

2.1 INTRODUCTION

2.1.1 A detailed national CFC audit was carried out. Maps of Africa and Kenya are enclosed at Appendix 2.1 (A) and (B) for ready reference, showing the location of the country and also the important cities/towns in the country. As in Kenya there is no manufacture of CFCs, and there are no significant exports of CFCs or CFC based products, the consumption in the country is approximately equal to the import of CFCs.

2.1.2 The consumption, has therefore been worked out on the basis of import of CFCs (supply side approach) as well as utilisation/demand of CFCs in each sector, which in turn are estimated by building up sub-sectoral demand profiles (demand side approach). The import and utilisation of CFCs are estimated through a comprehensive survey carried out by the project team. The survey covers the following :

- Primary sources such as :
  - * importers/distributors of CFCs
  - * end users viz manufacturers/assemblers/ importers/servicing agencies/installations of CFC based equipment/products
  - * industry experts, associations and government bodies
- Secondary data sources including government bodies and associations

2.1.3 The CFC Audit has been done for the 'Airconditioning and Refrigeration' Sector, which is the largest and most important consumer of CFCs in Kenya, and hence was identified by UNIDO for a CFC audit.

The findings of the survey are presented in the sub-sections which follow :

2.2 SUPPLY OF CFCs

2.2.1 Source of Supply and Infrastructure

The entire requirement of CFCs in Kenya is met through imports.

The three main importers in Kenya (and their principals) are :

1. Twiga Chemical Industries Ltd (ICI, UK)

2. Hoechst East Africa Ltd (Hoechst, Germany)

3. East African Oxygen Ltd (Du Pont, Germany)

In addition, CFCs are also imported from Galco Ltd, Belgium, by Refrigeration Contractors Ltd., for their captive consumption in airconditioning and refrigeration contracts and also for supplying to other small users such as assemblers and servicing organisations. Some of the companies such as Premier Refrigeration & Engineering Co., Nairobi Afrigas, etc. import their requirements directly alongwith the components etc.

Refrigerant gases also find their way into Kenya through imports, although limited, of refrigerators, airconditioners, etc.

2.2.2 Level of Imports

The level of imports of CFCs and refrigerant gases in Kenya is summarised in Table - 2.1.

TABLE - 2.1

IMPORT OF REFRIGERANTS IN KENYA (MT)

TYPE	1989	1991
CFC-11	30	18
CFC-12	200	79
HCFC-22	50	56
Others (502 etc)	N.A.	5
	280*	158

* excluding 'others'
N.A. : Not available

Source : 1. 1991 data based on field audit covering importers of CFCs.
2. Past data (1989) from studies conducted by UNEP & World Bank missions.

The share of imports of refrigerants in 1991 by individual importers is given in Table - 2.2.

TABLE - 2.2

MARKET SHARE OF IMPORTERS OF CFCs IN KENYA

-	Twiga Chemicals Ind. Ltd (ICI)	25%
-	Hoechst East-Africa Ltd (Hoechst)	15%
-	East African Oxygen Ltd (EAO) (Du Pont)	36%
-	Refrigeration Contractors (Galco)	13%
-	Other direct imports	11%
	Total :	100%

The three main importers have their own refilling facilities, Hoechst in Nairobi and EAO & Twiga in Mombasa, where the refrigerants are transferred into cylinders from 1 MT containers.

The distribution is organised through a network of dealers as well as own outlets of the importers covering the major towns of Kenya.

2.2.3 Prices

The current CIF and retail selling prices of the refrigerant gases in Kenya are shown in Table - 2.3.

TABLE - 2.3

CURRENT PRICES OF REFRIGERANTS (1991) IN KENYA

REFRIGERANT	CIF (US $/KG)	CUSTOM DUTY (%) *	RETAIL PRICES (KSH $ PER KG)
CFC-11	1.50	31.25	80
CFC-12	2.2-2.5	31.25	130 - 220 **
HCFC-22	3	31.25	200

Exchange rate US$ 1 = KSH 28

* Duty @ 25% and Value Added Tax (VAT) @ 5%

** CFC-12 is sold in containers of various sizes ranging from 13.5 Kg. to 65 Kg. Hence the price per Kg shows a wide variation.

(Source : Importers/Dealers)

2.3 OVERVIEW OF THE USER INDUSTRY

2.3.1 Airconditioning & Refrigeration

a) Domestic Refrigerators & Deep Freezers :

There are four major assemblers of domestic refrigerators and deep freezers in Kenya, whose production levels are indicated below :

	Annual production (1991) (Nos.)
- Premier Refrigeration	5000
- Nairobi Afrigas	6000
- Sanyo Armco	4200
- Kamco	800
Total :	16,000

The daily production levels are thus very low and automation in the plants is minimal.

In addition to the above, about 4000 nos. assembled refrigerators were also imported, with pre-foamed cabinets. Hence the total demand of domestic refrigerators & deep freezers in Kenya is estimated at about 20,000 units during 1991.

The useful service life varies between 15 to 20 years. For the purpose of this report, the life expectancy is taken as 20 years. The existing stock of domestic refrigerators and deep freezers in Kenya is estimated at about 335,000 units based on imputed demand in the past years.

The most popular size in Kenya is 6 cubic feet capacity (Single door). However, the range is from 5 cu ft to 10 cu ft.

The norm of unit consumption of CFC-11 for foam blowing (insulation) is about 600 gm but the actual usage is about 10% higher due to wastages and rejections.

The refrigerant charging norm per unit ranges between 75 gm to 250 gm depending upon the size, with average charge of 120 gm. However, the actual data from the users gives an average per unit consumption of 300 gm of CFC-12 due to the low levels of production resulting in high losses in handling and rejections/reworking.

Similarly the actual per unit consumption for recharging is about 350 gm (CFC-12) due to excessive usage for leak testing, flushing and cleaning and also inefficient handling. About 12-13% of the population of refrigeratcrs require recharging every year due to compressor failure or leakages.

b) Commercial and Industrial Refrigeration

The main refrigerant used in various commercial and industrial refrigeration installations is CFC-12 and the major types of equipment are described below :

- Cold Rooms/stores and commercial deep freezers : These are used in Hotels, Fisheries, Butcheries, Mortuaries, food and horticultural crops storage, etc. There are a large number (about 8000 nos) of cold rooms of various capacities representing a total refrigeration capacity of about 35,000 to 40,000 tonnes. Some of the cold rooms/stores for very low temperature applications are operated on CFC-502, but such installations are very few.

  The major contracting companies engaged in design & fabrication are Hall Equatorial, Daikin Kenya, Refrigeration Contractors, Gilfilian Technical Services, Remco Ltd and Refrigeration Centre.

  The average charging norm is 6 Kg of CFC-12 per unit, but the actual quantity used, based on the user's data, is about 9 Kg per unit, due to high losses/wastages.

  The average life expectancy of cold rooms/cold stores is 20 years. About 6-7% of the population of equipment require recharging every year. The recharging is normally done at the site, and hence the quantity of CFC-12 per unit is about 15 Kg, including the use for flushing/cleaning and leak detection. Further, about 25% of the equipment require topping up every year to the tune of one third of the initial charge.

- Display Cabinets/Chests and Bottle coolers These are used in Departmental stores, retail outlets etc. Total population is about 18,500 units and annual production is about 2500 units of which the major share (about 50-60%) is of Premier Refrigeration and Engineering Ltd.

The CFCs used for display cabinets are CFC-11 for insulation foam and CFC-12 as refrigerant. The consumption norm for CFC-11 is about 1.8 Kg/unit, including the wastage factor of nearly 20%, which is mainly due to lack of high pressure foaming facilities. The actual CFC-12 consumption is two and a half times the norm of 0.5 Kg/unit.

About 4% of the population require recharging every year due to compressor replacement or leakage repair in the refrigeration system. The average unit consumption in recharging is about 2 Kg of CFC-12, because the same gas is used for flushing and leak detection. Nearly 25% of the equipment require topping up once or twice in a year, to the extent of half the initial charge, i.e. about 250 gms.

- Other small refrigeration equipment, including ice makers and commercial retail equipment have an average unit charge of 0.5 Kg. The demand is of the order of 12,000 nos. per annum. The consumption norm for charging and recharging are in the same range as for display cabinets etc.

- Process industries (breweries, beverages, plastics, engineering industries, etc.) use an estimated 5,000 tons of refrigeration, mostly based on ammonia and HCFC-22 but these are not controlled substances and not relevant.

- Mobile Refrigeration :

  * <u>Railway wagons (for transportation of perishables, restaurant cars)</u>:

    There are only 35-40 such wagons which hold a refrigerant charge of 7 kg/unit.

  * <u>Refrigerated containers for sea freight</u>:

    About 50 such containers are in use, constituting a total of about 100 Tonnes of refrigeration.

  * Few refrigerated commercial vehicles (mostly these are cooled with ice blocks).

The average consumption of CFC-12 is about 12 Kg per unit. In addition about 300 Kg per year is consumed for recharging, due to high incidence

of leakages (about 15% of population) for which the average consumption is about 20 kg of CFC-12 per unit. In case of minor leaks, only topping up is done which requires another 100 Kg per year.

In Kenya, the design, fabrication, installation and maintenance of commercial refrigeration equipment is done by contracting companies. There are about 10 companies, accounting for about 85-90% of the installations.

c) Domestic & Commercial Airconditioning

Almost the entire comfort airconditioning systems (central plants as well as window/split type units) used in Kenya are based on HCFC-22 refrigerant.

Central airconditioning plants are mainly installed in the five star hotels (about 20), and in some of the office buildings (estimated at about 10-12). The total capacity of central airconditioning plants in Kenya is estimated at 27,500 - 30,000 TR. All central airconditioning plants are based on reciprocating compressors.

The installation of the equipment is carried out mainly by the same contracting companies which are active in the commercial refrigeration sub-sector.

d) Mobile Airconditioning (Cars)

There are three vehicle assembly plants viz, General Motors, Associated Vehicle Assemblers (AVA) and Kenya Vehicle Assemblers (KVA). The latter two are assembling cars of 5-6 international makes based on imported kits.

The number of cars fitted with airconditioners every year is about 1500 only, which constitutes about 7% of total additional vehicles each year. The average refrigerant charge is 1.2 kg/car, although due to very low volume of production of airconditioned cars, the actual per unit consumption is about 3 Kg of CFC-12, in view of the high losses and wastages in handling.

The total population of airconditioned vehicles in Kenya, is around 9,500 nos, which represents a bank of about 12MT of CFC-12. The estimates from servicing agencies show that only about 5-6% of the car airconditioners are brought for recharging, mostly due to leakages. The incidence of leakages is actually much higher but often the owners do not get

these repaired as the airconditioners are rarely used due to the good weather conditions in Kenya. The average per unit recharging norm for CFC-12 consumption is about 3 Kg. In addition to recharging, about 5% of the car airconditioning units require topping up for which a total of about 200 Kg of CFC-12 is consumed.

It may be noted from the above that the average unit consumption norm for initial charging (in new equipment production) and for recharging are about the same, whereas, in other countries the recharging norm is much higher than initial charging. This is explained by the fact that in Kenya, the level of activity for new equipment production is very low and most of the manufacturing consists of piece by piece assembly. Hence the types of facilities & practices employed by OE manufacturers are similar to those of service/repair agencies.

In view of the above, there can be a substantial reduction in CFC consumption by improvement in facilities and code of practices in the airconditioning and refrigeration sub-sector.

The computation of new and recharging demand for each sub-sector in refrigeration and airconditioning in Kenya is enclosed at Appendix - 2.2.

Profiles of major enterprises in the airconditioning and refrigeration sector have been enclosed as per Appendix 2.3.

2.3.2 Aerosols

It was found that all the major aerosol manufacturing companies have already changed over from CFCs to propane/butane as propellants on their own initiative mainly due to economic viability of switching over. Although accurate figures were not available, indications are that a few small aerosol fillers (for cosmetics products) are still using CFCs and the consumption is less than 10 tonnes.

2.3.3 Plastic Foams (Other than for Refrigeration)

The major usage of CFCs in this sector upto 1989 was in the manufacture of polyurethane foams for flexible slabstock applications. However in 1990-91, the Kenya Bureau of Standards introduced a requirement that the density of foam must be no less than 22 Kg/cu.m. As a result all the major manufacturers viz Bobmil Industries, Foam Plastics Ltd, Megh Cushion Industries, etc. have already switched over to use of methylene chloride as the blowing agent in place of CFC-11.

2.3.4 Solvents and Degreasing Agents

The chemicals mainly used for these applications are methyl chloroform and carbon tetrachloride. The use of CFC-113 is negligible and hence this sector was not investigated for this study.

2.4 UTILISATION OF CFCs

Based on the CFC consumption norms in each sub-sector as elaborated above, the present consumption of CFCs in the various sectors/sub-sectors for new as well as recharging demand has been detailed in Appendix 2.2, which also describes the frequency and types of failures in various refrigeration and air-conditioning equipment. The summary of the sub-sector wise utilisation of CFCs is given in Table - 2.4 below :

TABLE - 2.4

CFC UTILISATION BY SUB-SECTOR (1991)

SECTOR	SUB-SECTOR	UTILISATION				UNIT CONSUMPTION AND COMMENTS
		CFC-11	%	CFC-12	%	
Air Conditioning & Refrigeration	Domestic Refrigeration & Deep Freezers	(MT)		(MT)		CFC-11 used for insulation foam-average 660 gms/unit CFC-12 for charging 300 gms/unit). The above norm includes wastages. Recharging - 350 gm of CFC-12. About 20% of fridges are imported pre foamed
	- New Demand	10.5		6		
	- Recharging	-		14.7		
	- Sub Total	10.5	49	20.7	24	
	Commercial & Industrial Refrigeration					Unit consumption norms (New) Cold Rooms etc.
	- New Demand	6		25		- CFC-11 - 2 kg
	- Recharging	-		26.7		- CFC-12 - 9 kg
	- Sub Total	6	28	51.7	63	Display Cabinets - CFC-11 - 1.8 kg - CFC-12 - 1.25 kg
						Mobile - CFC-12 - 12 kg
						Other - CFC-12 - 1.25 kg
						Recharging (CFC-12)
						- Cold Rooms - 15kg
						- Display Cabinets- 2kg
						- Mobile - 20kg
						- Others - 1.5kg

Table - .4 (Contd)

SECTOR	SUB-SECTOR	UTILISATION				UNIT CONSUMPTION AND COMMENTS
		CFC-11	%	CFC-12	%	
	Domestic & Commercial Air conditioning	-	-	Neg	-	Most of the airconditioning is operated on HCFC-22.
	Mobile Refrigeration & Air Conditioning					Cars average 3 Kg/ vehicle (CFC 12)
	- New Demand	-		4.5		
	- Recharging	-		2		
	- Sub Total			6.5	8	
	Total	16.5	77	78.9	95	
Aerosols	Cosmetics	5		4	5	
	Pesticides					Substitution by LPG being implemented
	Total	5	23	4	5	
Plastic Foams	Polyurethane	-	-	-	-	Full substitution by Methylene Chloride is claimed
	Polystyrene	-	-	-	-	
	Total	-	-	-	-	
Solvents		-	-	-	-	
Total		21.5	100	82.9	100	

- The detailed workings for computing CFC demand are shown in Appendix - 2.2.
- The table is as per the UNIDO format given at Annexure II of terms of reference.

The utilisation of CFCs is slightly higher than the import figures, due to the fact that CFCs are also imported as part of the equipment, i.e. pre-charged compressors, pre-foamed cabinets for refrigerators etc.

2.5 PROJECTED DEMAND OF CFCs BY SUB-SECTOR

2.5.1 The following steps were followed to estimate the future demand :

Step - I : Future demand and population for airconditioning and refrigeration equipment was estimated based on the expected growth rate of the various industrial sectors/sub-

sectors. The methodology adopted for demand projection is given in detail as per Appendix 2.4.

Step - II : Phase out of CFC based equipment has been worked out on the basis of the present trends and awareness among the industry regarding substitutes for CFCs, as well as certain assumptions regarding availability of compressors based on substitute refrigerants. As Kenya does not have any manufacture of CFC, nor of compressors, it is expected that the phase out of CFC based equipment will start as early as 1992 for commercial refrigeration equipment which can easily be designed for operating of HCFC-22. For other equipment such as domestic refrigerators and mobile airconditioners also, the phaseout will commence by 1995 and complete changeover to non CFC based equipment will be achieved by 1997. This of course is dependent upon the availability of compressors (based on substitute refrigerants) as well as the substitute refrigerants themselves. This is because most units are carrying out only assembly operation. The manufacturing facilities would therefore require changes, primarily new equipment for charging, foaming and leak detection. The impact of phase-out on demand and population of CFC based equipment has been therefore incorporated in the computation of projected demand for CFCs. Similarly, the demand of CFCs for aerosols, foams and solvents is expected to be completely phased out by 1992-93, and hence thereafter the CFC consumption will be only in the refrigeration and airconditioning sector.

Step - III: CFC refrigerant quantities were estimated for both original equipment as well as recharging demand, on the basis of present (1991) unit consumption norms estimated through field survey.

2.5.2 The projected demand and population figures for CFC based airconditioning & refrigeration equipment as well as demand for CFC refrigerants (New and recharging) for each sub-sector have been worked out in Appendix 2.5 and

summarised in the Tables 2.5 & 2.6 respectively.

TABLE - 2.5

FORECAST OF PRODUCTION AND POPULATION OF AIRCONDITIONING & REFRIGERATION EQUIPMENT ('000)

EQUIPMENT/SUB-SECTOR			1991	1996	2005	2007	2010
DOMESTIC REFRIGERATORS & DEEP FREEZERS	PRODUCTION ('000)	- Total	20.0	25.5	39.6	43.6	50.5
		- CFC based	20.0	12.7	0.0	0.0	0.0
	POPULATION ('000)	- Total	335.0	384.7	539.4	588.9	676.3
		- CFC based	335.0	365.8	224.9	189.1	132.0
COMMERCIAL & INDUSTRIAL REFRIGERATION - COLD ROOMS	PRODUCTION (Nos)	- Total	750	930	1260	1350	1500
		- CFC based	750	0	0	0	0
	POPULATION (Nos)	- Total	8000	12310	19590	20740	22870
		- CFC based	8000	8917	6267	4757	2557
- DISPLAY CABINETS	PRODUCTION (Nos)	- Total	2500	3840	7370	96717	119836
		- CFC based	2500	0	0	0	0
	POPULATION (Nos)	- Total	18500	35020	83890	103875	119836
		- CFC based	18500	21754	20134	16521	10601
MOBILE AIRCONDITIONING	PRODUCTION (Nos)	- Total	1500	1740	2270	2410	2630
		- CFC based	1500	348	0.0	0.0	0.0
	POPULATION (Nos)	- Total	9500	17680	28390	30090	32830
		- CFC based	9500	15610	11485	8865	4663

TABLE - 2.6

FORECAST OF DEMAND FOR CFC-11/12 IN KENYA (MT)

SECTOR/SUB-SECTOR		1991		1996		2005		2007		2010	
		CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12
I. REFRIGERATION & AIRCONDITIONING											
DOMESTIC REFRIGERATORS & DEEP FREEZERS	NEW	10.5	6.0	6.7	3.8	0.0	0.0	0.0	0.0	0.0	0.0
	RECHARGING	-	14.7	-	16.1	-	9.9	-	8.3	-	5.8
	SUB-TOTAL	10.5	20.7	6.7	19.9	0.0	9.9	0.0	8.3	0.0	5.8
COMMERCIAL & INDUSTRIAL REFRIGERATION	NEW	6.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RECHARGING	-	26.7	-	30.5	-	24.7	-	19.5	-	11.5
	SUB-TOTAL	6.0	51.7	0.0	30.5	0.0	24.7	0.0	19.5	0.0	11.5

Table-2.6 (Contd .)

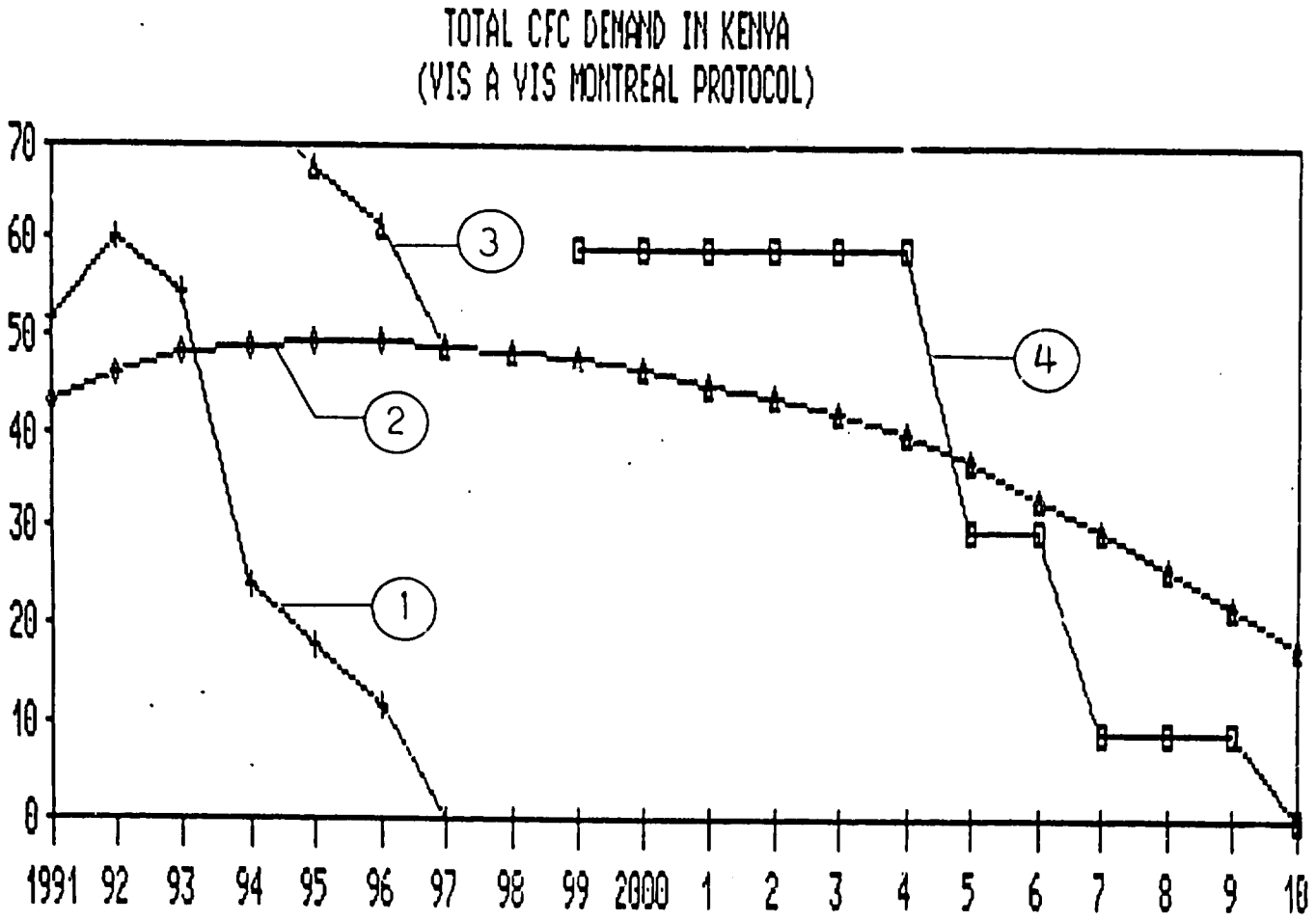
SECTOR/SUB-SECTOR		1991		1996		2005		2007		2010	
		CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12
MOBILE AIR-CONDITIONING	NEW	-	4.5	-	1.0	-	-	-	-	-	-
	RECHARGING	-	2.0	-	3.3	-	2.4	-	1.9	-	1.0
	SUB-TOTAL	-	6.5	-	4.3	-	2.4	-	1.9	-	1.0
SUB-TOTAL	NEW	16.5	35.5	6.7	4.8	0.0	0.0	0.0	0.0	0.0	0.0
	RECHARGING	0.0	43.4	0.0	49.9	0.0	37.0	0.0	29.7	0.0	18.3
	TOTAL	16.5	78.9	6.7	54.7	0.0	37.0	0.0	29.7	0.0	18.3
II. AEROSOLS		5.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
III.PLASTIC FOAMS		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IV. SOLVENTS		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRAND TOTAL		21.5	82.9	6.7	54.7	0.0	37.0	0.0	29.7	0.0	18.3
		104.4		61.4		37.0		29.7		18.3	

Tables - 2.5 & 2.6 show that by the year 1996, the production of new equipment in the refrigeration and airconditioning sector would be mainly based on CFC substitutes.

2.6 COMPLIANCE ASPECTS TO MEET MONTREAL PROTOCOL REQUIREMENTS

The future demand for CFCs (CFC-11 & CFC-12) vis-a-vis current Montreal Protocol limits has been indicated in Figure - 2.1. From the figure it can be observed that the phase out of CFC based equipment manufacturing is sufficient to keep the overall demand of CFCs below compliance limits during the period upto 2005. However, a

FIGURE - 2.1



LEGEND

1. NEW DEMAND (A/C & REF. SECTOR)
2. RECHARGING DEMAND (A/C & REF. SECTOR)
3. TOTAL DEMAND (IN ALL SECTORS)
4. CURRENT MONTREAL PROTOCOL

more significant reduction in demand of CFC would be achieved if a recovery and recycling programme is initiated.

The impact of the recovery and recycling programme in enabling compliance with the Montreal Protocol is brought out in the subsequent sections in this report.

2.7 PHYSICAL DISTRIBUTION OF CFC SUPPLIERS AND USERS

2.7.1 Supply :

The CFCs are imported in Kenya by two types of organisations -

a) Subsidiaries/associates of foreign manufacturers of CFCs.

As indicated earlier in section 2.2.2 there are three such companies accounting for over 75% of CFC imports. All of these companies are located in Nairobi. Two of them (East African Oxygen & Twiga) have their refilling facilities in Mombasa while Hoechst's facility is in Nairobi itself.

b) Importers who are also users of CFCs :

The two major companies in this category are M/s Refrigeration Contractors and Premier Refrigeration & Engineering Ltd. (including their group companies). Refrigeration contractors is located in Nairobi whereas Premier Refrigeration is located in Nakuru. The other group companies of Premier Refrigeration are Kenya Cold Storage, located in Nairobi, and Southern Engineering Co., located in Mombasa. These companies import CFCs directly.

Distribution Channel

The main importers receive their shipments at Mombasa and the CFCs are transferred from 1 MT containers into smaller cylinders in their refilling facilities as indicated earlier. The cylinders are distributed through a network of dealers/agents as well as own outlets of the importers, e.g. East African Oxygen has 22 agents in the country, to whom the filled cylinders are supplied by EAO and at the same time empty cylinders are collected back. The supplies by these importers are in 50 to 70 Kg cylinders only.

The small users of CFCs procure their requirements in disposable cylinders, of 13.5 kg, or in even smaller

quantities from other large users, who procure the large cylinder and then sell in smaller quantities. In such cases, the small users carry the empty cylinders to these outlets and purchase CFCs in quantities of 5-10 kg at a time.

2.7.2 Utilisation

The utilisation/consumption of CFCs in Kenya is summarised below :

-	Domestic refrigerators & deep freezers	30%
-	Commercial and industrial refrigeration	55%
-	Commercial airconditioning	Negligible
-	Mobile airconditioning	5-7%
-	Others (aerosols and foams)	8-10%

i) Domestic Refrigerators & Deep Freezers

There are four OE assemblers of these equipment in Kenya, of which three are located in Nairobi and one in Nakuru, which is about 75 km from Nairobi.

The servicing of these equipment is done by the OE assemblers as well as a number of small private agencies, mostly located in Nairobi. A few of these private agencies are also located in other towns/cities, such as Mombasa, Nakuru and Kisumu. Small agencies service about 150-200 refrigerators per year.

ii) Commercial Refrigeration

About 85-90% of all commercial jobs are handled by about 10 contracting firms, all of which are located in Nairobi, with only 2-3 having offices also in Mombasa. The normal practice is that these contracting firms do the fabrication in Nairobi and their team of technicians is sent to the site for installation & commissioning. Procurement of CFCs is done mainly in Nairobi & Mombasa.

The servicing of these systems is also done by the same 8-10 companies. It is either carried out at site or the equipment is brought to Nairobi for repairs, depending upon the type of problem. Some of the end users also have their own technical staff for

maintenance of the refrigeration systems, e.g. five star hotels, large cold storages etc. Such organisations are 40-50 in number, of which the majority are located in Nairobi & Mombasa.

iii) Commercial Airconditioning

The maintenance of these systems is normally done by the owner's engineering/technical staff, and only in the case of major breakdown the contracting companies are called in. In general the topping up/recharging is very low which is due to the fact that central airconditioning systems are only used for 2-3 months in a year.

iv) Mobile Airconditioning

The assembly plant of General Motors is located in Nairobi while the plants of Associated Vehicle Assemblers and Kenya Vehicle Assemblers are located in Mombasa and Thika respectively. Since only 7% of the vehicles are fitted with airconditioners, the normal practice is that the charging of airconditioners is done at the delivery point rather than in the assembly plants.

For the same reason, the servicing of car airconditioners units is concentrated in Nairobi, and almost all the vehicles are brought to Nairobi for servicing and recharging of airconditioning units.

The servicing of car airconditioners is being carried out by 8-10 service workshops, of which 4-5 are owned and managed by international car manufacturers (such as Toyota, etc). The rest are private agencies which service all makes of cars. All the service workshops are located in Nairobi.

The largest volume of car airconditioners are serviced by Hall Equatorial Ltd, approximately 500-600 cars per annum. The average number of airconditioned car serviced per agency is 150-200 per annum.

2.7.3 Overall Distribution

Based on the above, it is evident that, the airconditioning & refrigeration sector in Kenya, is basically concentrated in Nairobi and Mombasa, both from the supply as well as utilisation point of view.

Hence, even though the end users of the various types of airconditioning & refrigeration equipment are distributed throughout the country, the handling of CFCs is done by a relatively small number of companies, concentrated only in these two major locations.

2.8 Based on the survey carried out for assessment of the present and future demand for CFCs, and the structure as well as dispersion of industry, the techno-economic viability of the programmes for recovery and recycling of CFCs have been evolved in the following chapters.

CHAPTER - 3

EQUIPMENT DETAILS FOR COLLECTION AND RECYCLING OF REFRIGERANT GASES

3.1 As the focus of the study is on the collection and recycling of refrigerant gases, a considerable effort was put into obtaining maximum possible information about various types of equipment available for collection/recovery and recycling of refrigerants for different applications.

3.2 The schematic representation of the equipment used for collection/recovery and recycling are shown at Appendix 3.1 (collection/recovery only) and Appendix 3.2 (collection/recovery and recycling).

3.4 The salient features of some of these equipment are briefly described below and the detailed technical literature and pamphlets on the same are enclosed at Appendix 3.3.

A. REFRIGERANT RECOVERY SYSTEMS INC., FLORIDA, USA

i) Recovery System (Model RC-1)

- Designed for residential/commercial contractors
- Recovery & Storage in 50 lbs tank (refillable)
- Indicative Price US $ 1050

ii) Rejuvenator's

- Capable of processing R-12, R-22, R-500, R-502
- UL Certified as per SAE standards
- Patented one step distillation process
- Available in two models

	ST-1000	ST-100
- Recovery rate	3-6 lbs/min	2-3 lbs/min.
- Indicative Price	US$ 5700	US$ 2900

B. SPX CORPORATION, (OTC Division), USA

OTC refrigerant recovery and recycling systems are for cars, trucks, tractors etc.

* OEM 1380 (R-12)

- Recovers 1/2 lb/minute
- Recycling 2 1/2 lbs/minute
- Compatible with all charging stations
- Suitable for Mobile airconditioners/ refrigerators
- Indicative Price USD 4000

* OEM 1396 (R-12)

- Recovers 1/2 lb/min
- Recycles 0.8 lb/min
- Compatible with all charging stations
- Suitable for mobile airconditioners and refrigeration systems
- Indicative Price USD 3000

* OEM 1397

- Portable recovery system
- Recovery rate 0.5 lb per minute
- Can be used alongwith recycling equipment OEM 1396
- Indicative Price USD 1000

C. UNITED TECHNOLOGIES CARRIER, CARRIER CORPORATION, USA/Australia.

Refrigerant Management System for R-11 Centrifugal chillers model (19QA) is popular and conserves existing supplies of CFCs, minimises their leakage during service/maintenance and optimises chiller efficiency with recycled refrigerant.

Indicative price is A$ 10500.

D. ENVIRONMENTAL PRODUCT AMALGAMATED PTY LTD., AUSTRALIA

i) SKYE Split System consists of two separate units - one for recovery & another for recycling. These units, each about the same size as an average vacuum cleaner, can be used together or separately. Purifies R-12 by distillation.

SKYEMITE - Collection/Recovery Unit
SKYEMATE - Recycling Unit
- Compatible with other brands of recovery machines also.

ii) SKYE HIGH CAPACITY COLLECTION/RECOVERY & RECYCLING (for Heavy duty mobile & commercial air-conditioners & refrigeration applications)

- For fast collection/recovery from larger systems

EP-3
- R-12 (recovers both liquid & vapour)
- Collection/Recovery rate is 25 Kg/hr - Combined process of Filtration and Distillation
- Indicative Price A$ 2750

iii) Several other models of recovery and recycling machines are available, as per details given below :

EP4	-	Portable (Wt. 20 Kg)
	-	Recovery rate 25 Kg/hour
EP4HC	-	Portable (Wt. 20 Kg)
	-	Recovery rate 35 Kg/hr.
EP5	-	Portable (Wt. 24 Kg) recycling (25 kg/hr)

The above models are available for R-12, R-22, R-500, R-502 refrigerant gases.

Indicative Price range - A$ 1400 - 1800.

E. JAVAC RECO, AUSTRALIA

Javac Reco Refrigerant Recovery and Recycling Systems are available for cars, refrigerators, chillers, domestic and commercial airconditioning etc. as per following details :

- Recover and Recycle CFC-12, HCFC-22 and CFC-502
- UC certified as per SAE standards
- Available in three models

	RECO-1 (Commercial)	RECO-12s (DOM/Auto)	RECO-134s (DOM/Auto)
Recovery Rate			
- R-12	60 kg/hr	33 kg/hr	-
- R-134a	-	-	33 kg/hr
- R-22	30 kg/hr	-	-
- R-502	50 kg/hr	-	-
Recycling Rate	-	1 ltr/min.	1 ltr/min.
Indicative Prices (US $)	2,850	1,990	2,350

F. TECHNICAL CHEMICAL COMPANY, USA

a) Sercon 9000

- For high volume airconditioning/ refrigerating equipments
- Capable of Processing CFC-12, HCFC-22, R-500 and R-502
- Meets S.A.E J-1991 (1989) CFC-12 purity standards
- Recovers 25 lbs/min. (in liquid state)
- Indicative price US $ 3,000

b) Sercon 8000

- For high volume airconditioning/ refrigeration
- Capable of Processing CFC-12, HCFC-22, R-502 & R-500
- Meets S.A.E J-1991 (1989) CFC-12 purity standards
- Recovers 25 lbs/min
- Recycles 40 pounds in 15 min.
- Indicative price US $ 2,200

c) Sercon 5000

- For small shops/auto dismantlers/HVAC/R industry
- UL listed, meets S.A.E J-1991 purity standards
- Capable of processing CFC-12, HCFC-22, R-500 & R-502
- Recovery rate 25 lbs/min.
- Indicative price US $ 1,250

The main features of the above equipment as well as equipment offered by other prominent suppliers in this field are compared at Appendix - 3.4.

3.5 The features incorporated in above recovery and recycling equipment are such that these can be easily operated and maintained by technicians, after initial training input of 1 to 2 weeks. The important operating parameters for these equipments are as follows :

	Recovery equipment	Recycling equipment
- Spares & consumables (US $/kg)	0.31	0.41
- Energy consumption (per kg)	0.05 kwh	0.05 kwh

3.6 The equipment details given at Appendix - 3.4 are representative of the range available for the collection/recovery & recycling of Refrigerant Gases, in terms of technology as well as prices which can be used for considering the technical options and the budgetary costs thereof. These equipment are being successfully used in Australia and USA and have been observed in operation by Mantec's experts to have a first hand experience on their utilisation. The technical options in various sub-sectors where Refrigerant Gases are used, are discussed in the next chapter.

CHAPTER - 4

TECHNICAL OPTIONS FOR COLLECTION/RECOVERY & RECYCLING OF CFCs IN VARIOUS SUB-SECTORS

4.1 Based on the study of the recovery and recycling equipment details and preliminary data collected from the field survey ,the various technical options (sub-sector wise) have been evolved for collection/recovery & recycling of refrigerant gases.

4.2 ANALYSIS OF TECHNICAL OPTIONS FOR RECOVERY & RECYCLING

The major sub-sectors of air conditioning and refrigeration industry, from the point of view of recovery & recycling are :

a) Domestic refrigeration/deep freezers and small commercial systems

b) Mobile Airconditioning systems

c) Large Commercial Installations (central air-conditioning plants, cold rooms etc.)

These may be further classified into equipment using CFC-11 such as large centrifugal compressor-based chillers, those using CFC-12 which include domestic refrigeration, deep freezers, small commercial installations (reciprocatory type) and those using HCFC-22 such as domestic airconditioning, large central airconditioning (open system), water coolers etc.

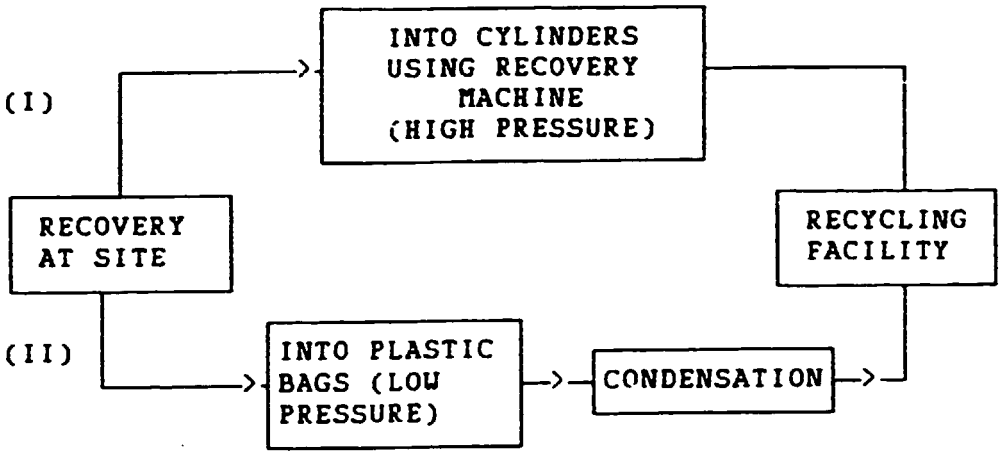
Recovery and re-use of refrigerant has been an established practice for large installations based on CFC-11. This is because CFC-11 at room temperature is a liquid and amenable to recovery and storage at site. It is therefore assumed that such practices will continue.

Our focus therefore is on equipment where CFC-12 and/ or HCFC-22 are used. CFC-12 is a gas at room temperature, requires high level of purity for use in refrigeration and is not usually recovered easily from the equipment. HCFC-22, though not covered under the project, is of interest as similar equipment could be used as for CFC-12 for recovery and recycling.

4.3 The following technical options for each of the above sub-sectors are largely for those using CFC-12 :

4.3.1 Domestic refrigerators/deep freezers and small commercial systems.

A. Repair done at site itself :



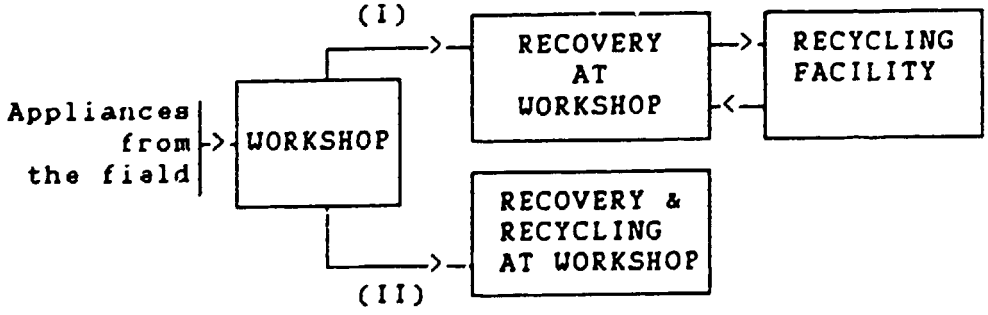
Notes :

Option (I) : The recovery equipment is carried to the site and the refrigerant gas is collected in an empty cylinder under vacuum.

Option (II) : When the servicing agency does not own the recovery equipment, or it is not feasible to transport the same to the site, the technician simply collects the refrigerant gas into a special plastic bag which is brought to his shop. These bags could then be taken to a facility with a recovery machine for condensing and storing in cylinders.

Alternatively a mobile unit (van) fitted with a recovery machine could recover gas from bags at different locations and condense into liquid in a cylinder to make it amenable for recycling.

B. Appliances from the field brought to the workshop for repair :



Notes :

Option (I) : Only recovery done at the workshop and the

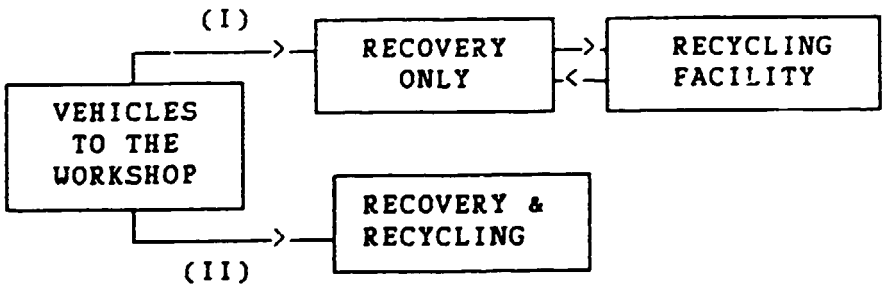
collected refrigerant is sold for recycling at a separate facility.

Option (II) : Recovery as well as recycling done at the workshop itself. This is feasible for large workshops where the number of appliances repaired is high.

As the appliance manufacturers cannot use recycled refrigerant, the same has to be diverted for use in other subsectors such as commercial refrigeration. Hence large servicing agencies/workshops, which cater to both domestic refrigeration appliances as well as commercial refrigeration systems can have recycling facilities where the refrigerant recovered from domestic refrigerators can be recycled and used for commercial systems.

4.3.2 Mobile Airconditioners

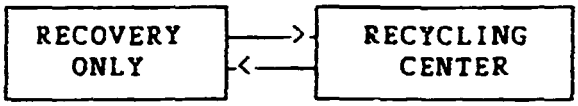
In the case of motor vehicles, the repair of airconditioners is always done at the servicing workshop. Depending upon the number of vehicles being repaired the workshop can install either only the recovery equipment (Option I) or recovery and recycling equipment (Option II).



4.3.3 Commercial Installations

In the case of commercial installations the maintenance is always carried out at the site itself. Depending upon the size and number of systems installed at the user's premises and the amount of refrigerant to be recovered, the servicing technician can either recover the refrigerant at the site and send for recycling, or do the recycling also at the site itself for reusing the refrigerant.

I.



II.

4.4 PRESENT SCENARIO IN KENYA

4.4.1 Kenya which is a signatory to the Montreal Protocol,has a per capita CFC-consumption levels as given in Table - 4.1 below :

TABLE - 4.1

PER CAPITA CFC CONSUMPTION IN KENYA

TOTAL CFC CONSUMPTION IN 1991 (MT)	ESTIMATED POPULATION IN 1991	PER CAPITA CFC CONSUM-PTION
104.4	25 Mn	4.15 gms

This is far lower than the limit of 0.3 Kg per capita, for distinguishing the developed and developing countries, and hence Kenya falls into the category of developing countries, as per this criterion as well. In terms of the Montreal Protocol the 100% phase out has to be achieved only by the year 2010, and the base consumption level on which the reductions apply will be known only in 1998 (because the average consumption of CFCs between 1995-1997 is to be considered).

Presently, the CFC requirements in the country is being met through imports which are mainly from Germany and UK. Even if these countries stop or curtail the production of CFCs in the next few years, Kenya will not have any problem in terms of availability of CFCs, as these will still be available from other sources such as China, India, etc., although prices of CFCs are likely to rise world-wide due to the accelerated phasing out of CFCs in developed countries.

The project team, however, saw a considerable amount of enthusiasm to counter the ozone depletion problem and to reduce the consumption/import of CFCs. Initiative taken to sign the Montreal Protocol alongside developed countries is indicative of the positive attitude of the Kenyan government to this issue.

We, therefore expect a favourable response for implementation of recovery & recycling technologies, wherever these are technically feasible & economically viable.

4.4.2 The total consumption of CFCs includes substantial quantity used for flushing/cleaning and leak detection during servicing and repair of the refrigeration and airconditioning equipment. This quantity is considered as technically possible to recover & recycle. However there can be a significant reduction in CFC consumption by introduction of better practices in this regard, i.e. use of dry compressed air or dry nitrogen for flushing and leak testing. This will also reduce the total recoverable quantity, but the extent of reduction will depend on various factors which cannot be quantified at this stage.

4.5 RECHARGING REQUIREMENTS AND RECOVERY OF CFCs

Presently there are no collection/recovery or recycling procedures being followed in Kenya during servicing or repair of airconditioning & refrigeration equipment. Hence as a normal practice the refrigerant is simply vented into the atmosphere.

4.5.1 Demand for Recharging

The two major CFCs used in Kenya are CFC-11 and CFC-12 as per details given in Chapter 2. CFC-11 is primarily used as a foam blowing agent for insulation. Hence the recharging requirement is mainly for CFC-12.

The sub-sector-wise break-up of refrigerant recharging demand in relation to the total CFCs consumption is given in Appendix 2.2.

4.5.2 Recovery rates and quantities feasible for collection

The sub-sector wise feasible refrigerant recovery rates and technically feasible quantities which can be collected

are given below in Table - 4.2.

TABLE 4.2

TOTAL QUANTITY OF CFCs TECHNICALLY POSSIBLE TO COLLECT/RECOVER IN KENYA (1991)

SUB-SECTOR	AVG. INITIAL REFRIGERANT CHARGE PER UNIT (Kg)	COMPRESSOR FAILURE: NO OF CASES (NOS)	COMPRESSOR FAILURE: TOTAL CHARGE REMAIN % (%)	COMPRESSOR FAILURE: TOTAL CHARGE REMAIN QUANTITY (MT)	LEAKAGE: NO OF CASES (NOS)	LEAKAGE: TOTAL CHARGE REMAIN % (%)	LEAKAGE: TOTAL CHARGE REMAIN QUANTITY (MT)	FLUSHING&LEAK DETECTION: TOTAL QTY USED (MT)	FLUSHING&LEAK DETECTION: QUANTITY RECOVERABLE % (%)	FLUSHING&LEAK DETECTION: QUANTITY RECOVERABLE QUANTITY (MT)	TOTAL RECOVERABLE QTY. (MT)
DOMESTIC REFRIGERATION AND DEEP FREEZERS	0.12	6,000	80	0.6	36,000	25	1.1	9.66	85	8.2	9.9
	-	-	-	-	-	-	-	-	-	-	-
COMMERCIAL AND INDUSTRIAL REFRIGERATION:											
- COLD STORES, COMML. FREEZERS ETC.	6	120	80	0.6	400	50	1.2	4.68	85	4.0	5.8
- DISPLAY CABINETS etc.	0.5	300	80	0.1	475	50	0.1	1.2	85	1.0	1.2
- MOBILE REFRIGERATION	7-10	Neg	-	Neg	15	50	0.1	0.08	85	0.1	0.2
- OTHER (Ice makers and small refrigeration equipment	0.5	2250	80	0.9	3000	50	0.8	5.27	85	4.5	5.2
SUB TOTAL				1.6			2.2			9.6	13.4
DOMESTIC & COMMERCIAL AIRCONDITIONING											
MOBILE AIRCONDITIONING	1.2-1.4	100	80	0.1	475	25	0.2	0.95	85	0.8	1.1
TOTAL				2.3			3.5			18.6	24.4

Note : The total quantity consumed for flushing and leak detection is derived as follows .
Total recharging demand for compressor failure & leakage cases - quantity refilled in the equipment (equal to no. of cases x initial charge)

4.6 RECOMMENDED TECHNICAL OPTIONS

The quantities for refrigerant recovery indicated in Table 4.2 above are the maximum quantities which are technically possible to be collected/recovered, given that all the

service agencies engaged in repair and maintenance of all types of refrigeration and air-conditioning equipment are properly trained and equipped with appropriate equipment to collect the refrigerants.

An important aspect for the success of recovery or collection programme is that it must provide adequate economic incentive for the personnel/agencies involved to motivate them to carry out the collection.

Also the total quantity of CFCs available for collection/recovery will substantially reduce with the improvement of practices for servicing and leak detection. Hence the immediate technical option to be considered is changing over from use of CFCs to using Nitrogen or compressed dry air for flushing and leak detection.

Some of the other important conservation practices which should be inculcated are :

- Proper accounting and record keeping for refrigerant purchase and utilisation (atleast in all large agencies).
- Care in handling of refrigerants in order to avoid wastage

The specific technical options with respect to collection and recycling have been outlined below for each sub-sector.

	Sub-Sector	Recovery	Recycling
A.	Domestic Refrigeration & Deep Freezer	- Use of plastic bags during servicing at users' end and small workshops. - Recovery station at large repairers shop. - Recovery station at all dealers/ manufacturer service center.	- Recycling station with each CFC supplier alongwith a recovery unit.

Sub-Sector	Recovery	Recycling
B. Commercial and Industrial Refrigeration	- Portable recovery equipment are recommended	- Common recycling facilities with the CFC suppliers
C. Mobile Air Conditioning	- Use of portable recovery equipment is recommended.	- Demand for recycling to be met through common recycling facilities.

4.7 OTHER ASPECTS OF TECHNICAL FEASIBILITY

i) Feasibility of Local Manufacture

Technical capability to produce and/or assemble the required collection and recycling equipment is available in the country but the required numbers being small it may not be economically worthwhile to establish a manufacturing line in Kenya specifically for the production of recovery and recycling equipment.

ii) Appropriateness of Technology

The technology and equipment for recovery and recycling of CFCs are now fully developed and brought to a state where the operation and maintenance of these is quite simple. Hence in view of the technical services and expertise available in Kenya, the technology and equipment available for recovery and recycling is appropriate for adoption. This will however require adequate training of the technical personnel to ensure proper usage and maintenance of the equipment.

iii) Attainable Level of reduction in CFC consumption

The total CFC consumption in Kenya in the airconditioning and refrigeration sector is of the order of 95.4 MT per annum, of which the demand for recharging accounts for 43.4 MT. The maximum reduction attainable through recycling would be about 24.4 MT as brought out in Table 4.3 above. This amounts to 56% of recharging demand or about 26% of the total demand for CFCs.

While the total reduction in CFC consumption, which is technically possible to collect, has been computed in the above paras, the practical and feasible collection rate will depend upon several factors, of which the major ones are :

a) Geographical distribution of the equipment from which the refrigerant is to be collected

b) Economic viability of the activity, so that it is self motivating for the service agencies to adopt.

c) Legislative and other measures introduced by the Govt. of Kenya to induce compliance with the requirement of collection of refrigerant during servicing of equipment.

iv) Logistics of Collection for On-site Recycling

However, the CFC-12 based equipment are widely dispersed and the recoverable quantity per unit is very small. Hence on-site recycling is not considered economically viable.

4.8 RECOVERY OF CFCs FROM RELATED MATERIALS (INSULATION FOAM)

The recovery of CFCs from related materials comprises primarily of recovering CFC-11 from rigid foam. This requires an air-tight crushing unit which reduces the volume of the foam to approximately one fifth of its expanded size, thereby releasing the entrapped CFC. The released CFC gases are then collected by drawing them through a filter and passing them into a condenser.

However, in many cases, insulating foam needs to be segregated from the product or location in which it is used. This can present major problems as, for example, foam is often found adhering to metal sheets. For the insulating foam contained in domestic refrigerators the most likely recovery method is mechanical grinding or crushing of the complete units within sealed plants with subsequent recovery of the released CFCs.

Thus the recovery and recycling of CFCs from rigid foam in refrigerators for re-use by manufacturers is technically possible. However, the disparate location of the foam "bank", which is the population of discarded and scrapped refrigerators and the way it is used within the internal structure of the refrigeration units and its volume relative to the CFC content, present significant economic problems in terms of retrieval and transportation. The difficulties can be overcome, but they make the adoption

of the recovery and recycling option economically unattractive. Reported initial estimates from developed countries suggest that the overall cost of CFCs recovered from domestic refrigerators, including the refrigerants and from the rigid foam, would be nearly twenty five times the cost of virgin CFC. Hence the recovery of CFCs from rigid foam is logistically & economically not feasible in Kenya.

4.9 SAFE DISPOSAL

Refrigerants used in various appliances, get contaminated which can be recovered and reused after recycling or reclaiming. However, in some cases the contamination is too heavy and it can not be recycled or reclaimed. Also, in certain applications, such as foams, the recovery of CFCs is not practical, at the time of scrapping of the product. Such CFCs should be destroyed in such a manner that it does not effect the environment. There are many methods available for destruction of CFCs which are given below :

- Thermal incineration
- Catalytic incineration
- Pyrolysis
- Active metal scrubbing
- Chemical scrubbing
- Wet air oxidation
- Super critical water oxidation
- Corona discharge

Out of the above, only thermal incineration is the commercially available method of CFC destruction.

Incineration

The destruction of CFCs can be achieved thermally by exposing to high temperature of about 850°C for long period of time in the presence of excess hydrogen. the necessary heat is supplied through firing supplemental fuel or by co-firing other wastes that have a substantial net heat of combustion.

The thermal decomposition produces either halogen acids or free halogen molecules. The attack of thermal decomposition products on the refractory incinerator walls has been a problem as they are very corrosive. To protect the incinerator walls use of special refractory materials and/or frequent incinerator relining is required. The halogen acids or free halogens must also be scrubbed from the stack gases before emissions and other residue must be properly captured and disposed of.

In the United States, performance standards have been developed by EPA for incinerator burning CFC wastes. For grant of license, a trial burn must show 99.99% destruction and removal efficiency.

Disposal of CFC refrigerants is not a practical proposition in Kenya. This is because destruction of CFCs requires high temperature incineration facilities with appropriate treatment of effluent gas. Such facilities cannot be specifically designsd for CFCs alone since the size of these waste incineration facilities have to be of a suitable (large) scale for them to be commercially viable. The minimum economic capacity of these incinerators is normally over 15,000 tonnes per annum. The cost of CFC destruction with such a capacity is around US $ 3000 - 3500 per mt. The cost of building a completely new facility is over US $ 40 million.

Considering the minimum scale of capacity required, as well as the high cost of destruction, the possibility of building a destruction facility solely for CFCs in Kenya or even in Africa has to be discounted.

In addition, the necessary technical expertise for managing such a complex and large scale disposal system is lacking.

CHPATER - 5

ECONOMIC ANALYSIS

5.1 METHODOLOGY

The methodology adopted for Economic Analysis consists of two components. The first is viability analysis at the venture level for collection and recycling, for various type of ventures suggested by the investigation of technical options.

The second is an analysis of the net national economic benefit based on the proposed national system for collection and recycling.

5.2 Viability analysis at venture level :

In the venture level analysis each venture is treated as an independent entity which is set up as a project. Stemming from the technical options, three kinds of basic ventures have been considered.

a. Venture for collection using plastic bags

b. Venture for recovery only using a portable recovery machine

c. Venture for recycling using a stand alone recycling machine together with a portable recovery unit.

While there is a technically feasible option of having a portable recovery cum recycling unit, our analysis has shown that in Kenya, none of the sectors will have sufficient recovery volumes at one location to justify use of such a recovery cum recycling machine. Accordingly this has not been considered for techno-economic viability.

A summary of the various steps is given below.

Step 1 is to establish the dimensions of the venture. For each of the basic ventures this has been arrived at on the following basis.

Type of Venture	Basis
Recovery only using portable recovery machine	A venture assumed to consist of a single unit of equipment (Indicative price - US$ 1000 based on model OEM 1397 of SPX Corpn., USA (Refer Chapter - 3)

Recycling	Venture assumed to consist of a single recycling machine and a portable recovery machine. (Indicative price : Recycling Equipment - US$ 1400 (A$ 1800) based on model EP5 of Environmental Products Amalgamated Pty Ltd., Australia (Refer Chapter 3.) Recovery equipment - same as above Total Equipment cost - US$ 2400

The activity of collection through plastic bags in the above categorization as this activity does not involve any investment in capital assets unlike the other ventures. The computation of viability of this activity is fairly straight forward as shown in Appendix - 5.3 .

The subsequent steps in the methodology are as follows :

Step 2 : Estimation of the cost of the project and the means of financing.

The costs for each type of project has been worked out in the local currency and on the basis of latest exchange rates for imports in foreign currency.

Likewise, means of financing and the associated costs have been worked out on the basis of current norms for such projects.

The project life is taken to extend till the year 2010 which is the terminal year for elimination of CFC consumption as defined under the Montreal Protocol.

It has also been assumed that the recycling equipment and the portable recovery equipment will have a life equal to the project life.

Step 3 : involves estimating the operating revenues and costs for each type of venture.

Operating revenues are computed on the basis of quantity of CFC processed. (i.e. collected, recovered or recovered and recycled) and the price to be realised for collected CFC gas, CFC liquid and recycled CFC in cylinders.

The typical scale of activity per venture has been based on the present level of activity of the typical service agency who will adopt the venture.

Further, the level of activity in subsequent years is assumed to follow the same pattern as the aggregate quantity of CFC available for recycling which will of course decline over the years. This has been done to assess the viability of the venture over the total project life.

Operating costs include costs of raw material (in this case CFC collected gas, or CFC collected and condensed), consumables and spares, power, labour, transportation (wherever applicable), depreciation, interest and selling & administrative overheads. In the working sheets the costs have been further classified as fixed or variable.

The spreadsheet formats for the viability analysis are furnished in Appendix 5.1 for venture (a) and Appendix 5.2 for Ventures (b) & (c).

The computation of financial viability of the venture has been done in an iterative manner by varying different parameters. These are

- duty on imported equipment
- duty on imported CFC and prices realised for recovered CFC in cylinders or bags as a percentage of landed price of virgin CFC
- interest rates for funding investments
- capital structure of the venture

The output of the first stage is an assessment of financial viability of each type of venture and the associated pricing for recovered and recycled CFC, as also the mode of financing :

The working sheets depicted in the Appendix thus provide the following for each type of venture.

* Costs of recovery per Kg
* Costs of recycling per kg for each alternative
* The capital investment required and desired level of government subsidy by way of grants/soft loans for ensuring viability
* The value of CFC saved

Having established the profile of a venture for recovery

and that for recycling the next step is to estimate the total number of ventures in the country.

This has been done by using the following inputs :

- The maximum number of recovery and recycling vontures computed by dividing the total recoverable quantity by the quantity to be handled by one venture (based on break-even analysis).

- The number of ventures so obtained for each country were suitably downscaled, as it is recognised that it is not possible to achieve 100% recovery. Hence the practical number of ventures were arrived at, based on the following considerations.

    - concentration and dispersion of sectors addressed by a particular type of venture. e.g. for garages servicing car airconditioners, the population dispersion of airconditioned cars across the country

    - level of activity, e.g. the number of cars being serviced by a venture

    - the realistic proportion of the target population that would be addressed by the ventures, e.g. there would always be some cars which are not serviced at a garage for logistical or other reasons.

    - manpower available with the individual enterprises, and their technical competence

    - recognition of the fact that the total quantity of CFCs available for recovery and recycling will progressively reduce due to phasing out of CFC based equipment, as well as adoption of better practices. Hence the number of ventures should be such that long term viability is ensured for each venture.

The number of ventures has also been based on eligibility or appropriateness of agencies to set them up.It is suggested that large manufacturers of refrigeration equipment who service commercial installations be required to have a recovery equipment as part of code of practice, as the aggregate quantities dealt in are low and the number of such agencies are few.

Based on the above, the number of ventures arrived at is given below in Table-5.1.

TABLE - 5.1

KENYA

	RECOVERY ONLY	RECYCLING
Maximum annual qty technically feasible(average for 1993to2010)	16 MT	~ 24 MT
Min.economic qty per venture @	180 Kg	1266 Kg
Max.no.of ventures possible	90	19
Proposed no.of ventures based on industrial Survey *	40	5
Avg.annual qty. per venture		
- Maximum	570 Kg	4800 Kg
- Practical as per field survey +	277 Kg	2871 Kg

~ Includes additional quantity collected through plastic bags which is processed with the help of portable recovery equipment installed at all the recycling ventures.

@ Taken as 25% higher than break-even volume

* The number of recovery & recycling ventures are indicative based on field survey and can be increased in future years depending upon actual operations.

+ This has been derived from Appendix 5 as the 18 years average (1993-2010) of the annual CFC recoverable quantity.

Having made an assessment of the number of ventures of each kind an assumption has been made that these ventures would be established over a period of three years.

Once the pattern of ventures is known the assessment of net national economic benefit was carried out.

5.3 RESULTS OF VIABILITY ANAYSIS AT VENTURE LEVEL

The economic viability of various types of collection/ recovery and recycling ventures in Kenya is shown at Appendix 5.3 attached, and summarised in the following paragraphs.

5.3.1 Types of Ventures :

Table - 5.2 below indicates the types of ventures identified for different sectors for recovery of CFCs.

TABLE - 5.2

SECTOR	TYPE OF VENTURE	PROMOTER OF VENTURE	TOTAL QUANTITY OF CFC RECOVERABLE IN SECTOR (FOR STARTING YEAR 1993) (IN MT)
Domestic refrigerators	-Collection through plastic bags	Small service agencies	9.45
	-Portable recovery machine	Manufacturers and their authorised service agencies	1.05
Commercial & industrial refrigeration	Portable recovery machine	Service agencies of large companies	15.30
Mobile airconditioners	Recovery machine	Garages servicing Car airconditioners	1.50

5.3.2 Institutional Considerations

Though the economy is in many ways a market economy and it is expected that recovered & recycled CFCs would find a price based on market forces, the total quantity of CFCs is so less that this process may not happen automatically.

Also, since CFCs are all imported it is felt that the obligation of buying back recovered CFC should rest on the CFC suppliers.

In terms of institutional capability for developing recycling systems and providing technical, financial and

managerial support, while Kenyan industry may not be highly developed but since the number of ventures proposed are very few and are with large service agencies, there would not be a problem for providing support as above.

For recycling it is assumed that the suppliers of CFCs will promote ventures involving recycling equipment. These ventures will have equipment to recycle CFCs collected through portable recovery equipment and brought in cylinders and equipment to recover CFCs from plastic bags and feed to the recycling equipment.

The table - 5.3 below summarises the results of the venture level analysis.

TABLE - 5.3

	VENTURE TYPE	
	RECOVERY	RECYCLING
Equipment Cost	KSH 32,340	KSH 77,616
Project Cost	KSH 38,247	KSH 90,842
Total Quantity of CFC handled over project life (1993 - 2010)	4981 Kg	51,676 Kg
Average Annual Quantity (18 years)	277 Kg	2,871 Kg
Annualised operation cost (18 years)	KSH 8,092	KSH 468,123
Annualised revenues (value of CFC saved)	KSH 27,673	KSH 574,177
Operational cost/kg. of CFC processed (av. annual)	KSH 29.21	KSH 163.05

Table 5.3 (Contd..)

	VENTURE TYPE	
	RECOVERY	RECYCLING
Break even volume	145 Kg	1013 Kg
Payback period for venture - on equity - on total capital	One year Four years	8 months Two years
Internal Rate of Return(IRR) - on equity - on total capital	93.9% 27.9%	179.9% 75.6%

A sensitivity analysis has also been carried out on specific parameters to assess impact on IRR.

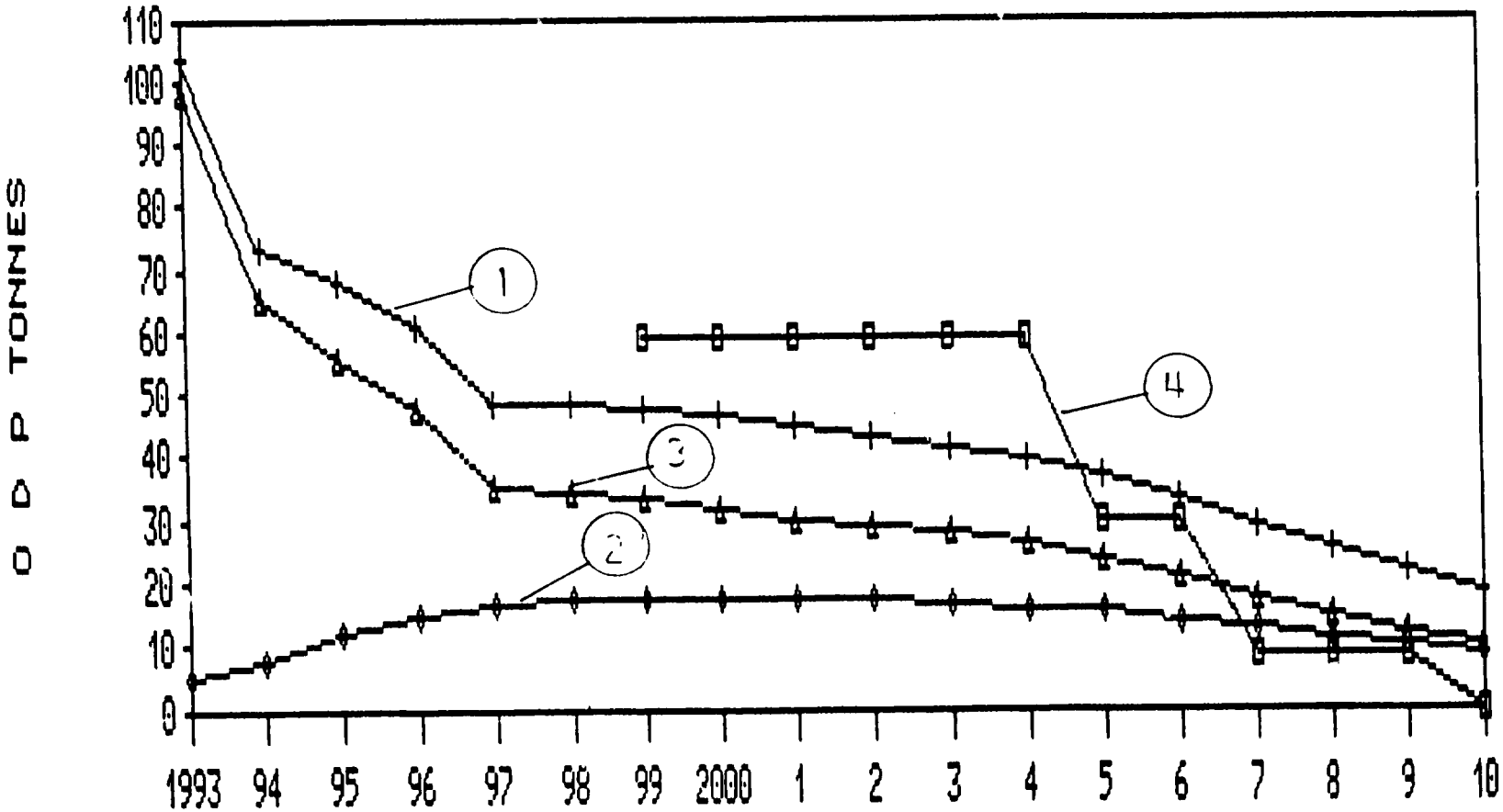
TABLE 5.4

CHANGE IN IRR BY PARAMETERS

VENTURE	PRESENT IRR	10% INCREASE IN CAPITAL COST	10% DROP IN CAPACITY UTILISATION	INCREASE IN SUBSIDY FROM 20to30%	INCREASE IN CFC PRICE BY 10%
RECOVERY					
- equity	93.9%	76.4%	78.4%	191.8%	112.7%
- capital	27.9%	25.5%	24.7%	27.9%	31.7%
RECYCLING					
- equity	179.7%	152.0%	147.6%	344.3%	233.7%
- capital	75.6%	70.3%	65.9%	75.6%	91.0%

The impact of recovery and recycling programme on the total CFC consumption, with respect to the requirements of Montreal Protocol, is presented in Figure - 5.2, which shows that with recycling of CFCs, the net demand would fall within the Montreal Protocol limits upto the year 2007, after which the additional demand can be met through a CFC bank to be created for this purpose.

IMPACT OF RECOVERY & RECYCLING IN KENYA
(VIS A VIS MONTREAL PROTOCOL)



LEGEND

1. TOTAL PROJECTED CFC DEMAND
2. PRACTICABLY RECOVERABLE QUANTITY
3. NET CFC DEMAND
4. MONTREAL PROTOCOL

5.4 NET NATIONAL ECONOMIC BENEFIT ANALYSIS

The second stage of the economic analysis involves computing the net national economic benefit by adopting the recovery and recycling programme.

5.4.1 Methodology

The net national economic benefit has been worked out using the principles of social cost benefit analysis within the limitations imposed by the necessity of confining ourselves to quantifiable variables.

The methodology has been detailed in Appendix - 5.4. Given below is a summary of various costs and benefits considered in the exercise.

Benefits

- Savings in imports of refrigerants (CFCs)
- Increase in employment measured in terms of increased private consumption and investment (taken equal to savings).
- Weighted increase in consumption and investment of owners of enterprises
- Increased Government revenues on duties of CFCs

Costs

- Outflows on account of equipment and consumables
- Training costs and publicity at venture level and Government level
- Increase in costs of overheads and maintenance of ventures
- Duties and taxes foregone by the Govt. on imports of CFC saved.

The above costs and benefits have been assessed till the year 2010 and measured in the local currency at 1991-92 prices.

A discounting factor of 2% has been used to determine the 'net present value' of Net National Economic Benefit, i.e. benefits - costs to the economy in each year from 1993 to 2010.

The working sheets are given at Appendix 5.5 alongwith the basis used for the computations (Appendix 5.6).

The summarised results of the computations of Net National Economic Benefit are presented below in table 5-5, which shows the yearly costs and benefits to the economy.

TABLE 5.5

RESULTS OF COMPUTATION OF NET NATIONAL ECONOMIC BENEFIT FOR KENYA

(IN Mn KSH)

YEAR	COSTS	BENEFITS
1993	8.00	5.97
1994	4.44	2.06
1995	4.71	2.78
1996	4.09	3.00
1997	4.20	3.23
1998	4.24	3.38
1999	4.26	3.50
2000	4.23	3.54
2001	4.16	3.52
2002	4.07	3.46
2003	3.98	3.42
2004	3.87	3.32
2005	3.74	3.24
2006	3.59	3.07
2007	3.41	2.87
2008	3.23	2.66
2009	3.03	2.42
2010	2.81	2.16
NPV OF NET BENEFITS (@ 2% DISC.)	KSH Mn	-13.52
	US$ Mn	-0.48

CHAPTER - 6

FRAMEWORK FOR IMPLEMENTATION

6.1 This chapter deals with :

a) The present legislative and institutional framework and extent of public awareness in the project countries and

b) The proposed organisation and legislative, institutional and other measures to implement recommended recovery and recycling programmes in each country.

6.2 PRESENT LEGISLATIVE AND INSTITUTIONAL FRAMEWORK AND EXTENT PF PUBLIC AWARENESS

The National Environment Secretariat (NES) under the Ministry of Environment and Natural Resources is responsible for formulating and implementing policies on environmental issues. The Environmental Law Unit (EL) which is a part of the NES, advises the Director NES on all matters related to the development, review and application of environmental legislation and related regulations. This section is responsible for formulation of appropriate legislation and institutional framework for policy implementation and legal enforcement as they relate to natural and manmade environment.

However, as on date, specific legislation does not exist in the area of CFC usage or emission.

Infact the present scenario is one where exercise of governmental controls on functioning of industrial enterprises is limited.

For instance, even the major manufacturers or service agencies in the air-conditioning and refrigeration sector are not required to report their performance to the Government except for the specific purpose of obtaining licenses for imports.

There are no codes of practice adopted for maintenance/ repair in the air-conditioning and refrigeration sector.

The magnitude of CFC consumption in the country is low in absolute terms and the framework for monitoring of supply and usage is absent.

The pattern of CFC usage as discussed earlier is concentrated more in commercial and industrial refrigeration as compared to domestic refrigeration or cars.

The manufacturing industry is assembly oriented and the major components are imported. Hence there will be a change-over to equipment based on substitutes alongside such developments taking place in developed countries especially in car airconditioners and domestic refrigerators.

While the manufacturer/assemblers do undertake servicing and maintenance activities, neverthless there is an unorganised sector comprising of small agencies which also does servicing work.

6.3 PROPOSED MEASURES FOR IMPLEMENTING A RECOVERY & RECYCLING PROGRAMME

The proposed measures have been drawn up keeping in view the above background and the national system for recovery and recycling developed in the earlier chapters.

A summary of the system contemplated is depicted in the table below :

TABLE - 6.1

SYSTEM FOR RECOVERY/COLLECTION, RECYCLING & DISPOSAL IN KENYA

SECTOR	RECOVERY/COLLECTION				RECYCLING	
	COLLECTION AGENCY	COLLECTION METHOD	DELIVER TO	INPUTS FOR ECONOMIC VIABILITY	OPERATING AGENCY	INPUTS FOR ECONOMIC VIABILITY
Commercial & Industrial Refrigeration	Large Service Companies	Portable Recovery Unit	Suppliers of CFCs @	*Free/low cost equipment *Pricing for recovered CFC	Suppliers of CFCs	*Exemption of duty on equipment *Subsidy on capital investment *Increased price of CFC
Car Air-conditioners.	Large Service Companies	Portable Recovery Unit	Suppliers of CFCs @	*Free/low cost equipment *Pricing for recovered CFC	Suppliers of CFCs	*Exemption of duty on equipment *Subsidy on capital investment *Increased price of CFC
Domestic Refrigerators.	*Large Service Companies *Manufacturers	Portable Recovery Unit	Suppliers of CFCs @	*Free/low cost equipment *Pricing for recovered CFC	Suppliers of CFCs	*Exemption of duty on equipment *Subsidy on capital investment *Increased price of CFC

@ Selling agencies of CFCs would also be the recycling agencies who would have separate recovery equipment as well.

It is apparent that the measures should be drawn up to encourage the large servicing companies, which in many cases are equipment manufacturers, to adopt practices for recovery and to encourage suppliers of CFCs to accept collected/recovered CFCs and recycle them.

The proposed measures in various areas are :

6.3.1 Command and Control Measures

Legislation related to -

a) Supply of CFCs :

CFCs in Kenya are currently imported. Legislation should be enacted to make it necessary to

* Maintain record of imports, by type of CFC, source, quantity etc

* Maintain records of sales, by customer, by sector (eg. refrigeration equipment manufacturer, foam blower etc)

* Registration of dealers, if any, at other locations

Legislation should be enacted to make it obligatory for suppliers of CFCs to accept recovered CFCs from accredited servicing agencies, manufacturers etc for recycling.

Legislation is also required in respect of -

* Drawing up of standards for recycled CFCs and limitations to its use, if any.

* Need to maintain records of sale of recycled CFC.

An illustrative extract of legislation covering the above aspects in the State of Victoria, Australia is presented in Appendix 6.1 (Sections 14, 15, 16 of EP Act 1970-Victoria Govt Gazette).

b) Use of CFCs

The scope of legislation in this area for Kenya should ensure

* Identification and registration of all purchasers and users of CFCs

* Restricting the use of CFCs to persons/agencies who are accredited/certified by NES based on

competence and possessing necessary infrastructure to handle and minimise emission of CFCs

Appendix 6.2 shows illustrative provisions of section 23 in Waste Management Policy - State of Victoria, Australia)

* Making it obligatory for users to maintain records of purchase and use

Appendix 6.3 shows such a provision in the Waste Management Policy of State of Victoria, Australia

* Adoption of codes of practice by manufacturers and servicing agencies which will include obligations to prevent leakage and to recover CFCs to the extent possible. This will also require that recovery stations are purchased, installed, used and the recovered gas transferred to recycling stations.

In fact it could be made obligatory for large users such as manufacturers or assemblers of refrigerators, installations like chilling plants and car repair workshops to have a recovery station/system.

It can also be made obligatory for prospective new installations to provide for a recovery system in their contract.

An illustrative extract of legislation covering some of the above points in the State of Victoria, Australia is presented in Appendix 6.4 (Sect 32, 33, 34 & 35). Also enclosed is an extract from the rules laid down by South Coast Air Quality Management District, California (presented in Appendix 6.4 A) on Recovery or Recycling of Refrigerants from Motor Vehicle Airconditioners and Reduction of Emission from Stationery Refrigeration and Airconditioning Systems.

* Furthermore, to encourage compliance legislation could be introduced which would require all purchases of CFCs by service agencies on the basis that they return a certain quantity of recovered CFC for purchasing new CFC. Suppliers' records would also require to show how much recovered CFC was brought back and how much fresh CFC supplied.

c) Disposal

In respect of disposal it may be recognised that in developed countries purchases of white goods are frequent and trading-in is a common practice before the full life of an equipment. In such a situation one could have a mechanism supported by legislation whereby a dealer could take away (e.g. Swiss Law - see Appendix 6.5). However in Kenya, as is the practice in many developing countries, equipment are retained by the owner as long as it can be kept running and discarded only after all possible measures to salvage the same fail and at that point it is often sold to the service agency who cannibalises it or sells it as scrap.

Thus legislation for disposal of equipment may not be appreciated or logistically feasible to adopt. Furthermore, as discussed in an earlier chapter the costs of recovery of CFCs from discharded equipment especially from foams would be prohibitively expensive as to make it unviable.

Therefore no specific proposal is made on legislation for disposal of CFCs at this stage.

6.3.2 Financial Support Measures

In Kenya notwithstanding the small magnitude of CFC consumption, the real impetus for adopting practices for recovery and recycling can come only by providing financial incentives. Such incentives include the following :

a) Providing a subsidy on recovery and recycling equipment would establish the economic viability of undertaking such a program and would encourage the

participants to conform to the legislative measures proposed earlier. In our workings on economic analysis of recovery/recycling enterprises, we have assumed a subsidy of 20% on the cost of equipment which was the minimum to ensure economic viability. It is recommended that the actual subsidy be fixed between 20% and 50% depending on the speed of introduction of ventures desired.

b) Supply bags at nil cost/negligible cost to accredited servicing agencies for the domestic refrigerator and deep freezers.

c) Progressively increase in duties on virgin CFCs

One consequence that is anticipated is the phase-out of the small repair agency in the unorganised sector who may find it uneconomical at his scale of operation to undertake repair of equipment involving recharging of CFCs.

However in a developing economy, other avenues could open up for such enterprises.

d) Funding of training programmes for technicians as well as public awareness programmes.

e) Abolish duties on recovery and recycling equipment

6.3.3 Compliance with Requirements of Montreal Protocol

From the profile of CFCs demand in Kenya after taking into account the recovery and recycling, it is clear that, needs of CFCs in the years after 2005 could perhaps be best met through a CFC bank, for complying with the requirements of Montreal Protocol. This bank could be created, and maintained by the Government, in the years when the demand is within the Protocol limits, say year 2002 to 2004, to meet the additional requirements during the years after 2005. However a final decision regarding this should be taken depending upon the availability of "drop-in" substitutes for CFCs at that time.

As in the other countries, there would be a significant cost to Kenya for taking various actions indicated above for implementing a recovery and recycling programme including maintaining CFC bank. This has been worked out in Chapter - 5. We suggest that a fund be created which could be supported by multilateral aid.

6.3.4 Measures for Increasing Public Awareness

Given that CFC based equipments are mainly used by the economically stronger sections of society, we envisage no difficulty in increasing awareness about CFCs, their

effects on the ozone layer and recovery and disposal through programmes on TV, Newspapers etc.

6.3.5 Institutional Framework

The prime initiative for formulating and implementing the above measures could be by the National Environment Secretariat (NES) which could enlist support of industry associations. One of the first steps that could be taken is to encourage setting up of a body or association of manufacturers and service agencies involved in the air-conditioning & refrigeration sector either separately or as part of air existing body, such as Kenya Assosication of Manufacturers (KAM).

NES along with the association could be entrusted with the following:

a) Evolving codes for better manufacturing and service practices

b) Training the mechanics in better manufacturing and servicing practices and also in recovery/recycling

c) Accreditation of mechanics and service stations

d) Collection and compilation of CFC consumption data

e) Establishing demonstration stations for recovery through plastics bags, recovery stations and recycling stations

f) Coordination with recovery/recycling stations established in a network

g) Providing technical support to industry in (b), (c) above and also in the use of CFC substitutes

h) Organizing public awareness programmes

i) Coordinate setting up and maintaining a CFC bank

NES will also coordinate with other Government agencies for formulation and enforcement of policy measures. Some of the agencies are Registrar of Industries, Kenya External Trade Authority, (KETA) and Kenya Bureau of Standards (KBS).

Further, constructive roles can also be played in the above by Kenya Association of Manufacturers (KAM) and Kenya Consumers' Organisation (KCO) which are well established and respected organisations and can provide an effective interface with the private sector and consumers.

6.4 CONCLUSION

The present legislative and institutional framework with respect to CFC use recovery and recycling is limited. The country lacks an established machinery to enforce elaborate regulations or legislation.

Unlike in developed countries the public awareness or consumer pull is also limited and cannot be counted upon to 'drive' a recovery and recycling program.

On the other hand the economic situation, import dependence and the absence of Government controls make for a case to use a profit driven private sector managed program for recovery & recycling of CFCs.

In Kenya with the overall magnitude of CFC consumption as also the quantity recoverable being small, the Government/nominated environmental agency could actively push the large refrigerator manufacturers, which are few in number, to instal recovery equipment at their works as well as authorised service stations.

Also from the point of view of complying with the Protocol the above agency may itself set up a CFC bank in 2002 which could cater to recharging requirements in the years after 2005 and thus avoid premature scrap or costly retrofits of CFC-12 equipment.

Specific action would be for the government to

- exempt duty on equipment for recovery and recycling
- provide grants/subsidies to assist in setting up collection/recovery and recycling ventures. Such subsidies would range from 20-50% of capital cost. A minimum of 20% subsidy is necessary for ensuring viability, whereas a higher subsidy of upto 50% would be based on the individual country's approach to the motivational level desired for expediting implementation.
- fund training costs and public awareness programmes
- raise the price of imported CFC 11 & 12 to make recycling attractive.
- Strengthen existing institutions involved in environment and/or industrial activities to have a separate wing for implementing the recovery and recycling programmes in each country.
- enact legislation and a system of quotas to ensure that service agencies and suppliers participate in

the collection/recovery and recycling programmes.

The above could be met by creating a fund which could be set up with the help of multilateral aid.

CHAPTER - 7

CONCLUSIONS

7.1 CFC AUDIT

The detailed CFC national audits in the three project countries have shown that the total CFC consumption has reduced substantially in the last few years, mainly due to substitution by other substances in the foam and aerosol sectors.

As none of the project countries manufacture CFCs and there are no significant exports of CFCs or CFC based products, the consumption in each of the countries is approximately equal to the imports.

A summary of the total imports and utilisation of CFCs in the three project countries is given in Table 7.1.

TABLE - 7.1

IMPORT & UTILISATION OF CFCs IN 1991

(MT)

	EGYPT		KENYA		NIGERIA	
IMPORT	CFC-11	CFC-12	CFC-11	CFC-12	CFC-11	CFC-12
I IMPORT	1050	800	18	79	350	700
	1850		97		1050	
II UTILISATION						
- Refrigeration & Air conditioning	345	435	16.5	78.9	71.7	471.3
- Aerosols	90	360	5	4	-	150
- Plastic foams	640	50	-	-	280	-
Total	1075	845	21.5	82.9	351.7	621.3
	1920		104.4		973	

The utilisation in each country has been estimated by building up the demands for each of the sub-sectors,

through a comprehensive field survey of industrial enterprises.

The utilisation in the case of Egypt and Kenya is slightly higher than import figures, as part of the CFCs are indirectly imported, through refrigerators and foamed cabinets. However, in Nigeria the consumption of CFC 12 is lower than import quantity as about 10-15% of the imported CFC 12 is re-exported to neighbouring countries such as Ghana & Cameroon.

There is no significant consumption of CFCs in the solvent sector as CFC-113 has been substituted by Carbon Tetrachloride and Methyl Chloroform, which are also controlled substances as per the amended Montreal Protocol.

The current retail prices of refrigerants in the three project countries area are given at Table - 7.2 below :

TABLE - 7.2

(US$ PER KG)

	EGYPT	KENYA	NIGERIA
CFC 11	2.2	2.85	1.8 - 2.3
CFC 12	3.5 - 3.9	4.6 - 7.8	3.0 - 4.0
HCFC 22	4.2 - 5	7.10	3.5 - 4.5

CFC National audits have shown that the total consumption of CFC 11 and CFC-12 in the project countries has decreased during the last few years primarily due to substitution by other substances in the foams and aerosols sectors. In Egypt the import of CFC 11 & CFC 12 has gone down from 2400 MT in 1989, to 1900 MT in 1991. Similarly in Kenya there is a decrease from 230 MT (1989) to less than 100 MT in 1991; and in Nigeria the reduction has been less significant, i.e. from 1300 MT in 1985 to 1050 MT in 1991. Trends indicate that these figures will further go down.

7.2 DEMAND FORECAST

In the airconditioning and refrigeration sector, due to the complete dependence on imports for compressors as well as CFCs, the trend is that of phasing out the CFC based equipment in line with the developments in advanced countries. Hence gradual phaseout of CFC based equipment is expected to start from 1992/1993 itself, with complete

phaseout expected by 1997. The earliest phaseout will be for commercial refrigeration equipment which can be easily designed for operation with HCFC 22.

In other sectors viz aerosols, plastic foams and solvents, complete phase out is expected by 1995, 1993 and 1994 in Egypt, Kenya and Nigeria respectively.

Taking the above into account, the demand for CFCs upto the year 2010 has been arrived at for each of the three countries by aggregation of the demands for the various sub-sectors of airconditioning and refrigeration in the respective countries, as summarised in Table - 7.3 below.

Substantial part of this demand is on account of recharging and this emphasises the need of recovery and recycling systems as an important means to reduce the consumption further for an eventual phase out.

TABLE - 7.3

PRESENT & PROJECTED DEMAND FOR CFCs IN THE PROJECT COUNTRIES (MT)

COUNTRY	1991	1996	2005	2007	2010
EGYPT					
- Refrigeration & Airconditioning	780	658.7	295.7	247.7	172.3
- Aerosols	450	-	-	-	-
- Plastic Foams	690	-	-	-	-
- Solvents	-	-	-	-	-
	1920	658.7	295.7	247.7	172.3
KENYA					
- Refrigeration & Airconditioning	95.4	61.4	37.0	29.7	18.3
- Aerosols	9	-	-	-	-
- Plastic Foams	-	-	-	-	-

- Solvents	-	-	-	-	-
	104.4	61.4	37.0	29.7	18.3

Table - 7.3 (Contd.)

COUNTRY	1991	1996	2005	2007	2010
NIGERIA					
- Refrigeration & Air-conditioning	543	408.1	104.2	50.3	11.7
- Aerosols	150	-	-	-	-
- Plastic Foams	280	-	-	-	-
- Solvents	-	-	-	-	-
	973	408.1	104.2	50.3	11.7

In each of the three countries, the import and consumption of CFCs is concentrated in and around the national capitals. In Egypt, most of the importers of CFCs and the major users are located in and around Cairo. Similarly in Kenya & Nigeria the concentration of importers and users of CFCs is in Nairobi and Lagos respectively. However in Nigeria, the distribution network of the importers is quite spread out across the country, whereas in the other two countries it is limited to only few of the important cities/towns, where the manufacturers and/or servicing agencies for CFC based equipment are operative.

7.3 EQUIPMENT FOR RECOVERY AND RECYCLING OF CFCs

Equipment for recovery and recycling are available for different applications in various capacity models. These equipments have been in use in developed countries and the technology for the same is well established and brought to a level so that it can be easily adopted.

Since the volumes of CFCs handled by typical individual enterprises in the project countries are very small, it is recommended that the low cost low capacity and portable models of the recovery and recycling equipment would be most appropriate for early adoption in Egypt, Kenya and Nigeria. These equipment are versatile and can be used for recovery and recycling of HCFC-22. Their utility will thus continue even after the CFCs are phased out completely.

Features incorporated in the recovery and recycling equipment are such that these can be easily operated and maintained by local technicians, after initial training input of 1 to 2 weeks. The important operating parameters for these equipments are as follows :

	Recovery equipment	Recycling equipment
- Spares & consumables (US $/Kg)	0.31	0.41
- Energy consumption (per kg)	0.05 KWH	0.05 KWH

7.4 TECHNICAL OPTIONS FOR COLLECTION/RECOVERY AND RECYCLING OF CFCs

7.4.1 The recovery and recycling of CFC-11, which is a liquid at room temperature and is used for large commercial installations, has been an established practice. Hence the focus in this study was on recovery and recycling of CFC 12. Though HCFC-22 is not covered under the project, it is of interest as similar equipment could be used, as for CFC 12, for recovery and recycling.

7.4.2 All the three project countries - Egypt, Kenya and Nigeria which are signatories to the Montreal Protocol have per capita CFC-consumption levels as given in Table - 7.4 below :

TABLE - 7.4

PER CAPITA CFC CONSUMPTION

	TOTAL CFC CONSUMPTION IN 1991 (MT)	ESTIMATED POPULATION IN 1991	PER CAPITA CFC CONSUMPTION
EGYPT	1920.0	57 Mn	33.70 gms
KENYA	104.4	25 Mn	4.15 gms
NIGERIA	973.0	115 Mn	8.50 gms

These are far lower than the specified limit of 0.3 Kg per capita, and put them in the category of "Developing Countries".

Presently, CFC imports in these countries are mainly from France, UK and Germany. Even if these countries stop or curtail the production of CFCs in the next few years, the project countries viz. Egypt, Kenya & Nigeria, will not have any problem, as these will still be available from other sources such as China, India, etc., although prices of CFCs are likely to rise world-wide due to the accelerated phasing out of CFCs in developed countries.

The project team, however, saw a considerable amount of enthusiasm in these countries to counter the ozone depletion problem and to reduce the consumption/import of CFCs. Initiative taken by these countries to sign the Montreal Protocol alongside developed countries is indicative of the positive attitude of their governments to this issue.

7.4.3 The priorities for introduction of recovery and recycling equipment in the three countries are as follows based on the CFC consumption pattern and assessment of recoverable quantities for each sub-sector.

Country		Sub-Sector
Egypt	-	Domestic refrigeration & deep freezers
	-	Mobile airconditioning
Kenya	-	Domestic refrigerators & deep freezers
	-	Commercial & Industrial refrigeration
Nigeria	-	Mobile airconditioning
	-	Domestic refrigerators & deep freezers

7.4.4 Considerations for Adoption of Recovery & Recycling Equipment

Local manufacture/assembly of the recovery and recycling equipment in the project countries is technically feasible but not commercially viable due to low requirements. To make local manufacture/assembly in an African country viable, it would be necessary to club local requirements with the neighbouring countries' requirements. Therefore three or four projects can be considered for Africa as a whole.

However, the necessary technical skills and competence exists to operate and maintain the equipment, with necessary training inputs being provided initially.

7.4.5 Attainable Reduction in CFC Consumption

Recovery and recycling programmes in each country will help reduce the CFC consumption substantially. The total consumption of CFCs in each country includes substantial quantity used for flushing/cleaning and leak detection during servicing and repair of the refrigeration and airconditioning equipment. This quantity is considered as technically possible to recover & recycle.

Further, in the cases of compressor failure or leakages in the refrigeration system, some quantity of the refrigerant remains in the system which can be recovered at the time of servicing/repair.

The maximum reductions attainable, based on 1991 field survey data, are given in Table 7.5 below :

TABLE - 7.5

MAXIMUM ATTAINABLE REDUCTION IN CFC CONSUMPTION BY RECOVERY & RECYCLING (1991 DATA)

	as % of recharging demand	as % of total demand
Egypt	58	28
Kenya	56	26
Nigeria	36	27

Recovery of CFCs from related materials (Insulation Foam)

The recovery of CFCs from insulation foam is logistically and economically not feasible in the project countries, due to the wide dispersal of scrapped refrigeration equipment, and the highly capital intensive nature of requisite facilities.

Safe Disposal of CFCs

Disposal of CFCs is not a practical proposition for any of the project countries as the facilities for thermal incineration require very high capital investment (over US$ 40 million) and can be justified only if the quantity of CFCs to be destroyed is of the order of 15,000 MT per annum. Even then the cost of destruction is about US$ 3000-3500 per MT of CFC making it economically unviable.

7.5 ECONOMIC ANALYSIS

7.5.1 The three types of practical ventures for recovery and/or recycling of refrigerant gases in the Airconditioning and refrigeration sector for each country are :

a) Collection using plastic bags - for domestic refrigerators and deep freezers sub-sector

b) Recovery using portable equipment - all sub-sectors

c) Recycling using portable equipment (with additional recovery equipment) - all sub-sectors

These ventures will be operated as an extension of the existing activities of industrial enterprises in the field, and hence must provide sufficient economic motivation to the promoters.

7.5.2 The venture for collection using plastic bags does not involve any capital investment, while the ventures of type (b) & (c) would require initial capital investment for suitable equipment, which is estimated at about US $ 1000 and US $ 2400 respectively. This is based on the indicative prices of the specific models which are considered appropriate for adoption in the project countries.

7.5.3 The viability analysis for each type of venture is done taking the following aspects into account :

a) Estimation of cost of the project, in local currency, and means of financing on the basis of current norms in each country.

b) Computation of operating revenues for each type of venture based on quantity of CFC processed and the price to be realised for the same.

c) Assessment of operating costs including cost of raw materials, consumable & spares, power, labour, transportation, depreciation, interest and other overheads.

d) Projection of the level of activity/scale of operation for each type of venture in each country, upto the year 2010 (terminal year for CFC phaseout).

e) Estimation of the total number of ventures in each country, or the basis of :

- concentration and dispersion of sectors/sub-sectors to be addressed by each type of venture.

- level of activity of a typical venture.

- realistic proportion of the target population to be addressed.

- manpower availability.

- recognition of the fact that the recoverable quantity would progressively reduce due to phasing out of CFC based equipment.

7.5.4 The important findings regarding the viability of ventures are summarised at Table 7.6 below :

TABLE - 7.6

SUMMARY OF VENTURE VIABILITY ANALYSIS

VENTURE TYPE		EGYPT	KENYA	NIGERIA
Recovery only	- No. of ventures	100	40	150
	- Cost per kg of CFC recovered(US $)	0.92	1.04	0.92
	- Break-even volume	209 Kg	145 Kg	205 Kg
	IRR			
	- on equity	67.8%	93.9%	215.1%
	- on total capital	23.5%	27.9%	17.2%
	Payback Period			
	- on equity	1 Year & Six months	1 Year	6 Months
	- on total capital	4 Years	4 Years	2 Years
Recycling	- No. of ventures	12	5	10
	- Cost per kg of CFC recycled (US $)	4.10	5.80	4.47

Table - 7.6 (Contd.)

VENTURE TYPE	EGYPT	KENYA	NIGERIA
- Break-even volume	1439 Kg	1013 Kg	1306 Kg
IRR			
- on equity	197.2%	179.9%	325.1%
- on total capital	78.9%	75.6%	97.7%
Payback period			
- on equity	1 Year & 2 Months	8 Months	6 Months
- on total capital	2 Years	2 Years	1 Year & 6 Months

7.5.5 Based on the venture level viability analysis, the net national economic benefit for each country, for adopting a recovery and recycling programme, has been worked out by taking into account the following :

Benefits:

- savings in imports of refrigerants
- increase in employment
- increase in consumption and investment
- increase in government revenues

Costs:

- cost of equipment and consumables
- training and publicity costs
- increase in costs of overheads and maintenance of ventures
- duties and taxes foregone by the government

The above costs and benefits have been assessed till the year 2010 and net present value obtained by discounting at the rate of 2% for arriving at the net national economic benefit for each country.

The Net National Economic Benefits to the project countries, based on the above analysis, works out to (-) US$ 5.95 million, (-) US$ 0.48 million and (-) US $ 0.97 million respectively for Egypt, Kenya and Nigeria.

7.6 COMPLIANCE WITH MONTREAL PROTOCOL

In the context of compliance with the requirements of the Montreal Protocol, it is seen that in Egypt and Nigeria the total demand exceeds the limit in the year 2007.

However, in the case of Kenya, this takes place earlier, i.e. in the year 2005. With the implementation of recovery and recycling programmes, the compliance with protocol requirements can be achieved as follows :

- Egypt - upto 2007
- Kenya - upto 2007
- Nigeria - upto 2010

In Egypt & Kenya, the further reduction in CFC consumption required after 2007 to meet the protocol limits is of such an order that it can be met through CFC banks, or use of drop-in substitutes, which are expected to be available at that time.

7.7 FRAMEWORK FOR IMPLEMENTATION

7.7.1 Presently, none of the three project countries have any legislative regulations regarding collection/recovery and recycling of CFCs. Even regarding usage, only Egypt has introduced in 1989, a Ministerial decree banning the use of CFCs for aerosols.

7.7.2 In the context of the findings of the study, it is felt desirable and necessary to introduce regulatory legislative measures regarding various aspects of CFC consumption, viz sale, purchase and conservation, through recovery & recycling. These legislative and regulatory measures would be aimed at achieving the following:

a) identification of users of CFCs

b) imposing an obligation on sellers and users to report consumption or utilisation of CFCs

c) establishing codes of practice for repair/servicing agencies

d) accreditation of service mechanics and agencies

e) ensuring proper disposal of equipment containing CFCs

f) ensuring adoption of recovery and/or recycling equipment

7.7.3 Further, the analysis shows that recovery and recycling in the project countries will be economically viable at the venture level, provided that the following financial incentives are given.

- exemption of import duty on recovery and recycling equipment
- subsidy on equipment cost (@ 20% to 50% depending upon individual country's level of motivation to implement the programme)
- increase in import duty on CFCs
- free supply of plastic bags to service agencies for collection from domestic refrigerators and deep freezers
- funding the cost of training programmes on operation and maintenance of recovery and recycling equipment
- funding the public awareness campaign, etc.

7.7.4 In order to initiate and implement the above scheme, it is necessary to strengthen the institutional framework in each country. This would involve creating a specific organisation (which could be under the aegis of the present environmental agencies in each country) for overall coordination and monitoring, as well as creating proper awareness about the harmful effects of ozone layer depletion. The cost of the recovery and recycling programme, based on Net National Economic Benefit Analysis for each country, could be met from multilateral fund.

7.8 COMPARISON OF COUNTRY CASE STUDIES & FORMULATION OF REGIONAL GUIDELINES

The comparison of the country case studies brings out the following :

a) The present industrial infrastructure is poor and manufacture of CFC based equipment is dependent on import of components as well as CFCs. Hence the substitution with non-CFC based equipment in OEM would take place in line with the developed countries.

b) However, economic pressures would motivate extended use of existing CFC based equipment, resulting in continued requirement of CFCs for recharging.

c) In all cases, technical options identified are similar. These are

- Use of plastic bags for collection of CFCs from domestic refrigerators

- Recovery equipment for recovering CFCs from car airconditioners and commercial refrigeration systems

d) In all cases, recycling would be ideally undertaken by the CFC suppliers as they have the necessary infrastructure for collection, storage and distribution.

e) All countries would have to import the recovery and recycling equipment, hence the project cost for ventures is similar.

f) We have found that recovery and recycling ventures can be made viable by giving adequate financial support and instituting an appropriate pricing mechanism for collected/recovered and recycled CFCs.

g) In all countries, the present organisation under respective environmental agencies requires to be strengthened for implementing and monitoring of the CFC recovery and recycling programmes.

h) Existing legislative framework in each of the countries is inadequate with respect to CFC utilisation. This calls for necessary legislation to be enacted to cover the following :

- Sales & purchase of CFCs

- Formulation and implementation of codes of practice in manufacturing as well as servicing

- Collection/recovery of CFCs by service agencies and purchase of the same for recycling and sale by the selling agencies

i) Need for emphasis on increasing public awareness to make the collection/recovery and recycling programmes successful.

7.9 REGIONAL POLICY GUIDELINES FOR AFRICA AS A WHOLE

The regional guidelines for Africa as a whole have been formulated based on the above assessment.

As African countries do not manufacture CFCs, the only technical option to reduce CFC consumption/emissions is through implementation of viable CFC collection/recovery and recycling programmes.

The number of recovery and recycling ventures and formulation of an overall National System will require a detailed audit of CFC consumption and a study of manufacturing and servicing practices in each country.

The audit data would need to be analysed for prioritisation of sub-sectors for implementing the recovery and recycling programme. This would be based on the assessment of the quantities of CFC handled and geographical dispersion of users as well as servicing agencies.

Some of the significant guidelines are :

7.9.1 Institutional

Each country would require to have an organisation identified or created to implement the collection/ recovery and recycling programmes. This can be achieved by Institutional strengthening of any existing agency involved in environmental issues.

7.9.2 Legislative

Enactment of suitable laws in respect of supply and usage of CFCs

7.9.3 Market Measures

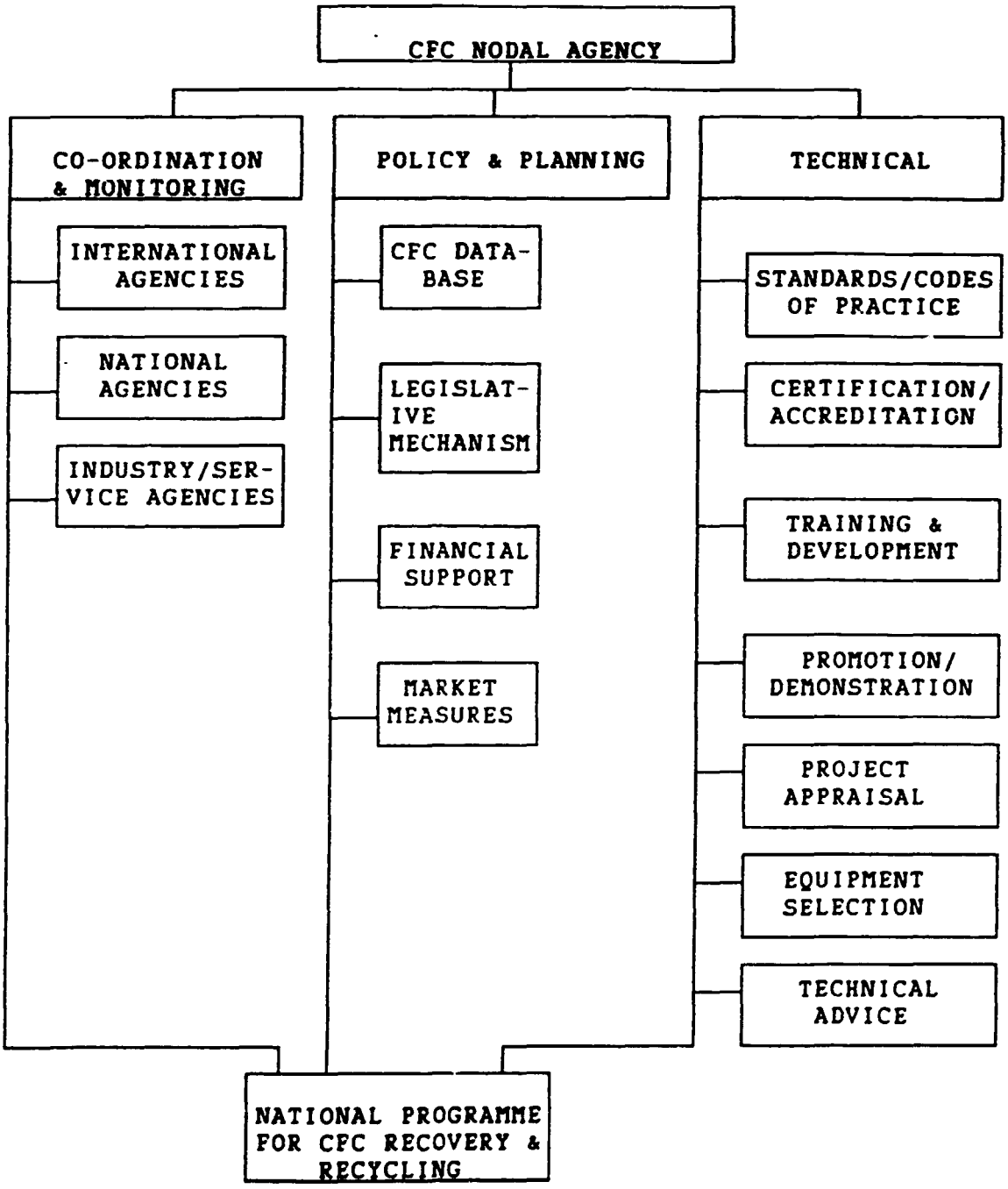
Intervention to raise prices of virgin CFCs, curbing of imports through limited quota allocation, setting up central recycling facilities, creation of public awareness etc.

7.9.4 Financial Support

Subsidies on capital investment for recovery and recycling

FIGURE - 7.1

REGIONAL POLICY MAKING FRAMEWORK



projects, funding of costs on training, waiving of import duty on equipment, subsidising the cost of plastic bags etc.

National Governments would, in turn, need support for funding this programme from external sources, i.e. multilateral fund created by the international community.

7.9.5 The proposed regional policy making framework is shown in Figure 7.1.

7.10 REGIONAL DATA BANK

7.10.1 A national data base would need to be created for each country which would comprise of data on enterprises, sub-sectors and sectors of industry using CFCs. The data base for each country can be integrated into a Regional Data Bank, for which a detailed outline has been presented in this report.

7.10.2 The regional data bank would be organised in four levels, as follows:

Level 1 : Enterprise level

Level 2 : Sub-sector level

Level 3 : Sector level

Level 4 : Country level

This data bank will form the heart of a system at country level to formulate policies for phase out programmes with projects for recovery and recycling. The pictorial presentation of such a system is given at Figure 7.2.

7.10.3 The country level data would provide the inputs at the regional level to facilitate comparative analysis of the CFC consumption and conservation under different policy regimes. Figure 7.3 shows the scheme of such a regional information system.

FIGURE - 7.2

SYSTEM FRAMEWORK AT COUNTRY LEVEL
FOR REGIONAL POLICY ANALYSIS

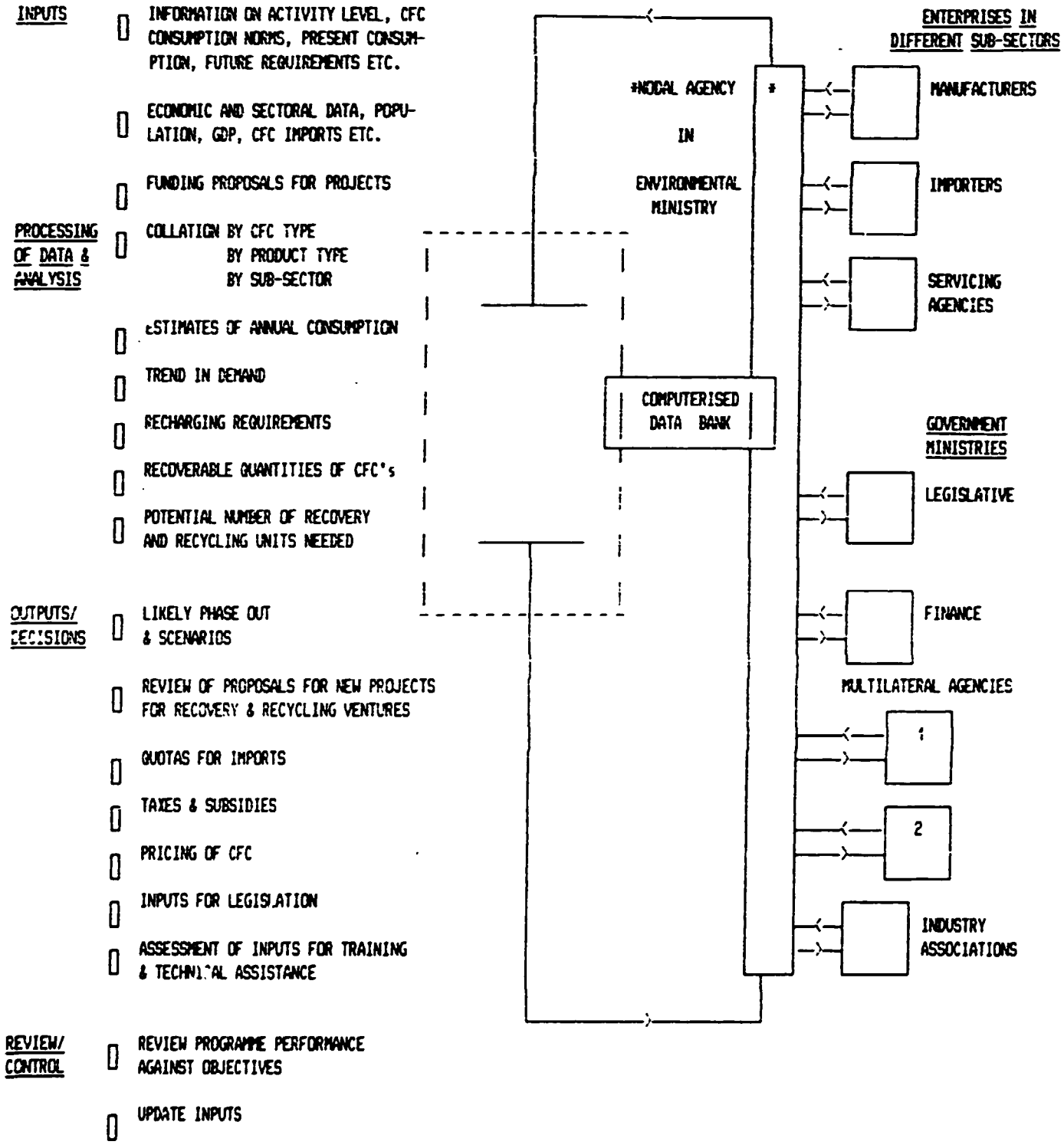
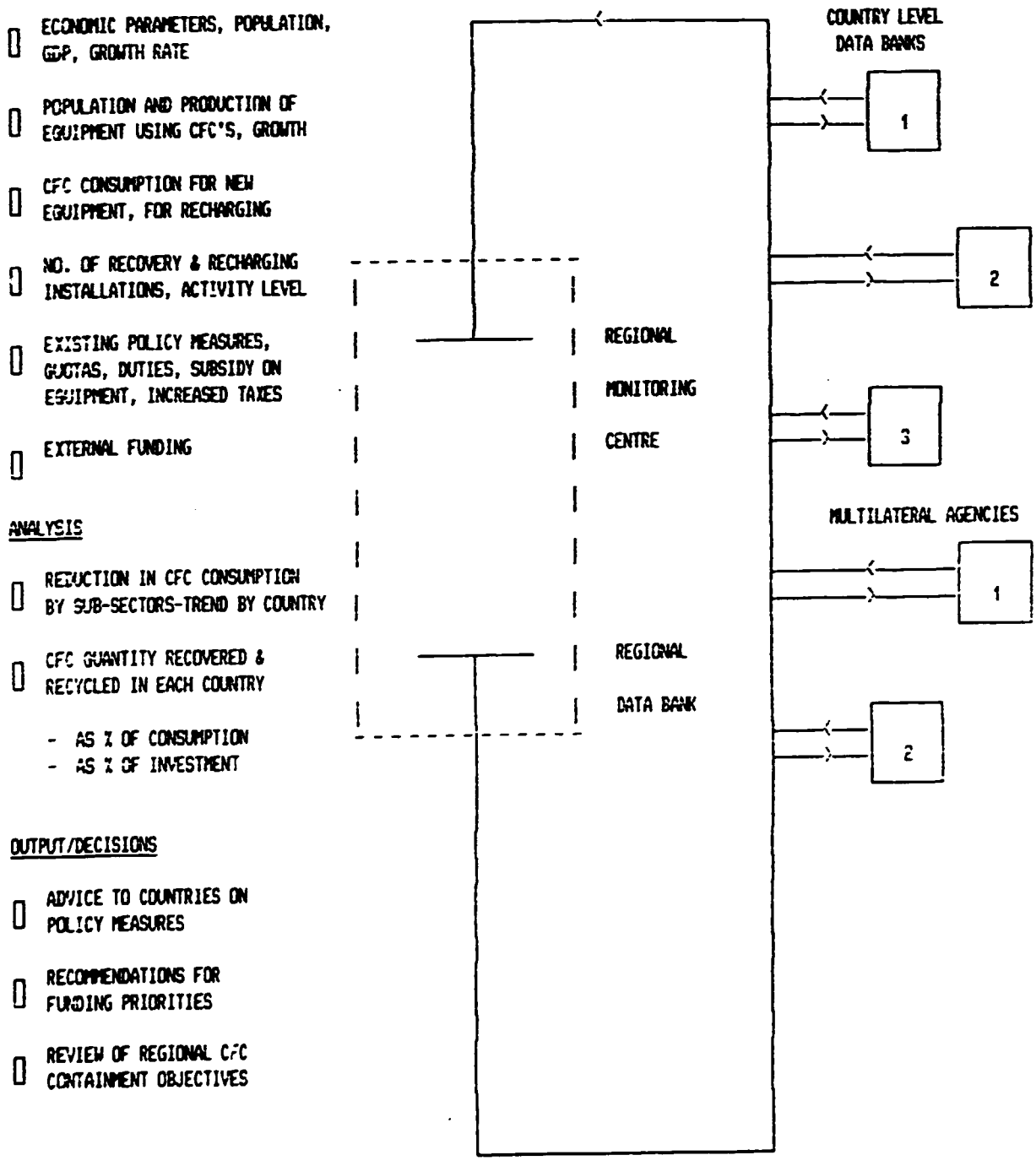


FIGURE - 7.3

SYSTEM OUTLINE AT REGIONAL LEVEL



7.11 SUMMARY

The findings of the study indicate that given adequate financial support from multilateral agencies and with appropriate legislation and institutional strengthening for implementation, viable programmes for recovery and recycling of refrigerant gases can be set up in Africa.

APPENDICES

APPENDIX - 1.1

LIST OF REPORTS/DOCUMENTS USED AS REFERENCE MATERIALS

1. Techno-economic assessment of the financial viability of the collection and safe disposal of refrigerant gases and relevant material in Africa: Background analysis.
(UNIDO - 1990)

2. Revised Montreal Protocol - requirements and assistance to the developing countries, Thailand.
(UNEP - 1991)

3. Costs to Egypt of protecting the Stratospheric Ozone Layer.
(Egyptian Environment Affairs Agency-1990)

4. Ozone Layer Protection : Kenya case study on costs and strategies.
(UNEP - 1990)

5. The costs to developing countries of entering the Montreal Protocol.
(UNEP, Nairobi, 1990)

6. The economic implications for developing countries of the Montreal Protocol.
(UNEP, Nairobi, 1990)

7. CFCs : Times of transition, American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE 1989)

8. Potential costs of restricting CFCs use.
(US Department of Energy, 1989)

9. Aerosols A - Z, British Aerosols Manufacturers Association.
(1988)

10. Ozone protection Act 1989, Australia.

11. Code of good practice (Australia) for -

    - The reduction of emissions of CFCs - R11, R12, R113, R114 and R115 in refrigeration and air-conditioning applications.
    (1990)

- R12 in domestic refrigeration applications.
  (1990)

- Minimisation of CFC emissions from degreasing/cleaning plants using CFC 113 solvents.
  (1990)

12. Code of practice for the control of CFCs from motor vehicle air-conditioners.
    (Motor Traders Association of Australia, 1991).

13. Equipment literature on refrigerant recovery and recycling machinery given at Para 5.2 of Interim Report, 1991.

14. Technology in Indian refrigeration and compressor industry.
    (Ministry of Science and Technology, Government of India, 1988).

15. CFC scenario and substitution options in Indian context.
    (Shri Ram Fibres, India, 1989).

16. Alternative to CFC infested polyurethane (PUF),
    (Glass Fiber Manufacturers Association, India, 1991).

17. Refrigeration and Air-conditioning study and recommendations.
    (Task Force on National Strategy for phasing out ozone depleting substances, India, 1991).

18. Report on the supply and use of Ozone Depleting Substances in India and sectoral analysis.
    (Ministry of Environment & Forests, Government of India, 1990).

19. Mexico's strategy on Ozone Layer Protection : A case study on the cost of implementing the Montreal Protocol.
    (National Manufacturing Industry Chamber, 1990).

20. Chile : Strategy on Ozone Layer Protection : A case study on the cost of implementation of the Montreal Protocol.
    (Ministerio de Bienes Nacionales, Chile & UNEP)

21. The World Bank and the Environmment - A Progress Report Fiscal 1991.
    (The World Bank, Washington DC)

22. Country Capacity to conduct Environmental Assessments in Sub-Saharan Africa :
(The World Bank, Africa Region)

23. Environmental Policy and the Public Revenue in Developing Countries.
(The World Bank, July, 1990)

24. Implemmenting the Montreal Protocol to Protect the Ozone Layer
(The World Bank)

25. Recovery or Recycling of Refrigerants from Motor Vehicle Air Conditioners (Rule 1411).
(South Coast Air Quality Management Distt Board, California)

26. Reduction of Chlorofluorocarbon Emissions from Stationary Refrigeration & Air Conditioning Systems (Rule 1415)
(South Coast Air Quality Management Distt Board, California)

27. CFC Alliance Bulletin (July/August, 1991)
(Alliance for Responsible CFC Policy, Arlington)

28. CFC-12 Refrigerant Recycling & Service Procedures for Automotive Air Conditioning Technicians-Certification Training Manual.
(Mobile Air Conditioning Society, East Greenville, PA 18041, USA).

29. Strategy for Ozone Protection
(Australian Environment Council, August 1989)

30. Technology in Indian Chlorofluorocarbons (CFCs) Refrigerants and their Substitutes Industry
(Department of Scientific & Indusutrial Research, Minisitry of Science & Technology, Government of India).

31. Reducing the consumption of Ozone Depleting Substance in India
(S.B. Billimoria & Co., India)

32. Technical Progress on Protecting the Ozone Layer Report on the Technology Review Panel (Pursuant to Article (6) of the Montreal Protocol on Substances that Deplete Ozone Layer, under the Auspices of the United Nations Environment Programme, June 1989)

APPENDIX -1.1 (Contd.)

33. Project Appraisal & Planning for Developing Countries by I.M.D. Little and J A Mirrlees

34. Swedish Code of STATUTES/SVENSK FOR FATTNINGSSAMLING ORDINANCE ON CFCs, HALONS ETC., (1988:716) (UNEP)

35. United Nations Environment Programme
(Pilot Workshop for CFC Officers, Bangkok, Thailand, 30 March - 2nd April, 1992)

36. Reduction Strategy - Austria, Switzerland
(Pilot Workshop for CFC Officers) (UNEP)

37. Sweden Experience on Recovery of Refrigerants and better Maintenance - Sweden
Pilot Workshop for CFC Officers (UNEP)

38. Automotive Airconditioning

Pilot Workshop for CFC Officers (UNEP)

39. Automotive Airconditioning - Code of Practice
(Pilot Workshop for CFC Officers (UNEP)

APPENDIX - 1.2

LIST OF ORGANISATIONS/PERSONS CONTACTED DURING FIELD SURVEY

KENYA

SL. NO.	COMPANY	NAME
i)	Importers of CFCs	
1.	Hoechst Industrial Chemicals Dept. II Hoechst East Africa Limited Mogadishu Road Industrial Area Nairobi - Kenya	P D Patel
2.	Twiga Chemical Industries Ltd Viewpark Towers P O Box 30172 Nairobi, Kenya	Mathew K Mwangi Techno-Commercial Representative
3.	Twiga Chemical Industries Ltd Town House, 5th Floor Kaunda Street P O Box 30172, Nairobi, Kenya	P E Mwangi Sales Manager Industrial Chemicals Dept.
4.	East African Oxygen Ltd P O Box 18196	Samuel Githagi Muchogu Business Manager - Industrial Gases
5.	East African Oxygen Ltd	John M Ngea
ii)	Airconditioing & Refrigeration Companies :	
6.	Refrigeration Centre P O Box 44893	M Alam
7.	Remco Ltd P O Box 18172 Nairobi.	J Dean Director
8.	Refrigeration Contractors Ltd P O Box 78782 Nairobi.	A Tejani Director
9.	Tropical Environment Consultants Ltd P O Box 50263 Nairobi.	M B Lambert Director

10.	Alphonso Refrigeration Enterprises P O Box 60330 Solai Rd, Nairobi	Joseph M S Alphonso Managing Director
11.	Daikin Kenya Ltd P O Box 39541 Nairobi.	Shekhar Bhole Cheif Engineer
12.	Hall Equatorial Ltd P O Box 30663 Baricho Road, Industrial Area	R K Kohli Managing Director
13.	-do-	S Sivaraj Installalation/Service Engineer
14.	Gilfilian Technical Services Ltd Funzi Road Box 30044 Nairobi.	M B Lambert Managing Director
15.	Daikin Kenya Ltd Wajir Road - Industrial Area P O Box 39541 Nairobi.	Nizar Samji Executive Director
16.	Kingsway Radio & Refrigeration Ltd Muindi Mbingu Street P O Box 40183 Nairobi.	Karim AR Didarali Manager
17.	Qualitrade Air Tech Services P O Box 48198 Nairobi	A K Mallick
18.	Car & General Ltd P O Box 20001, Nairobi	Manager

iii) Assemblers of Domestic Refrigerators & Airconditioners :

19.	Nairobi Afrigas Distributors (K) Limited P O Box 44922 Nairobi Head Off : Lusaka Road Show Room : Kimathi Street	C M Thakar Admn Manager
20.	-do-	M Yakub Production Manager

21.	Sanyo Armco (Kenya) Ltd P O Box 18263 Lunga Lunga Road Nairobi.	Y Hasegawa Technical Advisor
22.	Sanyo Armco (Kenya) Ltd P O Box 47167 City Hall Annex	Farook Qureishi Marketing Manager
23.	Premier Refrigeration & Engineering Ltd Sungura Avenue Industrial Area P O Box 2424 Nakuru	Mr D D Marathe General MAnager
24.	Kamco Engineering Ltd Nairobi	S Chandaria General Manager
25.	-do-	Edward Jumba Production Superviser

iv) Vehicle Assemblers :

26.	Toyota Kenya P O Box 45912 Uhuru Highway Nairobi	B M Gachoka Local Content Manager
27.	Kenya Motor Industry Association Kaunda Street Nairobi	Gavin Bennet
28.	General Motors Kenya Ltd Enterprise Road Mombasa Road P O Box 30527 Nairobi	John K Mwirichia Engineering & Product Development Manager

E Manufacturers of Foams

29.	Bobmil Industries Ltd P O Box 48876 Nairobi, Kenya	Mohankumar General Manager
30.	Megh Cushion Industries Ltd P O Box 18523 Enterprise Road	G S Kenth Director
31.	Foam Plastics Ltd Industrial Area, Nairobi.	Shanti Shah

F Users :

32.	Kenya Association of Hotel Keepers & Caterers P O Box 46406 Nairobi	Mr J Kiti Chief Executive
33.	Pullman International Hotels Nairobi Safari Club P O Box 43564 Nairobi	Antoni V Kuhnen General Manager
34.	-do-	Wilson M Kyuli Resident Engineer
35.	Nairobi Serena Hotel P O Box 46302 Nairobi	Charles Kiruthu Hotel Engineer
36.	Nairobi Hilton P O Box 30624 Nairobi.	M George Mansour Cheif Engineer
37.	Nairobi Hilton P O Box 30624 Nairobi.	Francis Shyanguya Maintenance Engineer
38.	Railways Workshop	Workshop Manager
39.	Fresh Produce Exporters Association of Kenya Gilfillan House Nairobi	Kasanga Mulwa Chairman
40.	Horticultural Crops Development Authority 4th Floor Uniafric House Koinange Street Nairobi	Martin A S Mulandi Director General
41.	Brooke Bond Kenya Ltd/ Sulmac Co Ltd Norfork Towers Kijabe Street P O Box 42011 Nairobi.	David H Gray Director
42.	Agriculture Development Corpn	J K Siror Head, Horticulture

G Institutions

43.	Kenya Bureau of Standards P O Box 54974 Nairobi	B D M Were Senior Standards Officer
44.	Kenya Consumers Organisation P O Box 21136 Nairobi	Francis O Orago Executive Secretary
45.	-do-	D F Oloo
46.	Kenya Association of Manufacturers Hughes Building Muindi Mbingu St. Room 133 P O Box 30225 Nairobi.	Kiarie Kamanu Senior Executive Officer

H Government Deptts

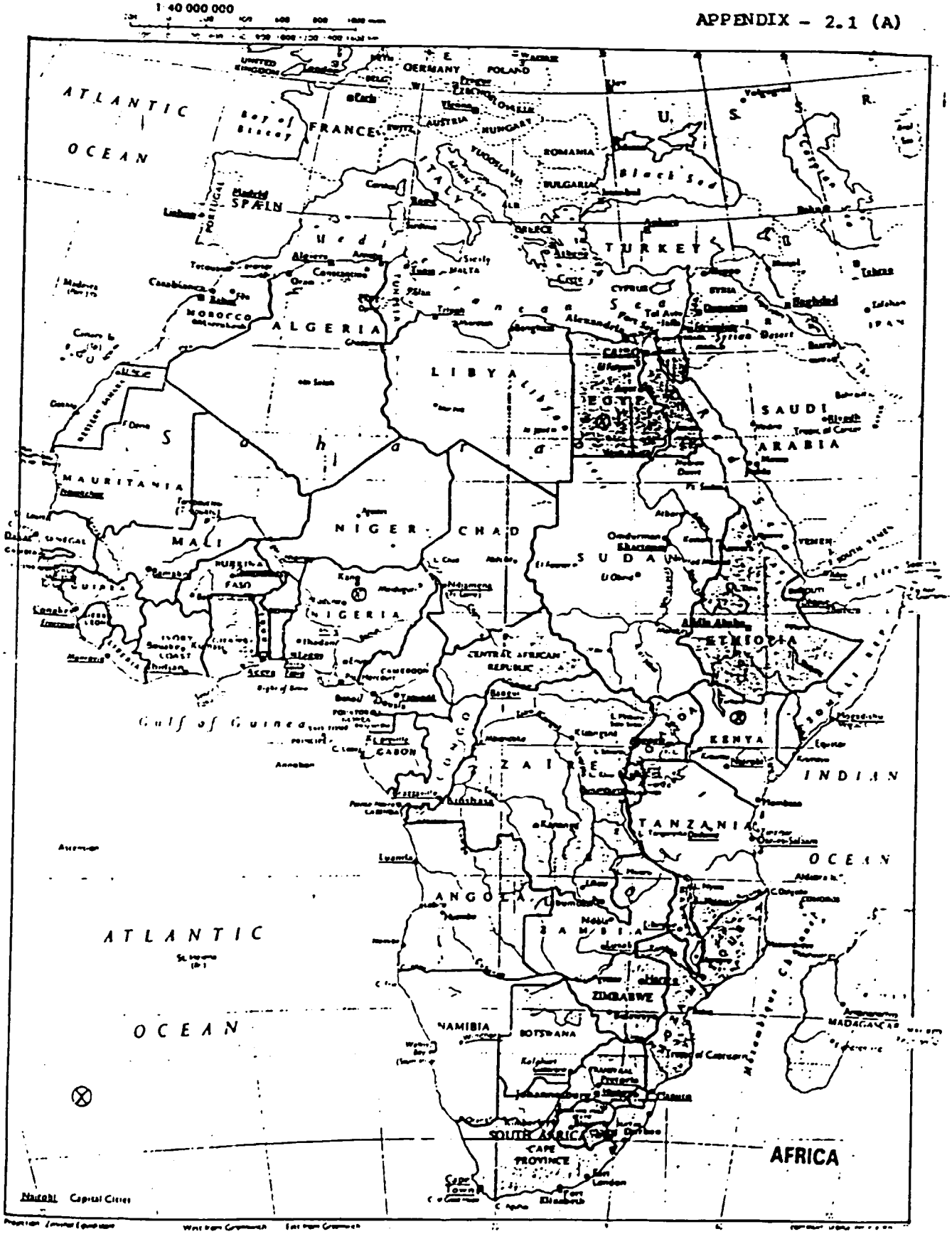
47.	National Environment Sectt Ministry of Environment & Natural Resources Govt of Kenya	Mr Mugo, Director Mr B O K'omudho Mr F N Kihumba Mr Mungai
48.	Kenya External Trade Authority	Mr Kaitany, Director
49.	Registrar of Industries	Mrs Alambo
50.	Director of Industries	Mr Olum

I United Nations and Others

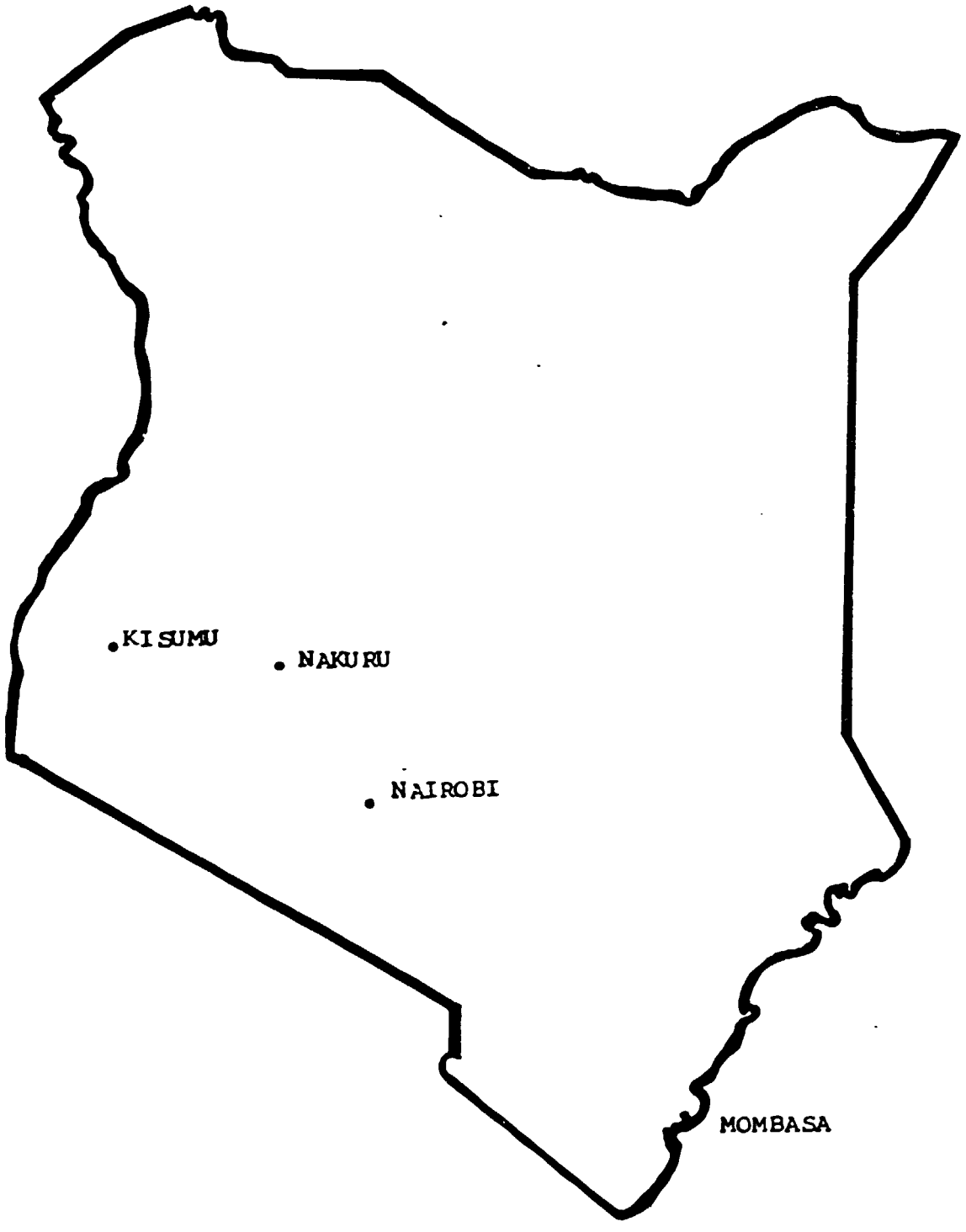
51.	United Nations Industrial Development Organisation Kenya International Conference Centre P O Box 30218 Nairobi.	Bjarne Larsen Programme Officer
52.	-do-	Paul Mwaka UNIDO Consultant
53.	United Nations Environment Program Ozone Secretariat P O Box 47074 Nairobi, Kenya	K Madhava Sarma Co-ordinator

54.	UNEP P O Box 47074 Nairobi	Yusuf J Ahmad Advisor
55.	UNEP	Naigzy Gebremedhin Chief Taeb
56.	UNEP	Tore J Brevik Chief, Information & Public Affairs
57.	Attache Commercial High Commission of India, Nairobi	Jitinder Bir
58.	High Commission of India P O Box 30074 Nairobi	Vishnu N Hade First Secretary
59.	Engg Export Promotion Council (India) Room No. 104 St George House Parliament Road P O Box 42030 Nairobi,	R Sundararajan Resident Director

APPENDIX - 2.1 (A)



APPENDIX -2.1(b)



KENYA

A. COMPUTATION FOR DEMAND OF CFCs IN NEW EQUIPMENT PRODUCTION - NEW DEMAND (1991)

SUB-SECTOR	TYPE OF CFC	AVG. UNIT NORM OF CONSUMPTION (KG)	WASTAGE FACTOR (%)	ACTUAL UNIT AVERAGE CONSUMPTION (KG)	DEMAND OF NEW EQUIP (NOS)	CONSUMPTION OF CFC FOR NEW DEMAND (MT)
DOMESTIC REFRIGERATION AND DEEP FREEZERS	CFC - 12	0.12	150	0.30	20,000	6.0
	CFC - 11	0.60	10	0.66	16,000	10.5
COMMERCIAL AND INDUSTRIAL REFRIGERATION						
- COLD STORES, COMML. FREEZERS ETC.	CFC - 12	6	50	9	750	6.8
	CFC - 11	1 - 1.75	20	2	750	1.5
- DISPLAY CABINETS etc.	CFC - 12	0.5	150	1.25	2500	3.1
	CFC - 11	1.2 - 1.5	20	1.8	2500	4.5
- MOBILE REFRIGERATION	CFC - 12	7 - 10	40	10 - 14	10	0.1
	CFC - 11	-	-	-	-	-
- OTHER (Ice makers and small refrigeration eqpt	CFC - 12	0.5	150	1.25	12,000	15
	CFC - 11	-	-	-	-	-
SUB TOTAL	CFC - 12					25
	CFC - 11					6.0
DOMESTIC & COMMERCIAL AIRCONDITIONING	CFC - 12	-	-	-	Neg	Neg
	CFC - 11	-	-	-	Neg	Neg
MOBILE AIRCONDITIONING	CFC - 12	1.2 - 1.4	150	3	1500	4.5
	CFC - 11	-	-	-	-	-

a) Demand for new equipment is taken equivalent to production plus imports of CFC based equipment
b) Wastage factor is applied to account for losses during storage & handling, reworking/rejections etc.
c) Demand for CFC - 11 for domestiic refrigerators sub-sector is only for the equipment assembled in Kenya. Imported refrigerator cabinets (4,000 Nos) are pre-foamed
d) Actual unit consumption of CFC - 12 is much higher than the norm, due to excessive losses. This can be substantially reduced by improving the manufacturing practices

B. COMPUTATION FOR RECHARGING DEMAND IN 1991

SUB-SECTOR	POPULATION (NOS)	CFC USED	COMPRESSOR FAILURE: NO OF CASES (NOS)	COMPRESSOR FAILURE: % OF POPULATION	COMPRESSOR FAILURE: QTY/UNIT (Kgs)	COMPRESSOR FAILURE: TOTAL QTY (MT)	LEAKAGE: NO OF CASES (NOS)	LEAKAGE: % OF POPULATION	LEAKAGE: QTY/UNIT (Kgs)	LEAKAGE: TOTAL QTY (MT)	TOPPING UP: % OF POPULATION	TOPPING UP: NO OF CASES (NOS)	TOPPING UP: QTY/UNIT (Kgs)	TOPPING UP: TOTAL QTY (MT)	TOTAL (MT)
DOMESTIC REFRIGERATION AND DEEP FREEZERS	335000	CFC-12	6000	1.75	0.35	2.1	36,000	11	0.35	12.6	0	0	0	0	14.7
		CFC-11	-												
COMMERCIAL AND INDUSTRIAL REFRIGERATION															
- COLD STORES, COMML. FREEZERS ETC.	8000	CFC-12	120	1.5	15	1.8	400	5	15	6.0	25	2000	2	4	11.8
		CFC-11	_	_	_										
- DISPLAY CABINETS etc.	18500	CFC-12	300	1.5	2.0	0.6	475	2.5	2.0	1.0	25	4625	0.25	1.2	2.8
		CFC-11	_	_	_										
- MOBILE REFRIGERATION	100	CFC-12	Neg	Neg	Neg	Neg	15	15	20	0.3	25	25	5	0.1	0.4
		CFC-11	_	_	_										
- OTHER (Ice makers and small refrigeration eqpt	150000 approx.	CFC-12	2250	1.5	1.5	3.4	3000	2	1.5	4.5	10	15000	0.25	3.8	11.7
		CFC-11	_	_	_										
SUB TOTAL		CFC-12				5.8				11.8				9.1	26.7
		CFC-11	_	_	_										
DOMESTIC & COMMERCIAL AIRCONDITIONING		CFC-12	Neg				Neg				Neg				Neg
		CFC-11	Neg				Neg				Neg				Neg
MOBILE AIRCONDITIONING	9,500	CFC-12	100	1	3	0.3	475	5	3	1.4	5	300	0.75	0.2	2
	_	CFC-11	_	_	_										

NOTES : 1. Quantity of refrigerant per unit for recharging includes the requirement for flushing & leak detection (wherever applicable) as well as wastage factor

2. "Neg" - Negligible

C. SUMMARY

SUB-SECTOR	TYPE OF CFC	NEW DEMAND (MT)	RECHARGING DEMAND (MT)	TOTAL CONSUMPTION (MT)
DOMESTIC REFRIGERATION AND DEEP FREEZERS	CFC - 12	6	14.7	20.7
	CFC - 11	10.5	-	10.5
COMMERCIAL AND INDUSTRIAL REFRIGERATION	CFC - 12	25	26.7	51.7
	CFC - 11	6	-	6
COMMERCIAL AIRCONDITIONING (CENTRIFUGAL CHILLERS)	CFC - 12	Neg	Neg	Neg
	CFC - 11	Neg	Neg	Neg
MOBILE AIRCONDITIONING (CARS)	CFC - 12	4.5	2	6.5
	CFC - 11	-	-	-

APPENDIX - 2.3

PROFILES OF MAJOR INDIVIDUAL ENTERPRISES ENGAGED IMPORTING/ASSEMBLING/PRODUCING AIRCONDITIONING AND REFRIGERATION EQUIPMENT IN KENYA

1. NAME & ADDRESS :
DAIKIN KENYA LTD, P O BOX 39541, NAIROBI

TYPE OF ENTERPRISE :
Assemblers/Contractors for Commercial Refrigeration and Air-conditioning equipment

CONTACT PERSONS :
Mr Nizar Samji, Executive Director
Mr Shekhar Bhole, Chief Engineer

ACTIVITY :
Commercial refrigeration and airconditioning : Assembly and installation of airconditioning & refrigeration systems (Commercial)

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Commercial and Industrial Refrigeration	-	3-10 Kg	New	-	1-1.5
			Recharging	-	0.5

GENERAL :
Daikin Kenya has an active association with their parent company for updated technical inputs regarding new developments in technology and equipment.

2. NAME & ADDRESS :
GILFILLIAN TECHNICAL SERVICES LTD, FUNZI ROAD, P O BOX 30044, NAIROBI

TYPE OF ENTERPRISE :
Assemblers/Contractors for Commercial Refrigeration and Air-conditioning equipment

CONTACT PERSON :
Mr M B Lambert, Managing Director

ACTIVITY :
Commercial refrigeration and airconditioning : Design and installation of commercial refrigeration systems. Compressors are imported from Carrier. All new designs being done are based on HCFC-22 instead of CFC-12. Also carrying out retrofitting of CFC-12 based systems with HCFC-22 compressors for some existing installations with flower exporters.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Commercial and Industrial Refrigeration	-	3-10 Kg	New Recharging	- -	1.5 0.2-0.5

3. NAME & ADDRESS :
HALL EQUATORIAL LTD, P.O.BOX 30663, BARICHO ROAD, INDUSTRIAL AREA

TYPE OF ENTERPRISE :
Assemblers/Contractors for Commercial Refrigeration and Air-conditioning Equipment

CONTACT PERSONS :
Mr R K Kohli, Managing Director
Mr S Sivaraj, Installation/Service Engineer

ACTIVITY :
Commercial refrigeration and airconditioning : One of the major contracting firms in Kenya, for refrigeration and airconditioning jobs. Services offered include design, fabrication & assembly, installation and maintenance of all types of commercial a/c and refrigeration systems. Hold about 40% market share in this segment. Had a tie up with M/s APV of Austria but the agreement has since expired.

Mobile Airconditioning : In addition to the commercial systems, Hall are also the leaders in servicing of mobile airconditioning units, handling about 2 vehicles per day (average).

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Commercial and Industrial Refrigeration	-	3-10 Kg	New Recharging	- -	2.5 3.5
- Mobile Air-conditioning	-	1.5 Kg per vehicle	New Recharging	- -	- 1.5

GENERAL :
The manpower available with the company comprises of 3 engineers and about 10 technical personnel (qualified as well as trainees).

The senior persons in the company are aware of the impact of CFCs on ozone depletion. Wherever possible, they recommend HCFC-22 based systems to their clients, but are often constrained to follow the tender specifications given by the clients' consultants.

4. NAME & ADDRESS :
KAMCO ENGG LTD, NAIROBI

TYPE OF ENTERPRISE :
Producers of Domestic Refrigerators and Deep Freezers

CONTACT PERSONS :
Mr S Chandaria, General Manager
Mr Edward Jumba, Superviser

ACTIVITY :
Commercial refrigeration and airconditioning : Assembly and repair of domestic refrigerators and deep freezers, under the brand name of Phillips. Installed capacity is 100 units per month, and the actual production in the year 1991 was about 800 units. Assembly line based on manual operations, includes a foaming machine. Make three models of 7.5 cu.ft., 10.5 cu.ft. and 18 cu.ft.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm (Kgs)		Utilisation (Kgs) 1991		
	CFC-11 (Insulation)	CFC-12		CFC-11	CFC-12
- Refrigerators and Deep Freezers	1.2 Kg/unit	80-300 gms	New Recharging	1.0 -	800 Neg

GENERAL :
Kamco is a subsidiary of the multi-national company Car & General. They also carry out recharging of about 50 fridges per year at their workshop.

5. NAME & ADDRESS :
NAIROBI AFRIGAS DISTRIBUTOR (K) LTD, P.O. BOX 44922, NAIROBI

TYPE OF ENTERPRISE :
Producers of Domestic Refrigerators and Deep Freezers

CONTACT PERSONS :
Mr C M Thakar, Administrative Manager
Mr M Yaqub, Production Manager

ACTIVITY :
Commercial refrigeration and airconditioning : Engaged in production of a wide range of white goods, including domestic

refrigerators, which are produced in three sizes 6 cu.ft, 8 cu.ft and 12 cu.ft. Have a collaboration with Siltal Casa, Italy, from whom the CKD kits alongwith the chemicals are imported. Installed capacity is about 50 fridges/day, while the production is 20-25 nos. per day. Foaming and charging is done at the works.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm (Kgs)			Utilisation (Kgs) 1991	
	CFC-11	CFC-12		CFC-11	CFC-12
- Refrigerators and Deep Freezers	-	75 to 190 gms/unit	New	3.5*	1.2
			Recharging	-	0.4

* Blended with polyol

GENERAL :
Also undertake servicing of domestic refrigerators as well as some commercial equipment (cold rooms etc.) but the level of activity is low.

6. NAME & ADDRESS :
PREMIER REFRIGERATION AND ENGG. LTD, SUNGURA AVENUE INDUSUTRIAL AREA (P.O. BOX 2424), NAKURU

TYPE OF ENTERPRISE :
Producers of Domestic Refrigerators and Deep Freezers

CONTACT PERSON :
Mr D D Marathe, General Manager

ACTIVITY :
Commercial refrigeration and airconditioning : The largest producers of domestic refrigerators, chest freezers, display cabinets and bottle coolers, in collabsoration with LEC Refrigeration Plc., UK. Have in-house press shop, paint shop and assembly lines for different products, including insulation foam blowing and charging.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm			Utilisation (Kgs) 1991	
	CFC-11 (Insulation)	CFC-12		CFC-11	CFC-12
- Domestic Refrigerators and deep freezers	0.5-1.0 Kg per unit	130 gms per unit	New	4.0	1.25
			Recharging	-	-
- Commercial (display cabinets & bottle coolers	1 Kg/unit	200-450 gms/unit	New	4.5	1.5
			Recharging	-	-

GENERAL :
Import their requirements of CFC-11 & CFC-12 directly from ICI, UK & Galco, Belgium respectively.

7. NAME & ADDRESS :
REFRIGERATION CONTRACTORS LTD, P.O. BOX 78782, NAIROBI

TYPE OF ENTERPRISE :
Assemblers/Contractors for Commercial Refrigeration and Air-conditioning equipment

CONTACT PERSON :
Mr R K Tejani, Director

ACTIVITY :
Commercial refrigeration and airconditioning : Refrigeration Contractors Ltd handle a variety of commercial refrigeration and airconditioning jobs for use in cold storages, ice plants, hotels.

Total quantity of CFCs handled comprise about 20 MT of CFC-12 out of which about 50% is sold to small users and balance for airconditioning and refrigeration jobs). For insulation foam in the panels, they use blended polyols with isocyanate which are sprayed on the panel surface.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Commercial and Industrial Refrigeration	-	3-10 Kg	New	1.25	7.0
			Recharging	-	4-5

GENERAL :
The total technical staff available is 6 persons besides two directors who are themselves experienced in the field of refrigeration & airconditioning.

Besides undertaking fabrication, installation and maintenance jobs, they are also engaged in import of CFC-12 (from Galco Ltd., Belgium) as well as various components for captive use as well as sales to other users by the industry. CFC-12 is sold by them to small users in disposable cylinders of 13.5 Kg capacity.

8. NAME & ADDRESS :
REFRIGERATION CENTRE P.O. BOX 44883, NAIROBI

TYPE OF ENTERPRISE :
Assemblers/Contractors for Commercial Refrigeration and Air-conditioning equipment

CONTACT PERSON :
Mr M Alam

ACTIVITY :
Commercial refrigeration and airconditioning : Engaged in assembly, installation and maintenance of commercial refrigeration and airconditioning equipment.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT) 1991	
	CFC-11	CFC-12	CFC-11	CFC-12
- Commercial and Industrial Refrigeration	-	3-10 Kg	New -	0.5-1
			Recharging -	2.0

GENERAL :
Nitrogen is used for flushing & cleaning. For leak detection they have a flame detector as well as electronic leak detection instrument.

9. NAME & ADDRESS :
REMCO LTD, P.O. BOX 18172, INDUSTRIAL AREA, NAIROBI

TYPE OF ENTERPRISE :
Assemblers/Contractors for commercial refrigeration and air-conditioning equipment

CONTACT PERSON :
Mr J Dean, Director

ACTIVITY :
Commercial Refrigeration and Airconditioning : Types of equipment assembled, installed and serviced include cold rooms, freezer rooms, ice plants etc. Main activity is fabrication of new equipment and providing maintenance support to clients.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT) 1991	
	CFC-11	CFC-12	CFC-11	CFC-12
- Commercial and Industrial Refrigeration	-	3-10 Kg	New -	1-1.2
			Recharging -	0.5

GENERAL :
The technical personnel consist of diploma holders and experienced technicians, who are supervised by the directors for specific jobs.

10. NAME & ADDRESS :
SANYO ARMCO (KENYA) LTD, P.O.BOX 18263, LUNGA LUNGA ROAD, NAIROBI

TYPE OF ENTERPRISE :
Producers of Domestic Refrigerators and Deep Freezers

CONTACT PERSONS :
Mr Y Hasegawa, Technical Advisor
Mr Farook Qureishi, Marketing Manager

ACTIVITY :
Commercial refrigeration and airconditioning : Assembly of pre-foamed kits imported from parent company Sanyo, Japan. Installed capacity-20 units per day, while the productien was approx. 4200 nos. per year in 1991. use imported equipment for vacuum charging and leak testing.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm (Kgs)		Utilisation (Kgs) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Refrigerators and Deep Freezers	-	85-170 gms/unit	New Recharging	N.A -	850 Neg

GENERAL :
Also servicing of Sanyo brand refrigerators handling about 10 refrigerators per month (for recharging).

11. NAME & ADDRESS :
TOYOTA KENYA LTD, P.O. BOX 45912, UHURU HIGHWAY, NAIROBI

TYPE OF ENTERPRISE :
Production of airconditioned cars

CONTACT PERSONS :
Mr B M Gachoka, Local Content Manager Mr Thomas Maina, Training Manager

ACTIVITY :
Mobile Airconditioning : Engaged in assembly and servicing of Toyota vehicles in Kenya. The kits are imported from Japan and the vehicles are got assembled at the facilities of Associated Vehicle Assembles (AVA) at Mombasa, who are also assembling the vehicles for Peugot, Marshall, Lancer, Subaru, Mitsubishi, etc. Have a market share of about 18% in Kenya with production of about 2000-2500 vehicles per year. Only one of the models (1600 CC corolla) is fitted with airconditioners which comprises about 10-15% of production. This too was introduced in August, 1990.

The charging of the refrigerant in the airconditioner unit is done at Toyota Kenya's workshop. They have a trolley mounted charging station imported from REFCO Manufacturing Company, Switzerland, and also a hand held Electronic Leak Detector.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT) 1991	
	CFC-11	CFC-12	CFC-11	CFC-12
- Mobile air conditioning	-	1.2 Kg	New -	0.5
			Recharging -	0.3

GENERAL :
Toyota Kenya have recently received technical literature from their Japanese principles giving details about the mobile airconditioning unit which uses R-134a as the refrigerant instead of CFC-12. This literature provides details about the differences between the two types of systems in terms of components, materials, oils, maintenance procedures etc.

APPENDIX - 2.4

METHODOLOGY FOR PROJECTING DEMAND OF AIR CONDITIONING & REFRIGERATION EQUIPMENT

I. For the purpose of projecting demand, the airconditioning and refrigeration equipment have been classified into two broad categories, defined as follows :

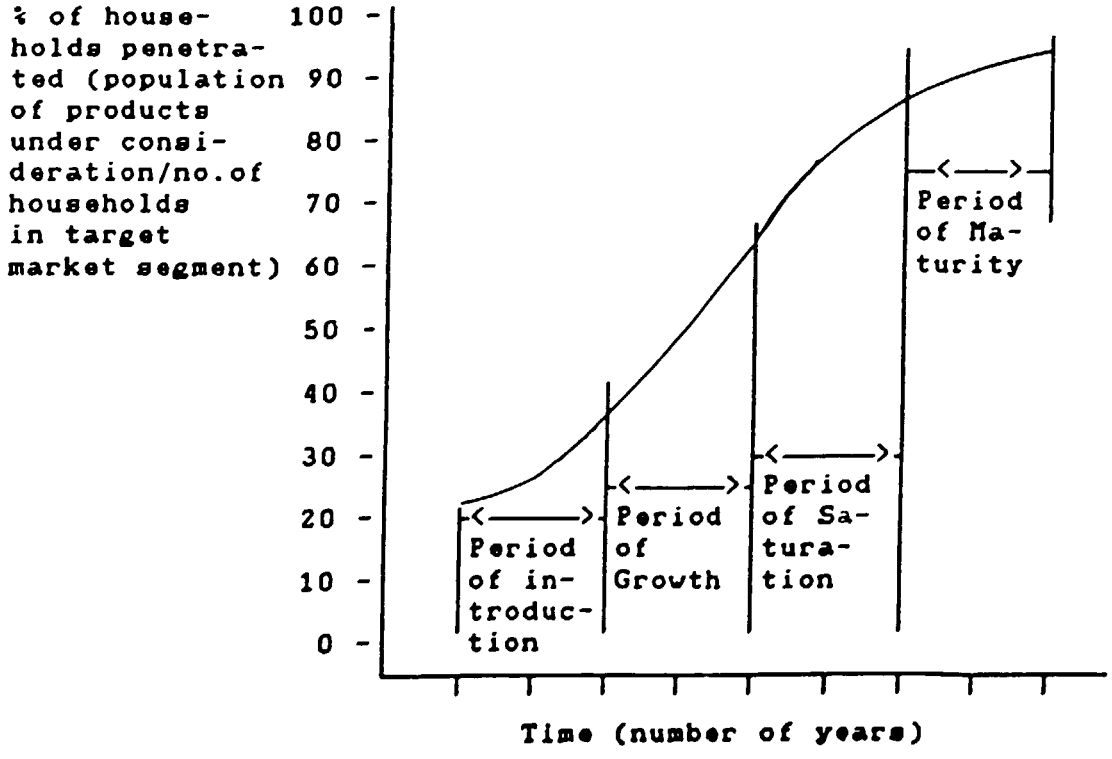
- Consumer Products : Those controlled by consumer driven markets. In case of products under the study, these would be include a domestic refrigerators & deep freezers and car-airconditioners.

- Industrial Products : Those controlled by growth in end use industries/sectors; these would include :

  * Commercial & industrial refrigeration (cold rooms, refrigerated trucks, industrial chillers etc)
  * Commercial airconditioning (chillers)

CONSUMER PRODUCTS

The type of consumer products being considered by us can be classified more specifically as "consumer durables" since these products have a long life (equal to or greater than 10 years). Since the bulk of the demand is for domestic household use, the household can be identified as the idependent entity which influences demand. The demand for household goods of a durable nature can often be predicted by adopting a s-shape penetration curve, as shown below :



The likely penetration in the future has been modelled by us using the S-shaped curve on the basis of two forecasts of growth - high and low. The methods considered by us to forecast growth were

- Multiple regression analysis; this consists of the following steps :

  * identification of factors likely to influence demand such as real per capita income of different consumer classes, real private final consumption expenditure of different consumer classes, price trend of products under consideration etc.

  * establishing statistical co-relation of above factors (independent variables) with past trend in demand of products under consideration (dependent variable)

  * projection of future values for independent variable(s) and, consequently for, dependent variable viz demand of products under consideration.

  The desired data on independent variables (such as class wise real per capita income) was not available separately for each country. Also, the past trend in demand of dependent variable (viz product under consideration) was available only for a limited number of years. Therefore, no meaningful statistical regression analysis could be obtained for any country.

- Judgements based on estimates given by manufacturers, industry experts and industry associations in respective countries. These estimates given by manufacturers, industry experts and associations were based on the experience/judgement of these agencies/ individuals regarding :

  * factors incluencing demand and expectations governing growth

  * supply constraints operating in the industry such as high cost of imported components and infrastructure constraints.

  In the absence of statistical analysis of past data, these estimates were used for estimating future demand for each country.

INDUSTRIAL PRODUCTS

The growth of these products can normally be linked to the growth of end use industries/sectors in which these products are being used after taking into account the following factors :

- Relative penetration/share of usage of product in different end-use industries/sectors.

- Presence/absence of any "substitution effects" viz impact on demand due to substitution by/of alternative products.

The level of data available on end-use distribution was not sufficient in any of the project countries to do a detailed end-use wise analysis of future demand. Therefore, estimation of future demand, has been based largely on discussions with manufacturers and industry experts, also by taking into account qualitatively the likely impact of above mentioned factors.

II. Basis used for demand projections for equipment as well as refrigerants, are as follows :

1. Demand for equipment has been taken as equivalent to production + imports, and computed for each year on the basis of an annual growth rate.

2. Two growth rates have been taken for projectionof 'High' & 'Low' demands. These growth rates are based on the estimates given by the industry/associations and/or Government bodies. Higher rates are mainly indicated by industry. Keeping in view that industry estimates are normally higher than practically and economically achievable, the lower growth rates have been taken as half of higher rates.

3. The Phase out (of CFC based equipment) has been indicated as a proportion (% age) of demand which is expected to be replaced by equipment based on CFC substitutes for the respective years.

4. The population of the equipment has been estimated for :

   a) Total population comprising of equipment based on both CFCs as well as substitutes.
   b) Population of only CFC based equipment

5. The population estimates have been carried at on the basis of age of the industry and life of expectancy

of the equipment, and after adjusting for number of equipment expected to be scrapped.

6. The demand for CFCs has been categorised as follows :

a)	Refrigerant	i) New Demand for original equipment manufactured/ assembled/imported. ii) Recharging demand for the arising from servicing of the existing population
b)	Foaming Agency	New Demand for original equipment manufactured/imported

7. The ratio of new CFC demand to equipment demand (CFC based) in 1991 has been used for computation of new CFC demand for future years.

8. Similarly, the ratio of recharging CFC demand to equipment population (CFC based) in 1991 has been used for computation of recharging CFC demand in future years.

9. The computation of recoverable quantities of refrigerant CFCs comprises of -

a) Recovery during servicing of existing population which is based on the ratio of recoverable quantity in 1991 to recharging demand in 1991. The norms for recoverable quantities for each sub-sector in 1991 are given in Chapter - V.

b) Recovery from CFC based equipment which is scrapped each year.

APPENDIX - 2.5

CONSUMPTION PATTERN FOR CFCs IN AIRCONDITIONING & REFRIGERATION SECTOR IN KENYA

		1991	1993	1995	1996	1997	1999	2005	2007	2010
A. DOMESTIC REFRIGERATORS AND DEEP FREEZERS										
1. Total demand ('000) *	LOW (NOS.)	20000	21010	22080	22630	23200	24370	28260	29690	31970
	HIGH (NOS.)	20000	22050	24310	25530	26810	29560	39620	43680	50560
2. Population of equipment ('000)	LOW (NOS.)	335000	351160	368150	376960	385990	404740	466890	489750	526230
	HIGH (NOS.)	335000	352200	373030	384740	397380	425690	539420	588900	676360
3. Phase-out of CFC based equipment (%)		0	0	25	50	100	100	100	100	100
4. No. of CFC based equipment	LOW (NOS.)	20000	21010	16560	11315	0	0	0	0	0
	HIGH (NOS.)	20000	22050	18233	12765	0	0	0	0	0
5. Population of CFC based ref.	LOW (NOS.)	335000	351160	362630	360125	345955	316555	219155	183355	126245
	HIGH (NOS.)	335000	352200	366953	365898	351728	322328	224928	189128	132018
6. Number of aged refrigerators**	LOW (NOS.)	12210	12830	13480	13820	14170	14880	17250	18120	19510
	HIGH (NOS.)	12210	12830	13480	13820	14170	14880	17250	18120	19510
7. Number of ref. reinstalled @ 60% of aged ref.	LOW (NOS.)	7326	7698	8088	8292	8502	8928	10350	10872	11706
	HIGH (NOS.)	7326	7698	8088	8292	8502	8928	10350	10872	11706
8. No. of scrapped ref. @ 40% of aged ref.	LOW (NOS.)	4884	5132	5392	12854	13180	13842	16050	16860	18154
	HIGH (NOS.)	4884	5132	5392	12854	13180	13842	16050	16860	18154
9. Demand for CFC 12										
- OE Demand	LOW (MT)	6.0	6.3	5.0	3.4	0.0	0.0	0.0	0.0	0.0
	HIGH (MT)	6.0	6.6	5.5	3.8	0.0	0.0	0.0	0.0	0.0
- Recharging Demand	LOW (MT)	14.7	15.4	15.9	15.8	15.2	13.9	9.6	8.0	5.5
	HIGH (MT)	14.7	15.5	16.1	16.1	15.4	14.1	9.9	8.3	5.8
- Total Demand	LOW (MT)	20.7	21.7	20.9	19.2	15.2	13.9	9.6	8.0	5.5
	HIGH (MT)	20.7	22.1	21.6	19.9	15.4	14.1	9.9	8.3	5.8
10. Demand for CFC 11	LOW (MT)	10.5	11.0	8.7	5.9	0.0	0.0	0.0	0.0	0.0
	HIGH (MT)	10.5	11.6	9.6	6.7	0.0	0.0	0.0	0.0	0.0
11. Total CFC Demand	LOW (MT)	31	33	30	25	15	14	10	8	6
	HIGH (MT)	31.2	34	31	27	15	14	10	8	6
12. Recoverable CFC	LOW (MT)	9.9	10.4	10.7	10.6	10.2	9.4	6.5	5.4	3.7
	HIGH (MT)	9.9	10.4	10.8	10.8	10.4	9.5	6.6	5.6	3.9
13. Recovery from scrapped ref.***	LOW (MT)	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
	HIGH (MT)	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2
14. Total recoverable quantity of CFC-12	(MT)	10.0	10.4	10.8	10.8	10.4	9.5	6.7	5.6	4.0
	(MT)	10.0	10.5	10.9	11.0	10.6	9.7	6.8	5.8	4.1

* Growth rate for demand of ref. taken as 2.5% (low) and 5% (high) per annum based on estimates of the industry associ

** Initial life of refrigerators taken as 20 years and life of reinstalled one is taken as 5 years

*** 10% of initial charge of scrapped refrigerators is recoverable

		1991	1993	1995	1996	1997	1999	2005	2007	2010
B. COMMERCIAL REFRIGERATION										
I. COLD STORES/COLD ROOMS										
1. Total demand *	LOW (NOS.)	750	810	870	900	930	990	1220	1300	1450
	HIGH (NOS.)	750	830	900	930	960	1030	1260	1350	1500
2. Population	LOW (NOS.)	8000	9590	11300	12200	13130	15080	19150	20200	22200
	HIGH (NOS.)	8000	9610	11380	12310	13270	15300	19590	20740	22870
3. Phase-out of CFC based equipment (%)			60	100	100	100	100	100	100	100
4. Demand for CFC based units	LOW (NOS.)	750	324	0	0	0	0	0	0	0
	HIGH (NOS.)	750	332	0	0	0	0	0	0	0
5. Population of CFC based units**	LOW (NOS.)	8000	8909	8909	8909	8909	8909	6259	4749	2549
	HIGH (NOS.)	8000	8917	8917	8917	8917	8917	6267	4757	2557
6. No of CFC based units scrapped *								610	810	660
II. DISPLAY CABINETS										
1. Total demand *	LOW (NOS.)	2500	2890	3340	3590	3860	4460	6890	7970	9900
	HIGH (NOS.)	2500	3090	3580	3840	4130	4770	7370	8520	10590
2. Population	LOW (NOS.)	18500	24080	30530	34120	37980	46590	79710	91477	112656
	HIGH (NOS.)	18500	24280	31180	35020	39150	48360	83890	96717	119836
3. Phase-out of CFC based equipment (%)			60	100	100	100	100	100	100	100
4. Demand for CFC based units	LOW (NOS.)	2500	1156	0	0	0	0	0	0	0
	HIGH (NOS.)	2500	1236	0	0	0	0	0	0	0
5. Population of CFC based units	LOW (NOS.)	18500	21674	21674	21674	21674	21674	20054	16441	10521
	HIGH (NOS.)	18500	21754	21754	21754	21754	21754	20134	16521	10601
6. No of CFC based units scrapped *								1620	1872	1745
III. DEMAND FOR CFC 12 (@)										
- OE Demand	LOW (MT)	25	24.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	HIGH (MT)	25	25.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Recharging Demand	LOW (MT)	26.7	30.5	30.5	30.5	30.5	30.5	24.7	19.4	11.4
	HIGH (MT)	26.7	30.5	30.5	30.5	30.5	30.5	24.7	19.5	11.5
- Total Demand	LOW (MT)	51.7	55.4	30.5	30.5	30.5	30.5	24.7	19.4	11.4
	HIGH (MT)	51.7	56.4	30.5	30.5	30.5	30.5	24.7	19.5	11.5
IV. DEMAND FOR CFC 11										
- OE Demand	LOW (MT)	6	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	HIGH (MT)	6	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V. RECOVERABLE CFC-12	LOW (MT)	13.4	15.3	15.3	15.3	15.3	15.3	12.4	9.7	5.7
	HIGH (MT)	13.4	15.3	15.3	15.3	15.3	15.3	12.4	9.8	5.8
VI. RECOVERY FROM SCRAPPED EQUIPMENT	(MT)							0.5	0.7	0.5
VII. TOTAL RECOVERABLE QTY. OF CFC-12	(MT)	13.4	15.3	15.3	15.3	15.3	15.3	12.9	10.4	6.2
	(MT)	13.4	15.3	15.3	15.3	15.3	15.3	12.9	10.5	6.3

Note :

* Growth rates for cold stores & cold rooms are taken @ 7% (high) and 3.5% (low) while for display cabinets it is taken as 15% (high) and 7.5% (low). These are based on the estimates of the producers and the projected growth rates for the major end user industries, viz hotels (5%), agricultural & horticultural crops (16%).

** Initial life of equipment is taken as 20 years and life of installed one is taken as 5 years.

*** 10% of initial charges of scrapped unit is recoverable.

\+ The other application areas of commercial refrigeration, viz industrial, mobile etc constitute only a very small proportion of the sub-sector and hence the demand projections, are done only for cold rooms/cold stores and display cabinets (including bottle coolers). However, the CFC demand forecast includes the requirement of all the application areas.

(@) This includes the total demand for cold stores/rooms, commercial freezers, display cabinets, refrigerated trucks as well as other small commercial refrigeration equipments

		1991	1993	1995	1996	1997	1999	2005	2007	2010
C. MOBILE AIRCONDITIONERS										
1. Total demand of cars *	- LOW (NOS.)	21000	21640	22290	22620	22960	23650	25860	26640	27860
	HIGH (NOS.)	21000	22280	23640	24350	25080	26600	31770	33700	36820
2. Demand for AC cars	- LOW (NOS.)	1500	1550	1590	1620	1640	1690	1850	1900	1990
	HIGH (NOS.)	1500	1590	1690	1740	1790	1900	2270	2410	2630
3. Population of AC cars	- LOW (NOS.)	9500	12570	15730	17350	18990	22340	25520	26280	27450
	HIGH (NOS.)	9500	12610	15940	17680	19470	23220	28390	30090	32830
4. Phase-out of CFC-12 based equipment (%)			0	40	80	100	100	100	100	100
5. Number of CFC-12 AC cars	- LOW (NOS.)	1500	1550	954	324	0	0	0	0	0
	HIGH (NOS.)	1500	1590	1014	348	0	0	0	0	0
6. Population of CFC-12 AC cars	- LOW (NOS.)	9500	12570	15090	15410	15410	15410	11285	8650	4363
	HIGH (NOS.)	9500	12610	15260	15610	15610	15610	11485	8865	4663
7. Number of aged car ACs **	- LOW (NOS.)							1500	1520	954
	- HIGH (NOS.)							1500	1550	1014
8. Number of reinstalled car ACs @ 50% Of aged car ACs	- LOW (NOS.)							750	760	477
	- HIGH(NOS.)							750	775	507
9. No. of car AC scrapped @ 50% Of aged cars	- LOW (NOS.)							1125	1385	1227
	- HIGH (NOS.)							1125	1400	1257
10. Demand for CFC-12										
- OE Demand	- LOW (MT)	4.5	4.7	2.9	1.0	0.0	0.0	0.0	0.0	0.0
	HIGH (MT)	4.5	4.8	3.0	1.0	0.0	0.0	0.0	0.0	0.0
- Recharging Demand	- LOW (MT)	2.0	2.6	3.2	3.2	3.2	3.2	2.4	1.8	0.9
	HIGH (MT)	2.0	2.7	3.2	3.3	3.3	3.3	2.4	1.9	1.0
- Total Demand	- LOW (MT)	6.5	7.3	6.0	4.2	3.2	3.2	2.4	1.8	0.9
	HIGH (MT)	6.5	7.4	6.3	4.3	3.3	3.3	2.4	1.9	1.0
11. Recoverable CFC	- LOW (MT)	1.1	1.5	1.7	1.8	1.8	1.8	1.3	1.0	0.5
	HIGH (MT)	1.1	1.5	1.8	1.8	1.8	1.8	1.3	1.0	0.5
12. Recovery from scrapped equipment ***										
	-LOW (MT)	0	0	0	0	0	0	1.4	1.7	1.5
	-HIGH (MT)	0	0	0	0	0	0	1.4	1.7	1.5
13. Total recoverable quantity of CFC-12	(MT)	1.1	1.5	1.7	1.8	1.8	1.8	2.7	2.7	2.0
	(MT)	1.1	1.5	1.8	1.8	1.8	1.8	2.7	2.7	2.0

* Growth rate for demand of cars taken as 1.5% on low estimate and 3% on high estimate based on feedback from industry and the associations

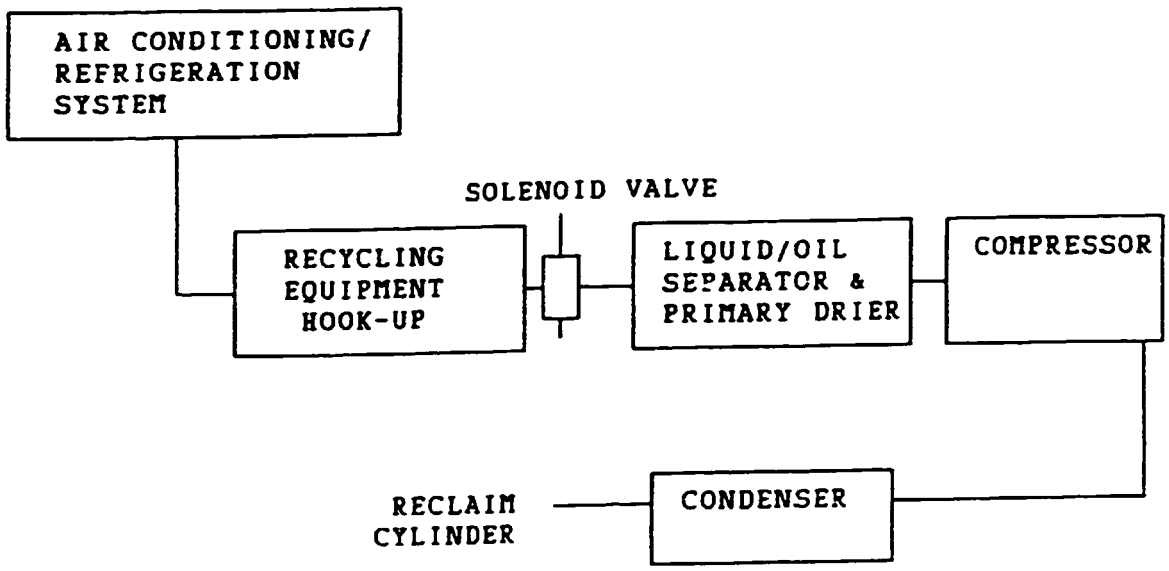
** Initial life of AC cars taken as 15 years and life of reinstalled one is taken as 5 years

*** 10% of initial charge of scrapped ACs is recoverable

		1991	1993	1995	1996	1997	1999	2005	2007	2010
TOTAL DEMAND FOR CFC -12 (MT)										
1. NEW DEMAND	LOW	35.5	35.8	7.8	4.4	0.0	0.0	0.0	0.0	0.0
	HIGH	35.5	37.2	8.5	4.9	0.0	0.0	0.0	0.0	0.0
2. RECHARGING DEMAND	LOW	43.4	48.6	49.6	49.5	48.9	47.6	36.7	29.3	17.9
	HIGH	43.4	48.6	49.8	49.8	49.2	47.9	37.0	29.7	18.3
3. TOTAL DEMAND	LOW	78.9	84.4	57.4	53.9	48.9	47.6	36.7	29.3	17.9
	HIGH	78.9	85.8	58.3	54.7	49.2	47.9	37.0	29.7	18.3
4. RECOVERABLE QUANTITY	LOW	24.5	27.2	27.8	27.9	27.5	26.6	22.2	18.7	12.2
	HIGH	24.5	27.2	28.0	28.1	27.7	26.8	22.4	19.0	12.5
TOTAL DEMAND FOR CFC -11 (MT)										
1. NEW DEMAND	LOW	16.5	17.0	8.7	5.9	0.0	0.0	0.0	0.0	0.0
	HIGH	16.5	17.8	9.6	6.7	0.0	0.0	0.0	0.0	0.0
2. RECHARGING DEMAND	LOW	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	HIGH	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. TOTAL DEMAND	LOW	16.5	17.0	8.7	5.9	0.0	0.0	0.0	0.0	0.0
	HIGH	16.5	17.8	9.6	6.7	0.0	0.0	0.0	0.0	0.0
4. RECOVERABLE QUANTITY	LOW	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	HIGH	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

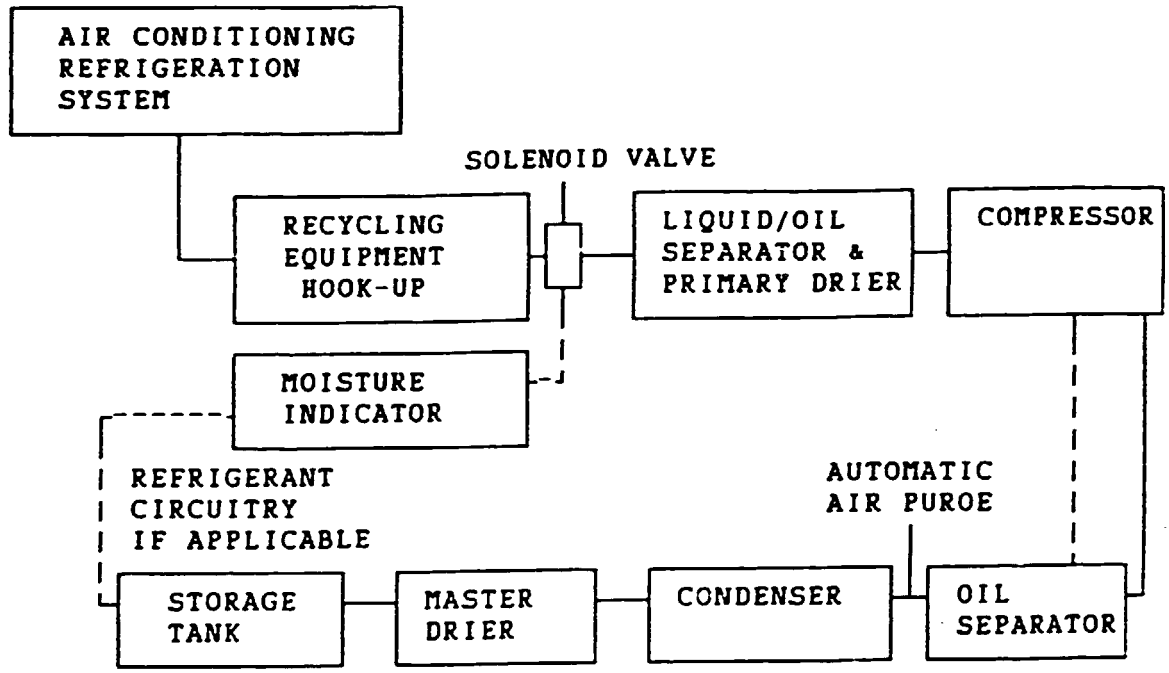
APPENDIX - 3.1

SCHEMATIC FOR REFRIGERANT RECOVERY EQUIPMENT

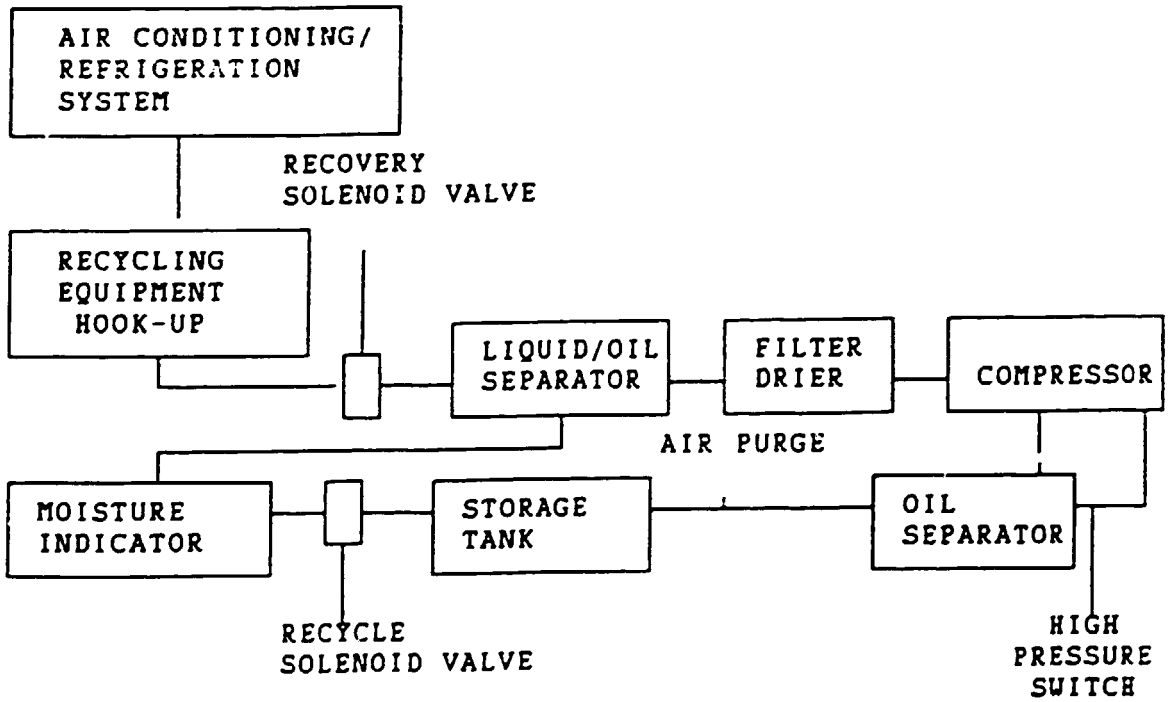


SCHEMATIC FOR REFRIGERANT RECOVERY & RECYCLING EQUIPMENT

A. SINGLE PASS



B. MULTI-PASS



BROCHURES/TECHNICAL DETAILS OF RECOVERY AND RECYCLING EQUIPMENT

1. Refrigerant Recovery System Inc., USA

   - Recovery system
     Model RC - 1

   - Rejuvenator (Recycling)
     Model ST - 1000
     Model ST - 100

2. SPX Corporation, USA

   - Model OEM 1380
   - Model OEM 1396
   - Model OEM 1397

3. United Technologies Carrier

   - Model 19 Q 4

4. Environmental Products Amalgamated Pty Ltd, Australia

   - Skyemite (recovery unit)
   - Skyemate (recycling unit)
   - High Capacity recovery & recycling

     - Model EP3HC
     - Model EP3HCM
     - SKYE 134a
     - EP4
     - EP4HC
     - EP5

5. Javac Reco, Australia

   - Model Reco - 1 (Recovery Unit)
   - Model Reco - 12S (Recovery & Recycling Unit)
   - Model Reco - 134S (Recycling Unit)

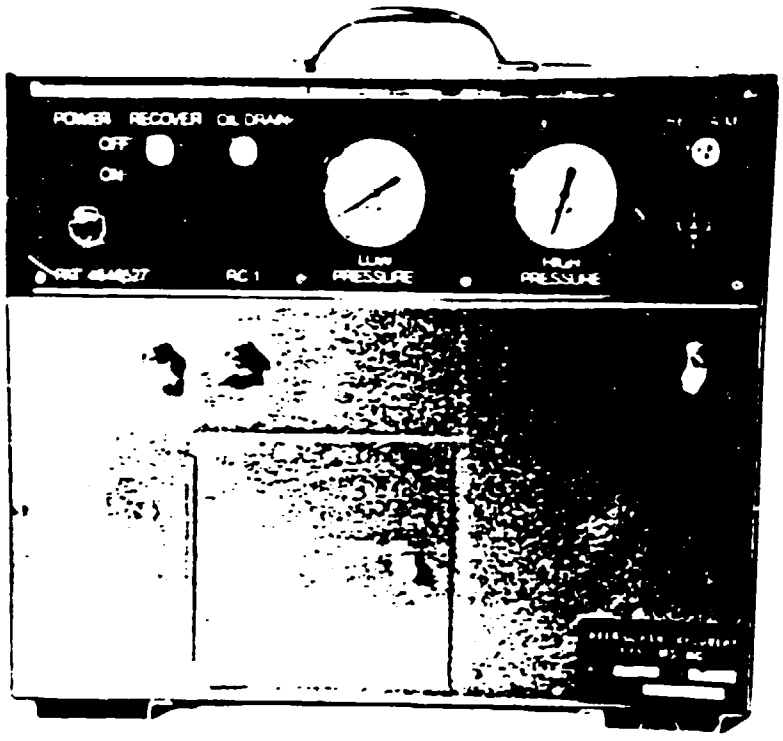
6. Technical Chemical Company, USA

   - Sercon 9000
   - Sercon 8000
   - Sercon 5000

New!

The RC-1

Recovery System



Specially Designed For Portability

REFRIGERANT RECOVERY SYSTEMS, INC.
P.O. Box 360298 • Tampa, FL 33673

Never Release Refrigerant In Shop Or Air Again

The Rejuvenators • Easy • Safe • Cost Effective

WHY RECOVER REFRIGERANTS "CFC'S": Several years ago Mr. Taylor, a parts manufacturer and owner of auto air conditioning repair facilities in the State of Florida, recognized the need to recover the large amount of refrigerant (R-12) being used at his facilities. Since that time, it has become increasingly evident that there is another need for recycling refrigerants and that is the continuing destruction of our earth's ozone layer.

The Ozone layer, often called a screen or shield, roughly 10 - 30 miles above the earth's surface has been credited with protecting us, the earth, from the damaging Ultra Violet Rays of the Sun.

We must act quickly to stop the destruction of our ozone shield, or canopy by recovering as many CFC'S as possible.

Join with Refrigerant Recovery Systems, Inc., the Company with the technology and experience to make a difference, in helping to eliminate this threat to the entire world.

INTRODUCTION

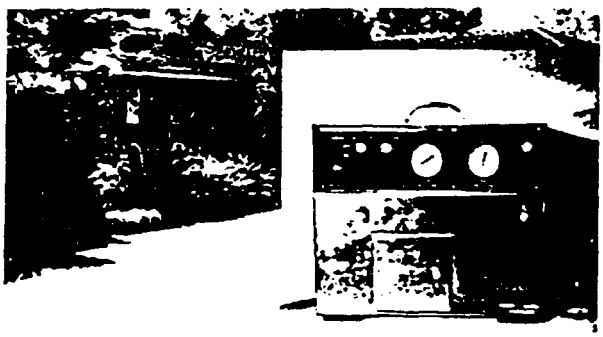
Refrigerant Recovery Systems, Inc., realizing the very special needs of the residential/commercial contractor is proud to present the RC-1.

Designed with the residential/commercial contractor in mind, the RC-1 will recover the refrigerants thru the day and allow you to process it at your facility later.

Weight, portability, and cost have been a factor long overlooked by the machine manufacturers. Here is the system for those jobs that are too small for the costly high tech recovery & recycle systems.

- Prewired and prepiped at the manufacturers facility.
- Easy access to filters for changing
- Cabinet: Aluminum construction with gauges, valves, and controls easily accessable for viewing and operation.
- Tank: D.O.T. 4BA-260 Tank Rated 47.6 W.C. 20.3 TW (50 lb.) for safe operation.

SAVE VALUABLE TIME AND LABOR COSTS WHEN RECOVERING REFRIGERANT FROM SMALLER UNITS



SPECIFICATIONS:

Dimensions: 16" High x 12" Deep x 18" Wide

Weight: 40 lbs

For Information On How To Order, Call Your Local Dealer or Call Toll-Free Numbers: Florida Wats - 1-800-533-2845

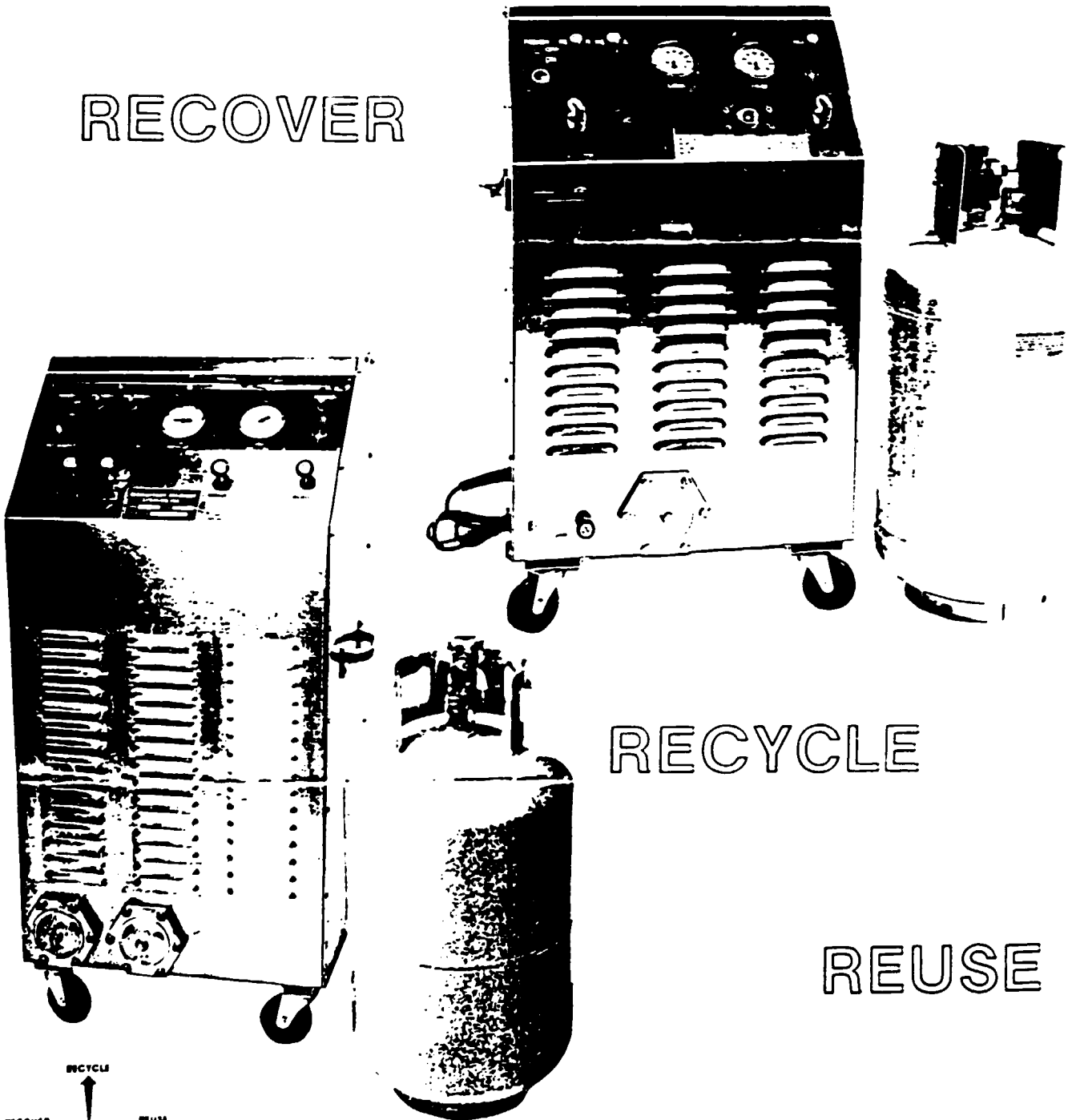
Outside Florida - 1-800-327-9142 • Local - (813) 237-1266

WARRANTY THE RC-1 HAS A 1 YEAR WARRANTY. Contact your distributor for full warranty information

The Rejuvenator

Removes And Cleans Contaminated Refrigerant

RECOVER



RECYCLE

REUSE

STOP POLLUTION

REFRIGERANT RECOVERY SYSTEMS, INC.
P.O. Box 360298 • Tampa, FL 33673

Never Release Refrigerant

In Shop Or Air Again

The Rejuvenators • Easy • Safe • Cost Effective

WHY RECOVER REFRIGERANTS "CFC'S": *Several years ago Mr. Taylor, a parts manufacturer and owner of auto air conditioning repair facilities in the State of Florida, recognized the need to recover the large amount of refrigerant (R-12) being used at his facilities. Since that time, it has become increasingly evident that there is another need for recycling refrigerants and that is the continuing destruction of our earth's ozone layer.*

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We must act quickly to stop the destruction of our ozone shield, or canopy by recovering as many CFC'S as possible.

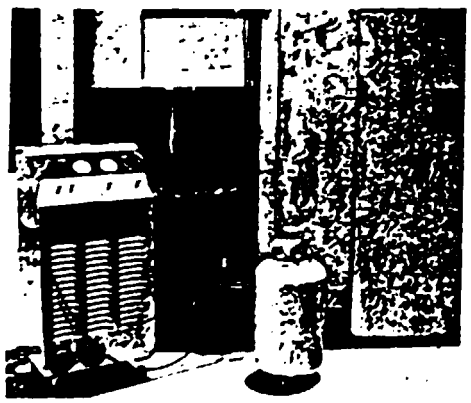
Join with Refrigerant Recovery Systems, Inc., the Company with the technology and experience to make a difference, in helping to eliminate this threat to the entire world.

INTRODUCTION:

Refrigeram Recovery Systems, Inc. Tampa, Florida, known to many as "The Company ahead of its time" with the *Rejuvenator,* a remarkably efficient refrigerant recovery machine. Now, "The Company ahead of everyone else" with both technology and quality, introduces the *"Rejuvenator"*.

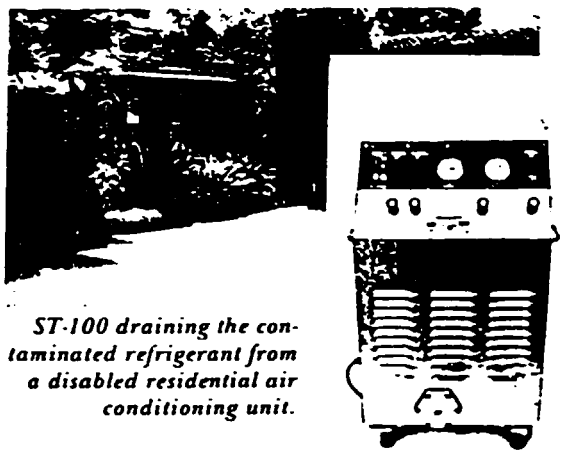
- UL Certified to meet SAE Standards.
- Using a patented distillation process, the Rejuvenator will recover refrigerants at a rate of 3-6 lbs. per minute for the ST-1000 and 2-3 lbs. per minute for the ST-100, depending on the amount of liquid available and the ambient temperature.
- Pre-wired and pre-piped at the manufacturers facility.
- Corrosions resistant copper tubes and fittings; Copper tube and aluminum fin condenser.
- High Pressure Relief Valve.
- Automatic Operation.
- Easy Access to filters for changing.
- Cabinet: Aluminum construction with guages, valves, and controls easily accessable for viewing and operation.

SAVE VALUABLE TIME AND LABOR COST WHEN RECOVERING REFRIGERANT FROM LARGER UNITS:



ST - 1000 Draining the contaminated refrigerant from a commercial air conditioning unit.

SAVE ON REFRIGERANT COSTS IN YOUR SERVICE CALLS:



ST-100 draining the contaminated refrigerant from a disabled residential air conditioning unit.

SPECIFICATIONS:

Refrigerants:	R-12; R-22; R-500; R-502
Dimensions:	ST-1000 — 34" High x 18" Wide x 14" Deep; ST-100 — 29" High x 18" Wide x 14" Deep.
Weight:	ST-1000 — 130 lbs. approximate; ST-100 — 76 lbs. approximate.
Storage Tank:	ST-1000 — 70 lb. refillable; ST-100 — 70 lb. refillable.

For Information On How To Order, Call Your Local Dealer or Call Toll-Free Numbers: Florida Wats - 1-800-533-2845
Outside Florida - 1-800-327-9142 • Local - (813) 237-1266

WARRANTY. ALL REJUVENATORS HAVE A TWO (2) YEAR WARRANTY. Contact your distributor for full warranty information.

U.S. PATENT #4,646,527

PATENTED IN THE UNITED STATES AND 14 FOREIGN COUNTRIES

The Solution: OTC

The majority of these CFC's come from the refrigerant used in mobile air conditioning units. They are released into the atmosphere from leaky A/C's and from recharging and service operations.

The United States, along with 48 other countries, has taken steps to limit production and use of CFC's, including the R-12 type used in vehicle air conditioning units. The plan is to eventually eliminate them completely.

Like you, we are concerned about the depletion of the ozone layer. But we know you can't afford to quit servicing air conditioners, either. We think we can help solve both problems.

INTRODUCING...
the OTC Refrigerant Recovery and Recycling System!

We've got two new units to help you in your quest for faster, safer, cleaner Freon recovery and recycling. Introducing the OEM1380 and OEM1396, each with features designed to make refrigerant recovery less of a chore!

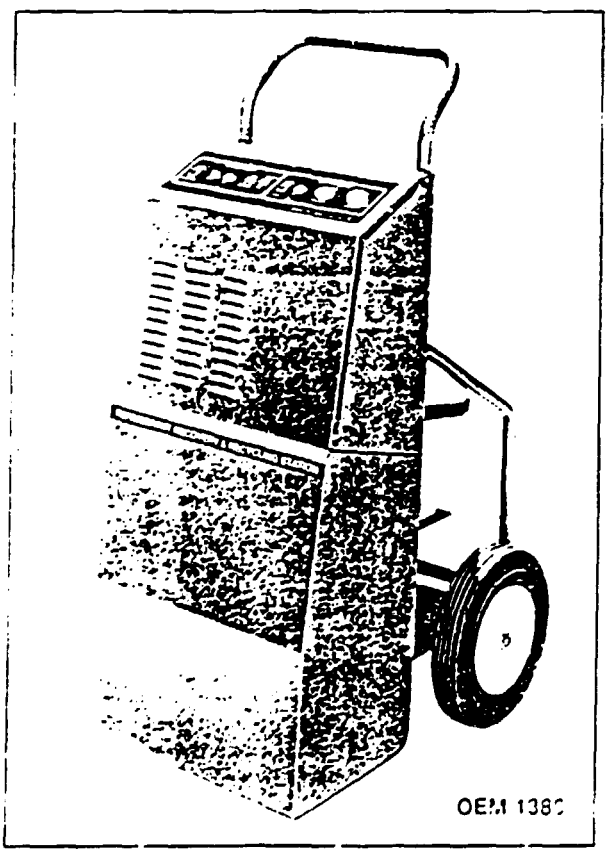
They can be used on cars, trucks, tractors, and RV's (using R-12 refrigerant), so your service potential isn't limited. The speed of recovery of both units means less chance of tying up your shop with vehicles just waiting to be serviced.

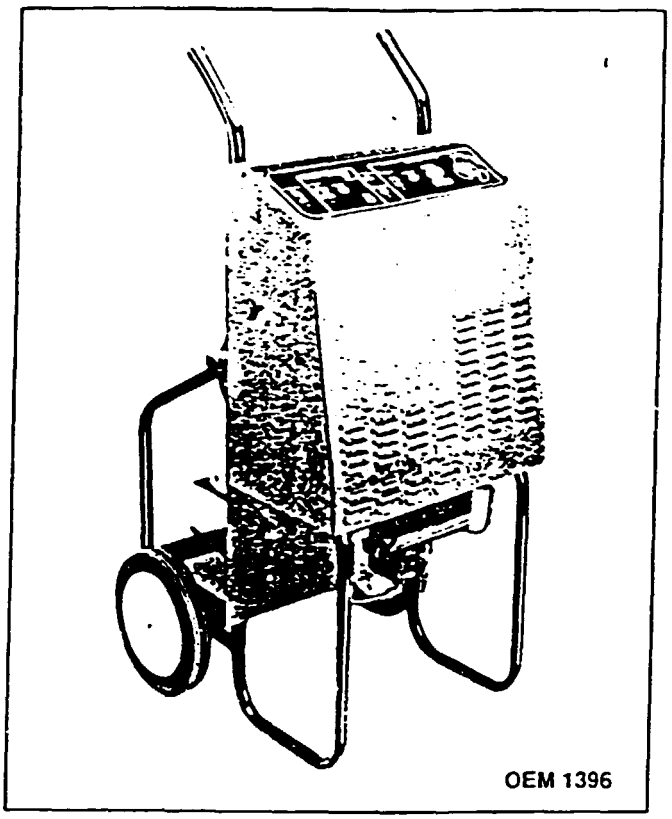
Both the OEM1380 and OEM1396 are U.L. approved – actually exceeding set U.L. specifications of air, oil, and moisture content of recycled refrigerant! Each also has: a patented heat exchange oil separator with catch bottle (oil separation occurs during recovery sequence); moisture level monitoring control; compressor cooling fan; compressor oil separator; portable cart design for easy transport; and continuous loop recycling. The built-in safety features – refrigerant tank overflow protection, automatic high pressure cut-off switch – make refrigerant recovery a much safer operation.

PLUS, these other features:

OEM 1380:

- U.L. approved.
- Ideal for high-volume shops. Recovers ½ lb. per min.; recycles 2½ cfs. per min. Reduces air conditioning system to a vacuum.
- Compatible with all charging stations. No additional equipment needed.
- Filter pressure monitor and high pressure light.
- Automatic air purge.
- Easy-to-use controls with moisture indicator. Multiple liquid recycling method assures complete purity.
- Shipped complete – only assembly required is insertion of a filter. Uses easy-to-change cartridge filter.
- Two 30 lb. D.O.T. approved refillable tanks included.
- Three "Quick-Seal" connecting hoses, 72" long. Can be used to update your current equipment.
- Full housing encloses all working components.
- Operating video and manual included.
- 115 volts A.C.
- Dimensions: 45" high x 23" x 25" deep. Weight: 140 lbs.


OEM 1380



OEM 1396

OEM 1396:

- U.L. approved.
- Lower-cost mocel for shops doing fewer A/C service jobs.
- Recovers ½ lb. per min.; recycles .8 lb. per min. Reduces air conditioning system to a vacuum.
- Compatible with all charging stations: no additional equipment needed.
- Manual air purge. with gauge.
- Easy-to-use controls with moisture indicator. Single/multiple vapor recycling method.
- Shipped complete. Uses easy-to-change canister type filter.
- Two 30 lb. D.O.T. approved refillable tanks included.
- Three "Quick-Seal" connecting hoses, 72" long. Can be used to update your current equipment.
- Operating video and manual included.
- 115 volts A.C.
- Dimensions: 45" high x 21" wide x 24" deep. Weight: 115 lbs.

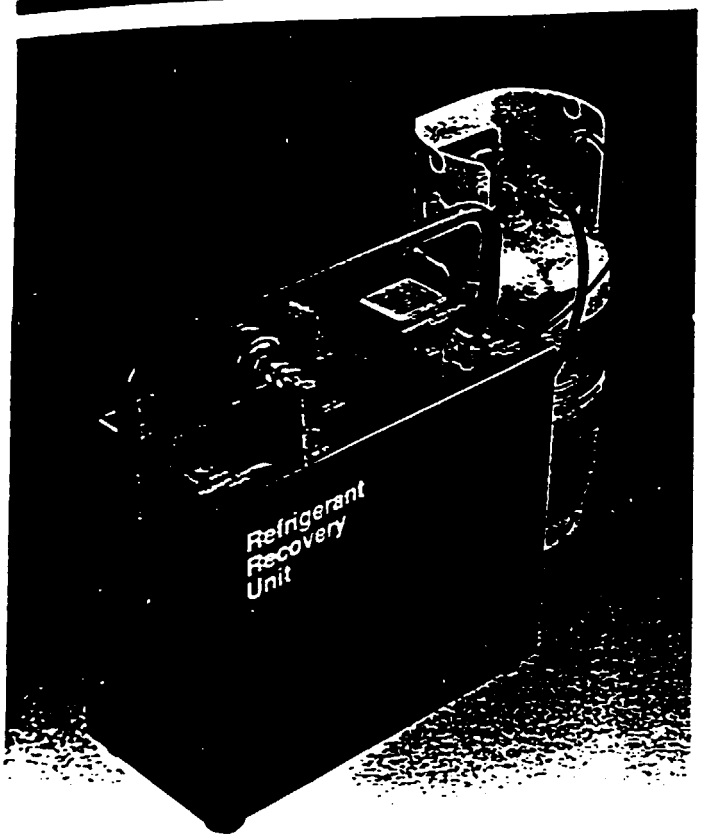
So why recycle? Because of the current agreement to cut CFC production, limited supply of refrigerants means limited availability. And that's practically a guarantee the price will go up. Plus, a new Federal tax of $1.37 per pound of Freon has been imposed, applying to all existing stock and new purchases. Air conditioners will continue to need recharging, and until an alternative for Freon is developed, recycling is the only practical, economical answer.

And what about Return on Investment? The following is a sample comparison between two different service shops:

	Shop A	Shop B
1. Systems serviced per week during 12 week* A/C season:	5	10
2. Average amount of Freon (R-12) per system:	4 lbs.	4 lbs.
3. Amount recovered from systems being serviced (many systems are low of refrigerant):	10 lbs.	20 lbs.
4. Amount of Freon (R-12) recovered from pressure check charge:	10 lbs.	20 lbs.
5. Total refrigerant recovered per week (#3 + #4 =):	20 lbs.	40 lbs.
Cost per lb.:	$5.00	$5.00
Savings per week:	$5 x 20 lbs. = $100.00	$5 x 40 lbs. = $200.00
6. Payback of cost of recycling equipment:	2 years	1 year

*Estimated minimum season

OEM-1397



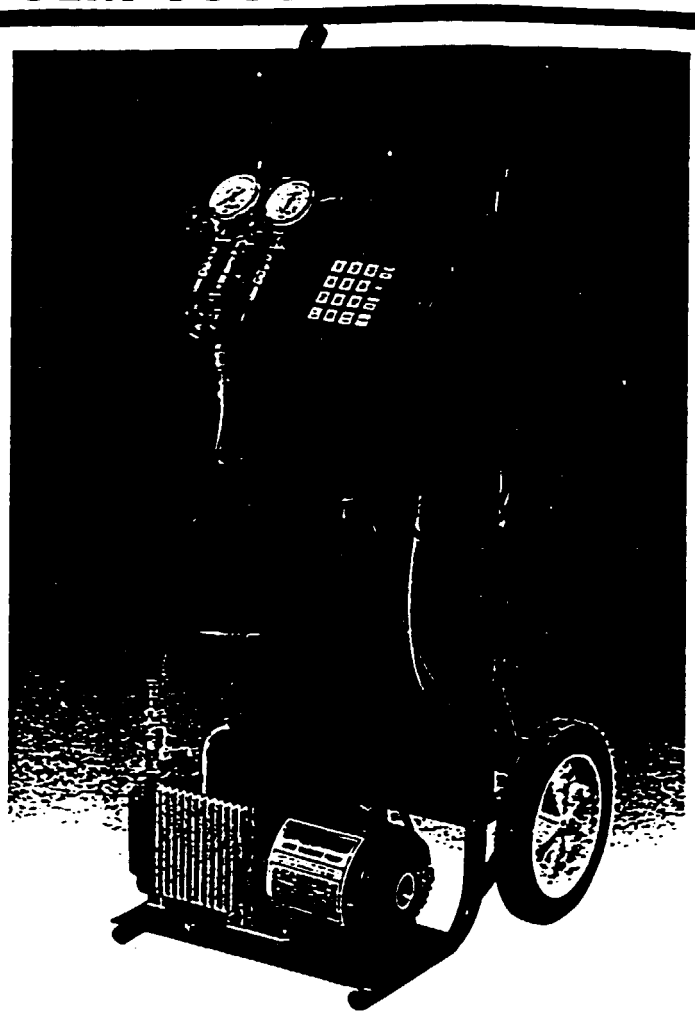
Portable Recovery Station

The perfect companion to your recovery and recycling system. This portable Freon recovery station saves you the cost of investing in another recovery and recycling unit. It's perfect for use in the body shop or on field service trucks, and at satellite service facilities.

- **Recovers ½ lb. per minute.**
- **Built-in oil separator.**
- **One 72" hose with "Quick-Seal" fitting.**
- **One, 30 pound reusable D.O.T. approved refrigerant storage tank with float switch.**
- **Fully enclosed working components. Cabinet rests on four rubber pads.**
- **115 volts A.C.**

Dimensions: 15" high x 20" wide x 14" deep. Weight: 53 lbs.

OEM-1365



Charging Station

To make your shop even more profitable, you'll want to add this charging station. Today's vehicles require a "precise" charge. With its computerized controls and solenoids to monitor the evacuation and charging processes, you won't waste a drop of refrigerant. You can even add refrigerant in .2 lb. increments for partial charging, leak checking or "topping off". An electronic strain gauge scale ensures the weight accuracy and easily handles 30 lb. bulk tanks.

- **Manifold gauge set and two, 96" color-coded hoses with "Quick-Seal" fittings are included.**
- **Adapter fittings package.**
- **Heater blanket for faster, more complete charging.**
- **Refrigerant capacity: 30 lb. bulk tank.**

Dimensions: 42" high x 21" wide x 20" deep. Weight: 96 lbs.

THE TIME IS NOW

LEGISLATION ENVIRONMENT PROFITS

Carrier
HEATING & COOLING

Product Data

19QA Refrigerant Management System

50/60 Hz

HCFC-123 COMPATIBLE

Carrier's 19QA Refrigerant Management System Conserves Existing Supplies of CFC's and Minimizes Their Leakage During Centrifugal Chiller Service and Maintenance

- Minimizes CFC emissions
- Conserves refrigerant and reduces costs
- Removes oil, water and acids from refrigerant
- Optimizes chiller efficiency with recycled refrigerant
- Designed for use on any manufacturer's R-11 centrifugal chiller
- Safely holds refrigerant during extensive chiller servicing.

Features/Benefits

Carrier's 19QA Refrigerant Management System (RMS) provides a timely solution to the problem of refrigerant loss during chiller servicing

Efficient refrigerant management

The RMS is a closed loop transfer pumping system and storage tank that isolates R-11 during routine chiller servicing or emergency repairs. By containing the refrigerant during maintenance operations, the RMS prevents evaporation of the refrigerant into the atmosphere. In addition to helping preserve the environment, use of the system can help conserve refrigerant and reduce costs. Contaminated refrigerant can be recycled on site, and excess oil, water or acids removed. Recharging the chiller with recycled refrigerant will optimize chiller performance and extend the life of the machine. The RMS can also be used with R-113 refrigeration systems.

Developed for application flexibility

The 19QA RMS is available in 2 sizes. Rigging holes are provided for crane lifting, as well as slots for use with a forklift. Connections to a chiller are made easy with the charging hoses and valves provided with the unit.

In the case of a single chiller application, the 19QA can be permanently installed and hard-piped to the chiller, if desired. Or, on sites with multiple chiller installations, a single RMS can be used to service several machines by temporary connection to each chiller using the hoses and valves provided. Optional field-installed casters for use with the smaller tank (19QA size 020) aid in the portability of the RMS.

Component description

The storage tank is designed for 15 psig working pressure and comes equipped with a one-in. rupture disc. A reflex type sight glass indicates when the tank is 90% full. The exact liquid level can be determined by use of the level gage provided. The smaller tank has a storage capacity of 1600 lbs (725 kgm) of R-11; the larger tank has a capacity of 3300 lbs (1500 kgm) of R-11.

Tube-in-tube condenser allows refrigerant vapor to be condensed when evacuating a chiller or when distilling refrigerant that contains excess oil. Garden hose connections (¾-in.) are provided for condenser water.

The 500-Watt electric heater is attached to the bottom of the storage tank. The heater is controlled by a toggle switch and is required when oil is being separated from the refrigerant by distillation. It is insulated and protected by a cover.

Four ½-in. charging hoses with shutoff connections allow easy interconnection of components. Two ½-in. ball valves with couplers are provided for use with the charging hoses to prevent the loss of the refrigerant in the hoses at the end of a transfer process. The hoses are designed to withstand high vacuum without collapsing.

The ½-hp diaphragm-type vacuum pump is equipped with a permanent split capacitor motor controlled by a toggle switch. Motor voltage is 115-1-50/60 Hz.

Manual reset high-pressure switches are provided to protect against overpressurization. One switch limits the tank pressure by shutting off the tank heater. The second switch limits the vacuum pump discharge pressure by shutting off the vacuum pump.

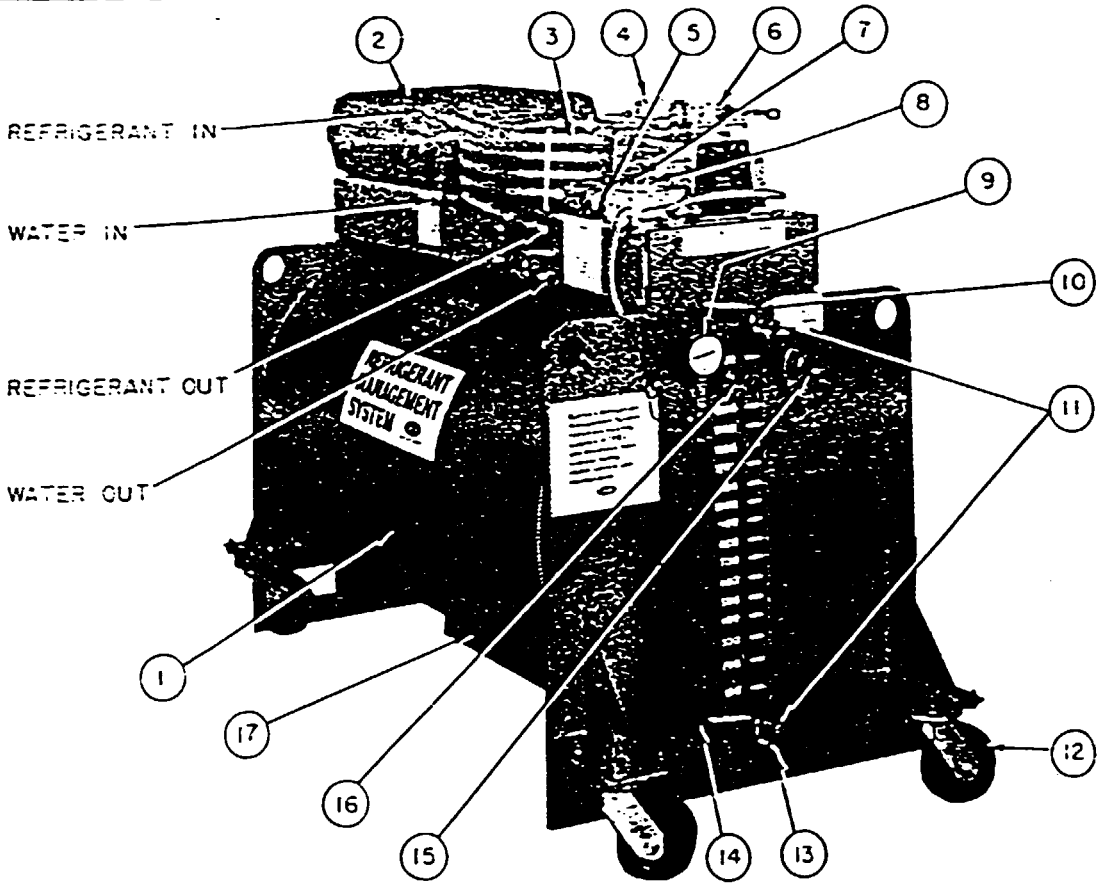
Table of contents

Physical data

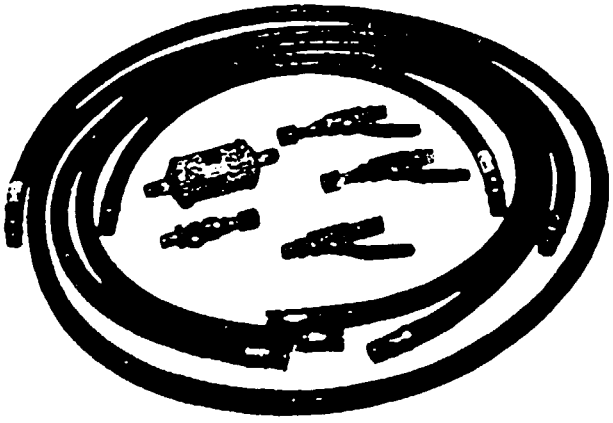
19QA	ENGLISH			SI		
	Size	020	040	Size	020	040
DRY WEIGHT	lbs	605	820	kg	275	370
TANK SIZE	cu ft	20	40	cu meters	.57	1.13
TANK STORAGE CAPACITY R-11 Liquid	lbs	1600	3300	kg	725	1500
DESIGN PRESSURE	psig	15		kPa	103	
MAX. OPERATING PRESSURE	psig	10		kPa	69	
CONNECTION SIZES	in.	½		In.	½	
HIGH PRESSURE SWITCHES						
Tank Heater and Vacuum Pump Cutout	psig	10		kPa	69	
Manual Reset	psig	<4		kPa	<28	
VACUUM PUMP PSC Motor Hp		½			½	
Max. Discharge Pressure	psig	10		kPa	69	
Max. Vacuum	In. Hg			kPa		
One Pump		25.5			86	
2 Pumps In Series		29			98	
Flow Rate	cfm			m^3/s		
60 Hz		3.6			.0017	
50 Hz		3.0			.0014	

PSC — Permanent Split Capacitor

Machine components



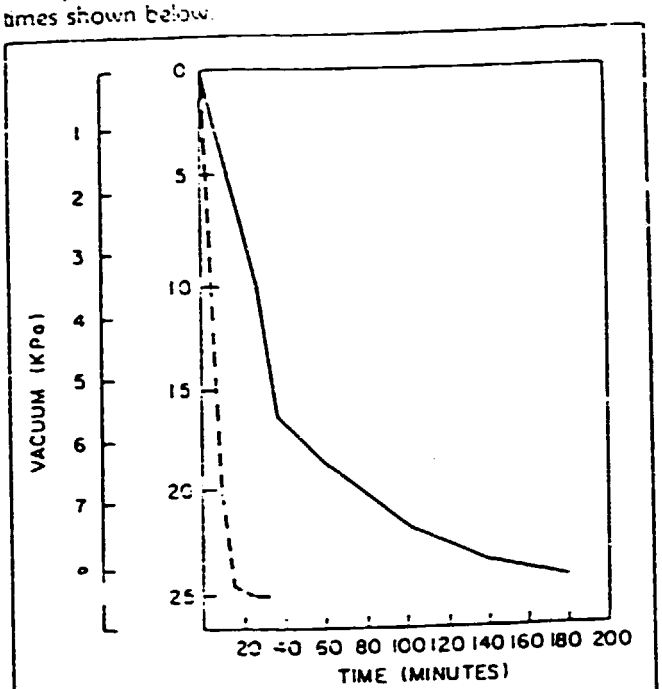
NO.	ITEM
1	— Storage Tank
2	— Accessory Case Charging Hose, 3 ft Charging Hose, 6 ft (2) Charging Hose, 12 ft Valve With Coupler (2) Chiller Vapor Valve Liquid Ind. With Coupler Filter-Drier ½-in. Flare ⅜-in. MPT x ½-in. Male Flare
3	— Tube-In-Tube Condenser
4	— Vacuum Pump
5	— Heater High Pressure Switch
6	— Vacuum Pump High Pressure Switch, Hidden
7	— Vacuum Pump Switch
8	— Heater Switch
9	— Pressure Gage
10	— Vapor Valve
11	— Level Gage Valve
12	— Optional Casters — Available for Small (20 cu ft) Tank Only
13	— Liquid Valve
14	— Water Separation Glass
15	— Rupture Disc
16	— Maximum Level Glass
17	— Heater



ACCESSORY CASE CONTENTS

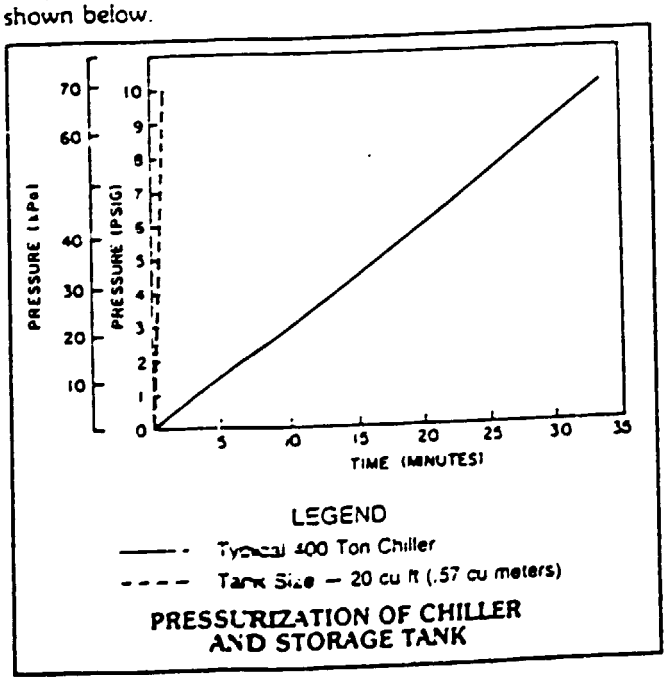
The 19QA RMS provides complete refrigerant management

Evacuation — To minimize refrigerant vapor loss, refrigerant-containing vessels such as chillers and storage tanks must be completely evacuated before charging. The 19QA vacuum pump can be used to evacuate these vessels in the times shown below.



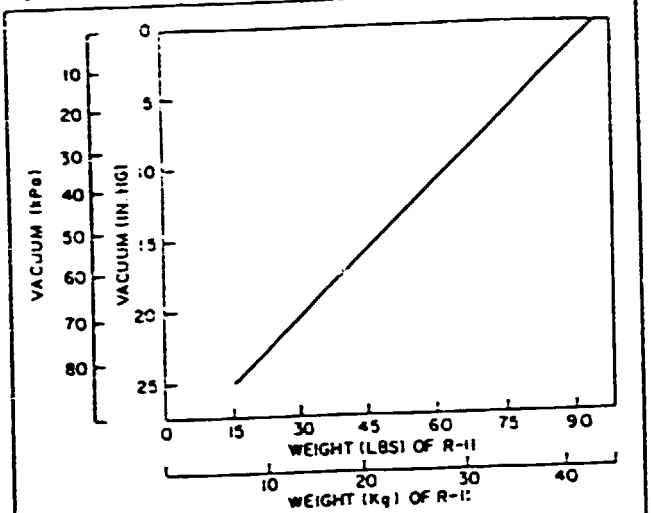
EVACUATION OF CHILLER AND STORAGE TANK

Pressurization — The vacuum pump can be easily used to pressurize a chiller or storage tank to 10 psig (69 kPa) for the purpose of leak testing. Typical pressurization times are shown below.

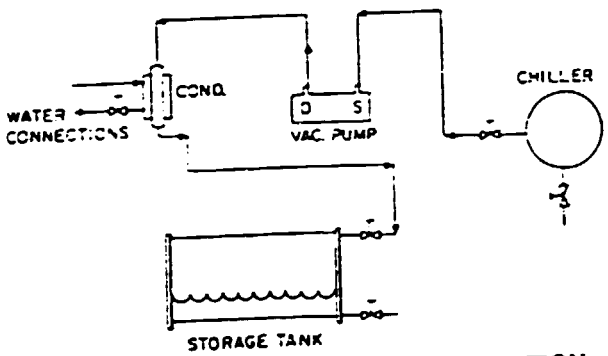


PRESSURIZATION OF CHILLER AND STORAGE TANK

Refrigerant Vapor Transfer — A typical 400-ton chiller contains about 95 lb (43 kg) of refrigerant vapor once the liquid refrigerant has been removed. With the 19QA Refrigerant Management System, it is possible to reclaim almost all of this refrigerant by evacuating the chiller and condensing the vapor.

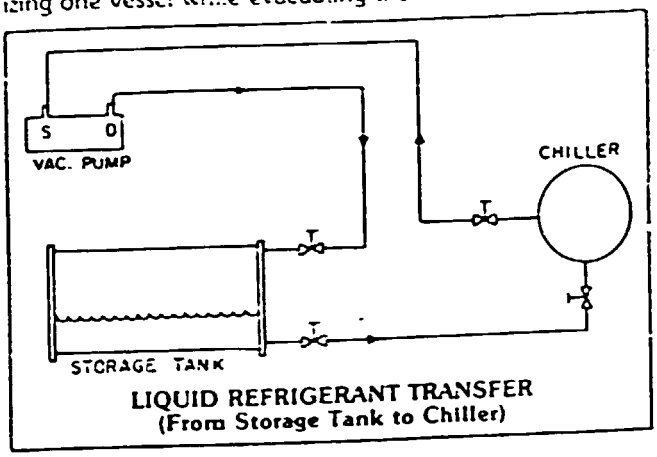


REFRIGERANT VAPOR REMAINING IN CHILLER AFTER REMOVAL OF LIQUID REFRIGERANT (400 Ton Unit)



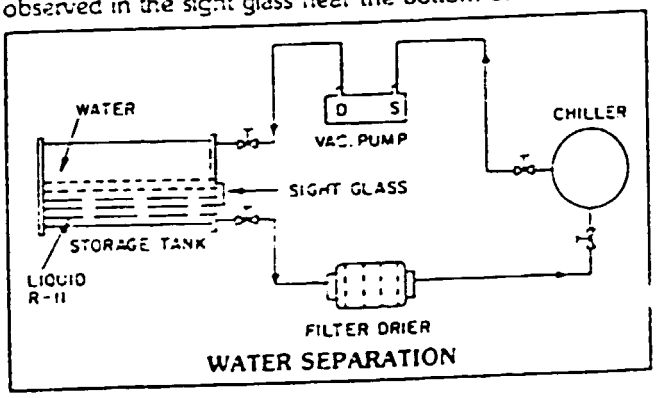
REFRIGERANT VAPOR TRANSFER/EVACUATION

Liquid Refrigerant Transfer — Liquid refrigerant can be transferred from the storage tank to a chiller (approximately 40 lbs [18 kg] per minute) or from a chiller to the storage tank (approximately 30 lbs [14 kg] per minute) by pressurizing one vessel while evacuating the other.



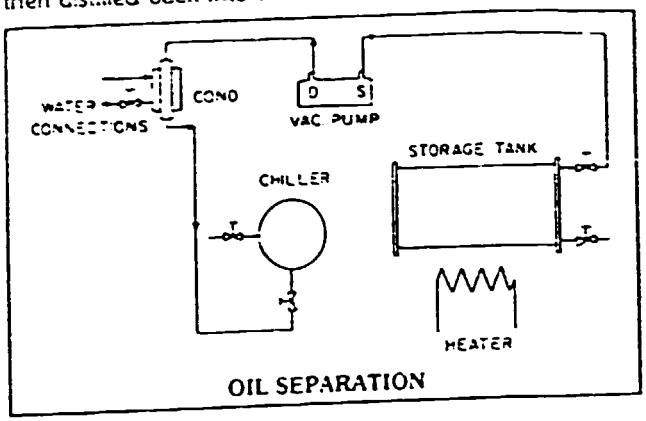
LIQUID REFRIGERANT TRANSFER
(From Storage Tank to Chiller)

Water Separation — Water is only slightly soluble in refrigerant (approximately 110 ppm) at typical temperature levels. Most of the water present will float on top of the refrigerant. This free water can be easily removed by stopping the transfer process when the water/refrigerant interface is observed in the sight glass near the bottom of the tank.



WATER SEPARATION

Oil Separation — The RMS can be used to separate oil from refrigerant through the process of distillation. The refrigerant is first transferred from the chiller to the tank and then distilled back into the chiller or another tank.



OIL SEPARATION

Application data

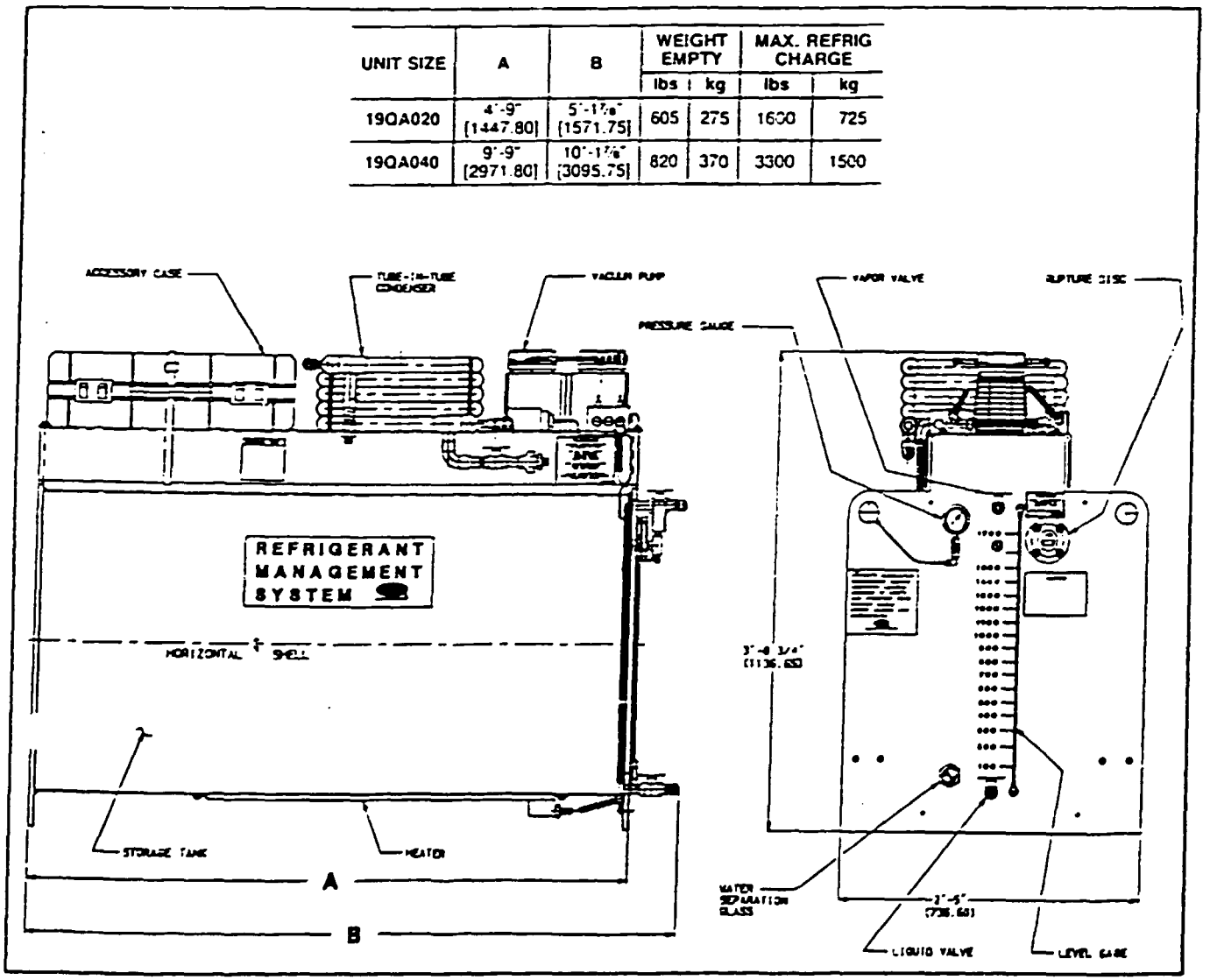
Vacuum pump — The diaphragm-type vacuum pump design reduces the probability of refrigerant leaks. The flow rate for this pump (free air) is 3.6 cfm (.0017 m^3/s) for 60 Hz and 3.0 cfm (.0014 m^3/s) for 50 Hz. The approximate maximum vacuum is 25.5 in. Hg (86 kPa) for a single pump and 29 in. Hg (98 kPa) for two pumps in series. The pump is capable of discharging to a pressure of 10 psig (69 kPa).

With heavy use, it may be necessary to replace the vacuum pump diaphragm. Repair kits are available. The vacuum pump also has internal filters which can be replaced.

Condenser — Condensing water temperature should be as low as possible to minimize the time required to complete an operation. A water flow rate of one gpm (.00006 m^3/s) at 70 F (21 C) is normally adequate.

Dimensions

UNIT SIZE	A	B	WEIGHT EMPTY		MAX. REFRIG CHARGE	
			lbs	kg	lbs	kg
19QA020	4'-9" [1447.80]	5'-1⅞" [1571.75]	605	275	1600	725
19QA040	9'-9" [2971.80]	10'-1⅞" [3095.75]	820	370	3300	1500



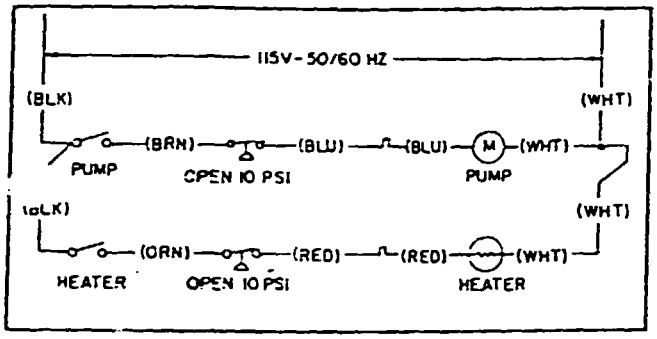
Electrical data

VOLTS-PH-HZ	115-1-60	115-1-50
MCA	12	12
MOCP (Amps)	15	15
HEATER Amps	4	4
VACUUM PUMP MOTOR Hp Amps	½ 4.9	½ 5.5

MCA — Minimum Circuit Amps
MOCP — Maximum Overcurrent Protection (Amps)

NOTE: Use time-delay fuse.

Control wiring schematic



Guide specifications

Refrigerant Management System

HVAC Guide Specifications

Carrier Model Number: 19QA

Part 1 — General

1.01 SYSTEM DESCRIPTION

A. The chiller manufacturer shall provide and install Refrigerant Management System (RMS) when using a CFC with an Ozone Depletion Potential of greater than 0.05.

B. Refrigerant Management System is designed for use with any low-pressure centrifugal chiller. The RMS shall provide conservation of low-pressure CFC's and prevent the release of CFC's into the atmosphere during routine servicing. In addition to safely holding the refrigerant during servicing, the RMS will recharge centrifugal chillers with recycled refrigerant. By means of a distillation/separation system, excess oil and water will be removed from the refrigerant to provide optimum chiller efficiency.

1.02 QUALITY ASSURANCE

Equipment and installation shall be in compliance with the Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1989.

1.03 DELIVERY, STORAGE AND HANDLING

Unit shall be stored and handled in accordance with manufacturer's recommendations.

Part 2 — Products

2.01 EQUIPMENT

A. General:

1. The RMS shall consist of a condenser, vacuum pump, storage tank and heater unit. Additional components shall include a filter drier, safety devices and all required instrumentation and interconnecting hoses.
2. All connections shall be by ½-in. charging hoses unless otherwise specified.

B. Storage Tank:

1. The storage tank shall be of sufficient capacity to contain the entire refrigerant charge of one chiller when 90% full at 90 F (32 C) in accordance with ANSI/ASHRAE 15-1989.
2. The storage tank shall be rated for a design pressure of 15 psig (103 kPa) and equipped with a rupture disc.
3. Means shall be provided for rigging and for use with a forklift.

C. Condenser:

The condenser shall be a copper tube-in-tube type rated for a minimum 450 psig (3103 kPa) refrigerant side and 300 psig (2069 kPa) water side design pressure.

Guide specifications (cont)

D. Heater:

The heater shall be a permanent strap-on type with a minimum 500-Watt rating at 115 v, one phase, 50/60 Hz, and shall be operated by means of a toggle switch.

E. Vacuum Pump:

1. The pump shall be a diaphragm type with ½-hp, 115-v, one-phase, 50 or 60 Hz motor and shall be capable of pulling a vacuum of 25.5 in. Hg (86 kPa) (ref. 30 in. barometric pressure). The pump shall be capable of maintaining a pressure differential of 9 to 10 psig (62 to 69 kPa) between the storage tank and the interconnected chiller.
2. The pump shall be equipped with a permanent split capacitor motor which shall be controlled by a toggle switch.

F. Safety Devices:

1. Pressure relief valve sized in accordance with ANSI/ASHRAE 15-1989.
2. Two high-pressure switches to protect the storage tank against over-pressurization. One switch shall limit the tank pressure to 10 psig (69 kPa) by shutting off the tank heater. The second switch shall limit the vacuum pump discharge pressure to 10 psig (69 kPa) by shutting off the vacuum pump.

G. Contaminant Removal:

The system shall be capable of removing contaminants from the refrigerant charge in accordance with the following requirements:

1. Oil separation shall occur through a distillation process and shall provide recycled refrigerant with less than 1000 ppm oil.
2. Water separation and removal shall provide recycled refrigerant with less than 50 ppm water.

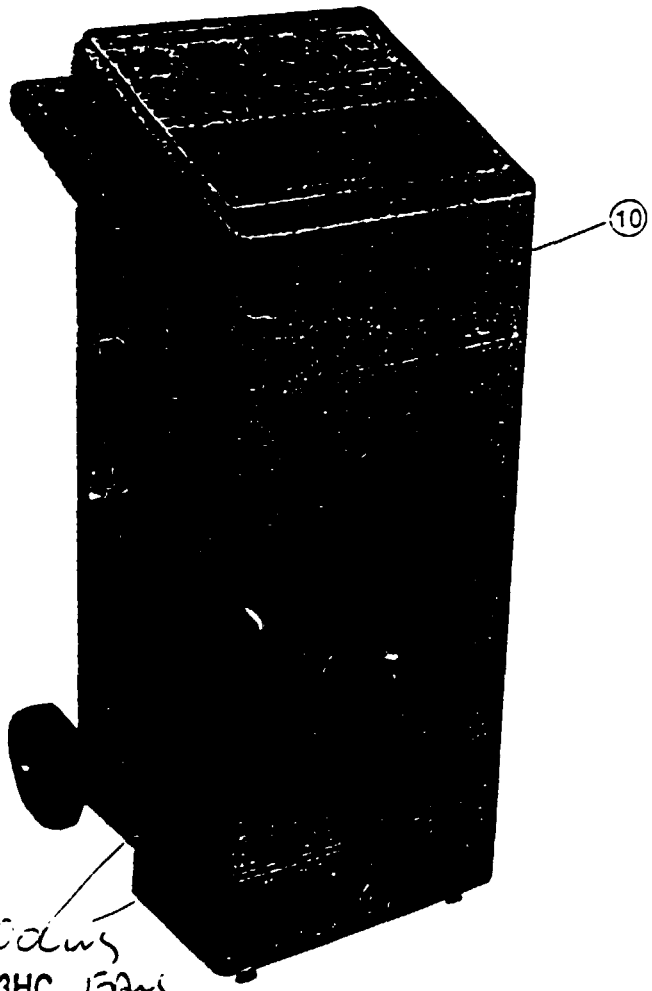
H. Additional chillers:

The RMS shall be able to accommodate multiple chillers when the proper crossover connections are supplied, and the storage tank is to be capable of containing the entire refrigerant charge of the larger of the 2 units, when 90% full at 90 F (32 C).

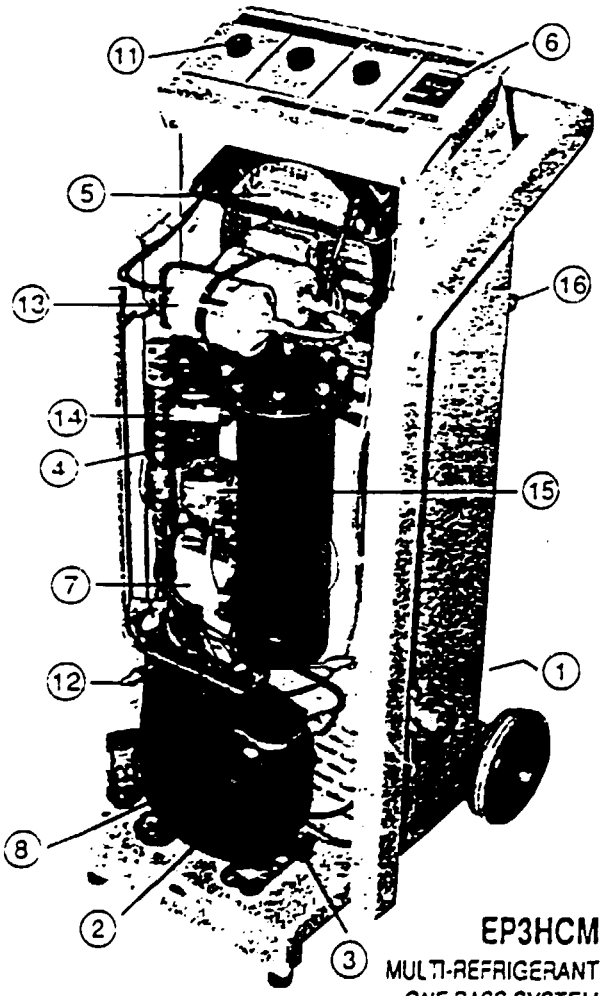
I. Special Features:

Casters:

Accessory package for use with 20-cu ft (.57-cu meters) storage tank shall include four 6-in. diameter swivel casters with wheel locks, mounting brackets and hardware.



EP3HC



EP3HCM
MULTI-REFRIGERANT
ONE PASS SYSTEM

FOR HEAVY DUTY MOBILE & COMMERCIAL AIR CONDITIONING AND REFRIGERATION APPLICATIONS
BUSES, TRUCKS, TRAINS, AIRCRAFT, REFRIGERATED TRANSPORT

EP3HCM OUR HEAVY DUTY RECOVERY/RECYCLING MACHINE FOR FAST RECOVERY FROM LARGER SYSTEMS RECOVERS BOTH LIQUID AND VAPOUR

FEATURE	BENEFIT
① Cylinder Weighing Platform	*Prevents dangerous overfilling of cylinders.*
Large ½ hp heavy duty Danfoss compressor ②	*For fast recovery and recycling (R12 up to 1kg/min).*
Set and forget operation	*No supervision required during recovery.*
Compressor oil change ③ and oil return system ④	*Returning compressor oil to the crankcase and making provision for changing the compressor oil ensures years of trouble free service.*
Fan forced fin and tube condensor ⑤	*Liquifying the refrigerant before it is stored in the cylinder prevents dangerous overheating of the recovery cylinder.*
Hourmeter ⑥	*Allows you to monitor oil change and filter change intervals.*
High pressure ⑦ high temperature ⑧ cut out switch	*Protects the machine and the operator.*
Scavenge effect	*Our machine will restart every two minures after completion of recovery to "scavenge" any refrigerant that may have boiled out of the compressor oil or the accumulator and drier(s).*
*TX valve ⑨ (not fitted to EP3HCM)	*Controls refrigerant flow during recycling.* **Note purity exceeds SAE standard J1991.*
Stylish steel ⑩ powder coated cabinet	*Tough, durable and easy to clean.*
Voltage	*Available in 220 volt 50Hz and 110V 60 HZ (Export).*
Electrical ⑪	*Aporoved by all Australian Electrical Authorities. We use quality Siemens electrical components.*
A choice of refrigerants	*Available for R12, R22, R500, R502 and can be easily converted.*

EP3HCM A MULTI REFRIGERANT ONE PASS VERSION OF THE UNIT ABOVE WITH THE FOLLOWING ADDITIONAL FEATURES.

FEATURE	BENEFIT
Multi Refrigerant	*Designed where there is a need to switch quickly and simply to either R12, R22, R500, R502.*
Minimum emissions during change over to another refrigerant	*A loop circuit allows this machine to recover the refrigerant in 98% of its high side circuit. Only 100mm of 6mm tubing ⑫ needs to be vented during changeover.*
One pass purification	*Adding dual filtration ⑬ to the high side (after the condensor) means that by simply recovering the refrigerant it is immediately ready to be reused.***
Crankcase pressure regulator ⑭	*Provides added protection for the compressor from high inlet pressures.*
Accumulator flow control ⑮	*A level sensitive control system monitors level to ensure proper low side vaporization and filtration.*
Large ⅜" inlet ⑯	*For fast vapour and liquid recovery.*
Patents	*Our patent applications protect you from poor quality copies which will not operate effecively.*

COMPLETE READY TO USE

The following accessories are included:

■ Two 25kg recovery cylinders and hoses with anti-blow back fittings ■ One Manifold gauge and 72" hose set

*** Highly contaminated refrigerant may need recycling*

DISTRIBUTED BY:

MADE IN AUSTRALIA BY:

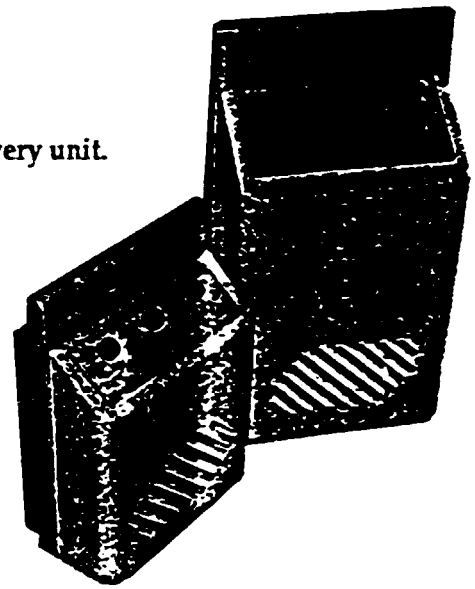
ENVIRONMENTAL PRODUCTS AMALGAMATED
P.O. Box 190, Shepparton, Victoria, Australia, 3630
Phone: (058) 31 2912 – Fax: (058) 21 0172
International: 61 5831 2912 – Fax: 61 5821 0172

PHONE TOLL FREE

(008) 039 092

A SIMPLE SYSTEM FOR MAKING GOOD MONEY OUT OF USED REFRIGERANT.

The SKYEMITE recovery unit.



The SKYEMATE recycler.

Announcing a new concept in recycling refrigerant. The SKYE Split System. Two units working together or apart.

The SKYEMITE is a simple and compact *recovery unit*, the SKYEMATE *recycles* R12 by removing contaminants. Both units are about the size of an average vacuum cleaner and are just as easy to use.

The SKYE Split System.

Nothing could be simpler. You keep your SKYEMATE recycling unit in a central location, where it quickly and efficiently removes the contaminants from R12, producing a purified refrigerant which is ready to use again!

You keep the SKYEMITE recovery unit in your ute or van ready to go out to factories, farms and workshops, to recover refrigerants. Then it's back to your SKYEMATE to complete the recycling.

You have a choice- invest in a SKYEMITE now and buy a SKYEMATE later.

Of course, you can run a number of SKYEMITES with only one SKYEMATE which reduces capital outlay and increases your flexibility.

And a bonus, your SKYEMATE Recycling unit can be run with other brands of 'recovery only' machines.

It will soon be compulsory to at least recover refrigerants, under laws designed to preserve the atmosphere.** However, the SKYE Split System can improve your profits right now! Why wait?

SKYE

Good for the world. Great for business.

**CHECK WITH LOCAL AUTHORITY

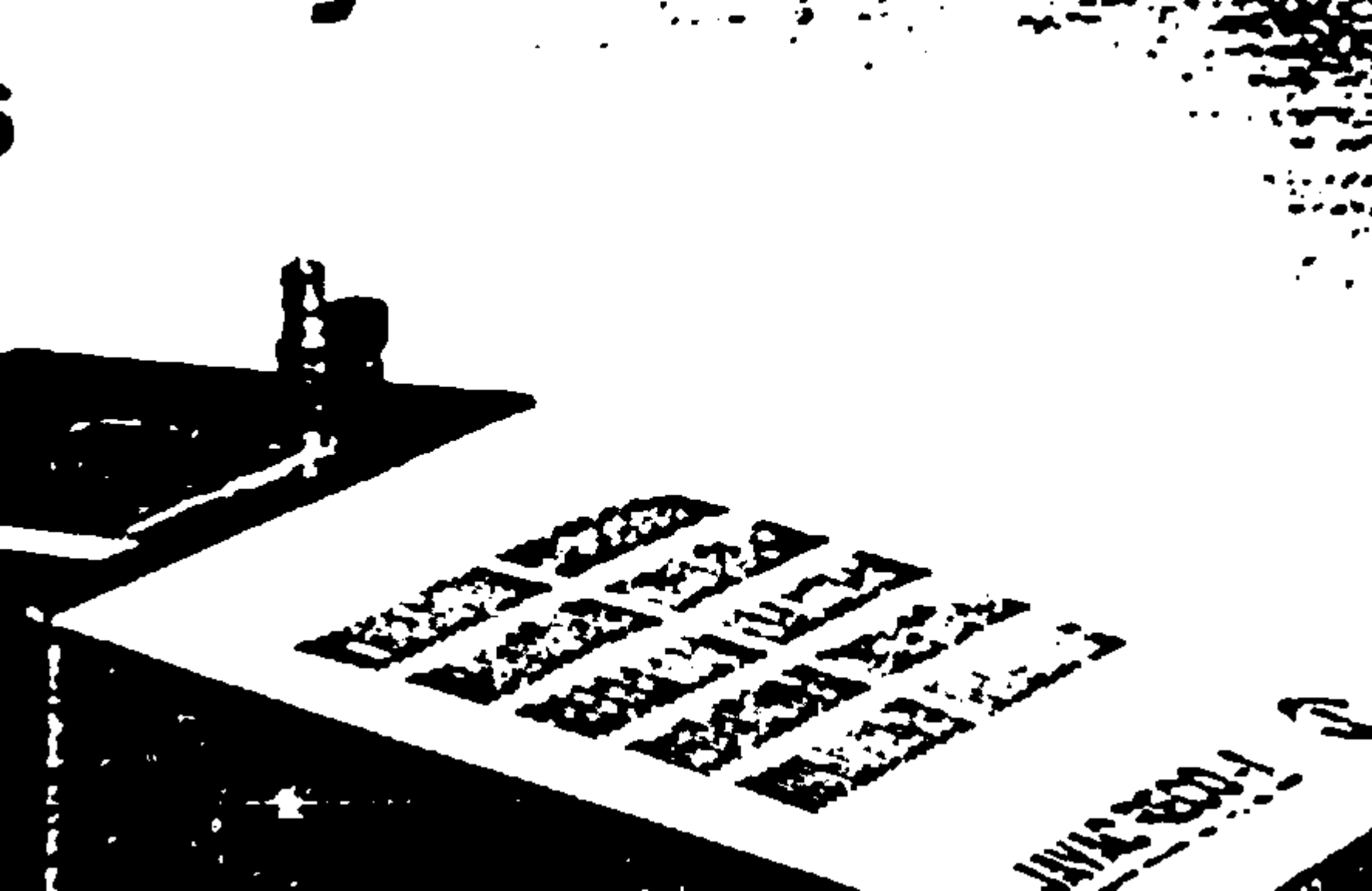
MANUFACTURED BY:

Environmental Products Amalgamated Pty Ltd

5/23-27 Callister Street, Shepparton, Victoria, 3630, Australia

Phone Int.: 61 58 312912 – Fax Int.: 61 58 210172

For details of your nearest distributor, telephone (within Australia) toll free 008 039092



The Javac range of RECO refrigerant recovery and recycling units is, we believe, the most comprehensive and advanced on the market today.

The investment required in a quality recovery/recycling unit is quite substantial, so it is important that you get the features, service backup and accessories you need. It is also important to select the particular model with the features and capabilities to best suit your requirements.

Javac has produced three models with quite specific applications in mind, and with features which in many cases are available only on the RECO range

When you choose a Javac RECO, you are also choosing the support of Australia's largest manufacturer of high vacuum pumps, respected for its innovation and quality in the refrigeration and vacuum industries for over 20 years.

Three models:

RECO–1

A true, multi-purpose workhorse, compact, fast, efficient, designed to rapidly remove large volumes of types R12, R22 and R502 refrigerants.

The only commercial unit available with built-in sub-cooling to actually chill the dumped refrigerant, for improved efficiency and safety. The RECO–1 features a belt drive compressor with oil recirculation, and multiple refrigerant recovery capability. Access is easy, servicing simple.

RECO–12S and RECO–134S

Specifically for the recovery of R12 and R134a, these units are also compact, but utilise high-capacity twin filtration systems with replaceable filter drier cores. Both units use commercial size hermetically sealed compressors, modified for simple oil checking and re-filling.

No-fuss recovery ensures minimum down-time and fast repair of domestic, and automotive installations.

The RECO–12S and 134S are both capable of vapour recycling, and can be connected as shown on the back page. This means that refrigerant can be cleaned and dried, thus providing real cost-saving benefits by enabling the re-use of costly refrigerants.

Service and support

In every detail, the RECO range exemplifies Javac's reputation for quality, no-nonsense engineering, reliability, and service. We provide, through our extensive distribution network, product support which is the envy of our competitors — our whole service and parts operation reflects a thorough, long-term commitment to excellence.

Engineering

All RECO units use proven and tested refrigeration components and feature interchangeability and user serviceability.

All units have fully variable high pressure safety cutouts, and adjustable low-pressure switching provides the choice of pressure or vacuum cutout.

All RECO units are fully automatic in operation and can be 'set and forget.' If required, full manual override and adjustment ensure the RECO units are adaptable to any task.

Air-cooled condensers, oil separators, sequence indication lamps and quick-connect no-loss fittings feature heavily.

Automotive application using a RECO–12S

Javac RECO features

Specification/Model		RECO-1	RECO-12S	RECO134S
Application		Commercial	Dom/Auto	Dom/Auto
Mobile refrigerant recovery		•	•	•
Mobile refrigerant recycle		•	•	•
Recovery rate —	R12	60	33	-
kg/hr @	R134a	-	-	33
150kPa RECO-1	R22	30	-	-
@300kPa RECO-S	R502	50	-	-
Recycle rate l/min		-	1.0	1.0
Belt drive serviceable compressor (cc)		140	-	-
Heavy duty hermetic compressor (cc)		-	15	15
Oil Type/Oil capacity (cc)		3GS/100	3GS/470	Ester/470
Compressor power motor kW		1.5	0.3	0.3
Maximum pressure kPa		2400	1500	1500
System piping size		38	38	38
Connection lines		3/8	1/4	1/4
Dimensions		390 x 440 x 600 (all models)		
Weight (kg)		48	35	35
Power requirement 240v 50Hz Max		10 amp	5 amp	5 amp
Automatic operation/cycling		•	•	•
Vapour recovery		•	•	•
Vapour recycle		•	•	•
Override facility		•	•	•
Inlet oil/liquid trap/filter		•	•	•
Inlet disposable filter		•	-	-
Inlet core heavy duty drier		•	•	•
Oil separator		•	•	•
Oil recirculation		•	-	-
Refrigerant recirculation		•	-	-
Condenser air cooled (fan)		•	•	•
Sub cooler		•	-	-
Sight glass/moisture indicator		•	•	•
HP safety cutout manual reset		•	•	•
HP cutout auto reset		•	•	•
Adjustable at LP Control		•	•	•
Oil check facility drain/refill		•	•	•
Quick fill capacity (ml)		•	-	-
Electrical approval SEC Victoria		•	•	•
Status indicator lights		•	•	•
Circuit breaker manual reset		•	•	•
Proximity switch		•	-	-
Thermal overload device		Manual	Auto	Auto
Hour run meter		•	-	-
Meets refrigeration standard AS1677		•	•	•
Meets SAE standards SAE J1991, 1989/1990*		•	•	•
MVAC Approval** ACR		•	•	•
	HC2	NA	•	TBA
Adjustable handle		•	•	•
Hoses supplied		2	2	2
Cylinder adaptor		3/8	1/4	1/4
Hansen quick release safety couplings		2	2	2
Warranty compressor/system		3/12	3/12	3/12
Catalogue number		R30084	R30085	R30086

• Standard feature
- Not applicable

*The RECO1 and 12S are certified to comply with these SAE standards. Tests were performed by Sharp & Howells Pty Ltd Melbourne
**MVAC Approval No. 5

Accessories

Autoff

A stand-alone automatic cut-off device designed to switch off the recovery unit when a specific cylinder weight reaches 80% capacity.

Suitable for P (28kg), Q (49kg), R (79kg) size cylinders, switchable. The Autoff can be used with any Javac RECO unit, or 240 volt recovery unit.

Cat. No. R30057

Cylinder trolley
(Incorporating AUTOFF)

A sturdy, folding trolley designed to transport P (28kg), Q (49kg) and R (79kg) cylinders. The trolley folds for easy storage and incorporates the AUTOFF automatic cutoff facility.

In practice, both the Javac RECO and cylinder trolley can be easily wheeled into position and connected up. The folding trolley is ideal for service personnel, as it takes minimum space in the service van.

Cat. No. R30087 (without AUTOFF)

Hermetically-sealed High Vacuum pump

The Javac Wombat series of high vacuum pumps are designed to be used in conjunction with Javac RECO units at the last stage of recovery. By using appropriately, evacuation and final recovery of up to 100% can be achieved in the one operation. The Wombat is available in single or double stage.

Cat. No. ODS040H (single stage)

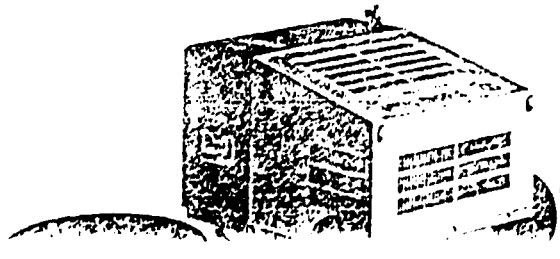
Cat. No. ODD040H (double stage)

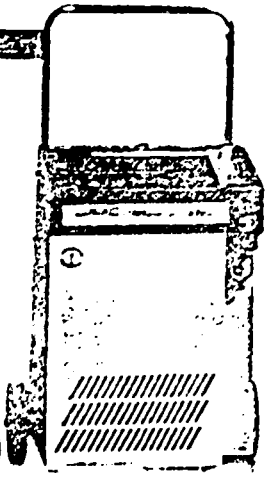
Analyser

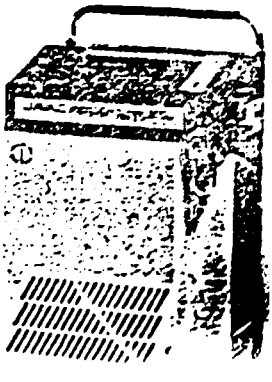
The Javac manifold/analyser can be optioned on a Javac high vacuum pump, or as an option for use with any refrigeration system. The analyser incorporates HP and LP gauging, valves, plus a vacuum pump valve.

Custom manufacture

Javac also offer custom designed and manufactured recovery, recycling and charging facilities. Information on request.





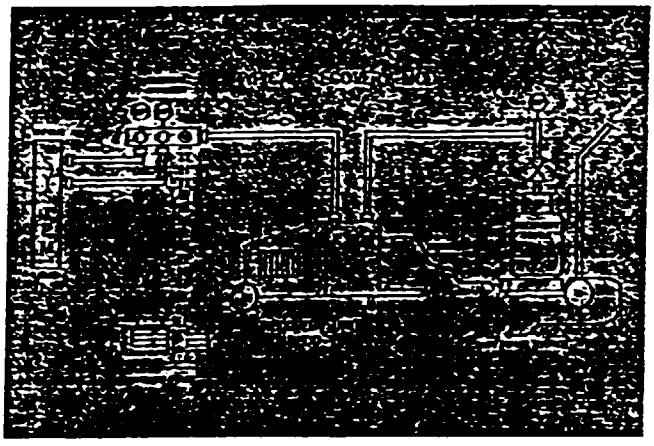


JAVAC RECO

Typical recovery

Connect the RECO unit to the vapour side of the system. Use a Javac AUTOFF beneath the recovery cylinder to prevent overfilling.

A vacuum pump installed via a systems analyser can be used to evacuate lines to prevent air entering the recovery cylinder. More than 95% can be recovered in this mode.



Final evacuation/ recovery (optional)

(A feature unique to Javac)!

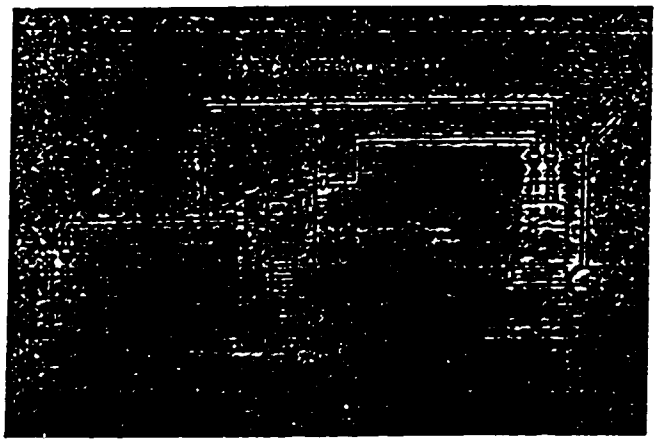
If desirable, use a Javac Wombat vacuum pump as shown to remove the final traces of refrigerant. Prior to recharging, exhaust the Wombat into the inlet of the RECO unit; adjust range switch for maximum run time and dwell.

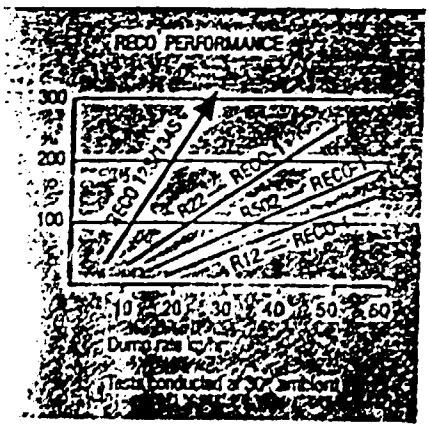
Always use an empty cylinder or a Javac AUTOFF during this optional final recovery.

Typical recycle

Using only a RECO-12S or 134S as shown, connect the inlet of the RECO-12S/134S to the vapour side of the recovery cylinder, and the discharge of the RECO-12S/134S to the liquid side of the recovery cylinder.

If using two cylinders, use vapour side on both. Monitor until the liquid and moisture indicator shows dry.





Designed and Manufactured in Australia by
Javac Pty Ltd
A.C.N. 004 477 543

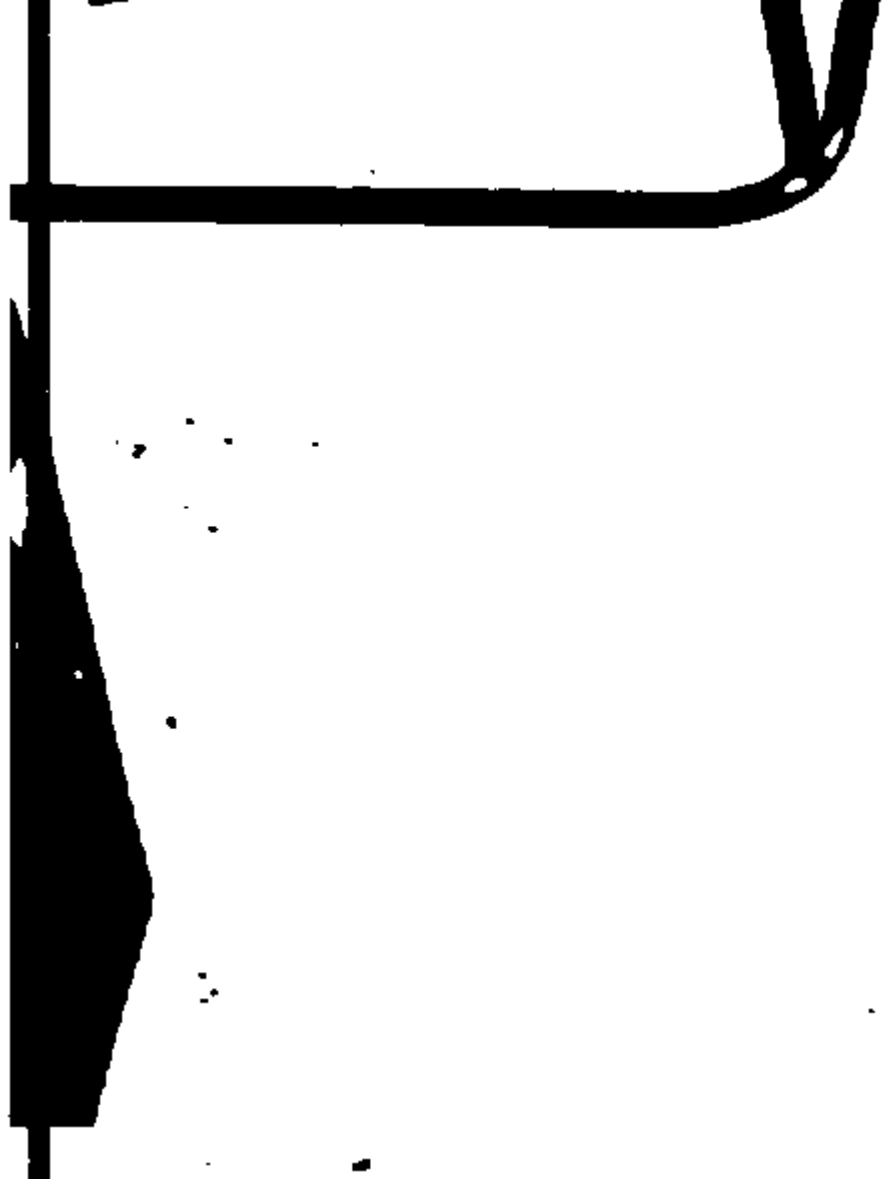
In line with its policy of continual product improvement, Javac Pty Ltd reserves the right to alter specifications without notice

ACTROL

Distributed in Australia by
Actrol Parts
A division of
GSA Industries (Aust)
Pty Ltd
A.C.N. 004 784 301

Melbourne	03 877 205
Sydney	02 749 1155
Brisbane	07 252 5591
Adelaide	08 234 1101
Perth	09 277 5922
Canberra	062 80 4176
Darwin	089 84 4877
Launceston	003 44 7088

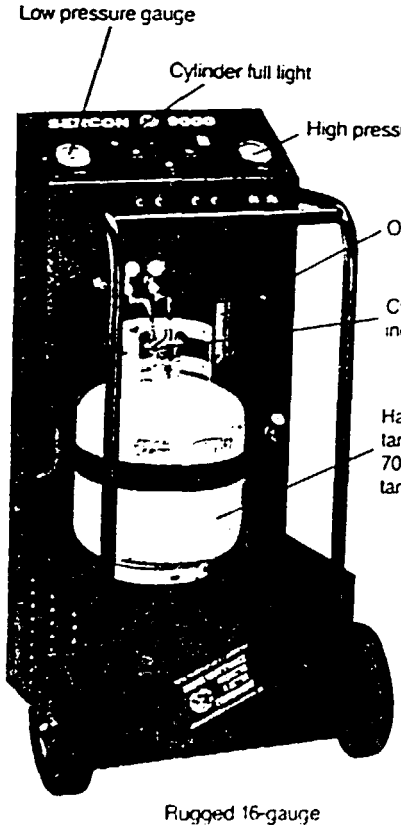
AUSTRALIAN MADE



REFRIGERANT RECOVERY & RECYCLING SYSTEMS

FROM TECHNICAL CHEMICAL COMPANY

Technical Chemical Company is the industry leader in Refrigerant Recovery and Recycling Systems. Sercon products are manufactured using only top-quality components; a complete inventory of parts and accessories is maintained. Sercon Refrigerant Recovery and Recycling Systems include a "hassle-free" one-year limited warranty.



SPECIFICATIONS:

Size: 20" x 20" x 45.5"
Weight: 175 lbs.
Connections: 1/4" flare
Power: 115/120 VAC, 60 Hz Current: 9 amps
Control Lamps: Green-Recovery, Red-Tank Full, Amber-Flush, Recycle

Safety Equipment: Low/high pressure controls, cylinder full shut-off, pressure relief valve, safety valves, check valves, crank case pressure regulator

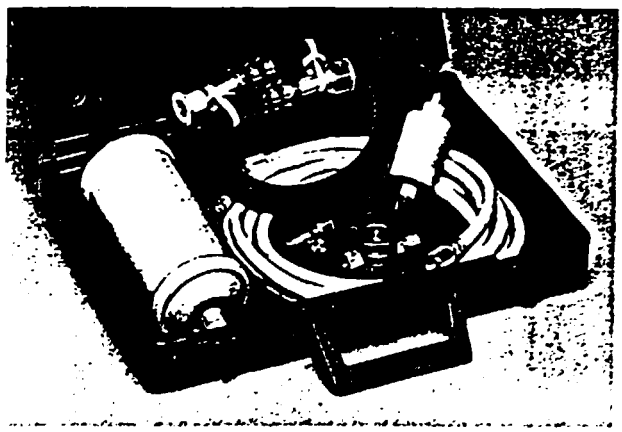
SERCON 9000

The Sercon 9000* is the industry standard in fast, safe, dependable Refrigerant Recovery & Recycling Systems for high-volume operations. It is UL listed and can be used with R-12, R-22, R-500 and R-502 refrigerants.

It boasts a powerful 1/4 horsepower Copeland compressor with a liquid pump that speeds recycling time and prolongs compressor life. The "continuous-loop filtration" system can recycle 40 pounds of refrigerant in just 15 minutes; dual filter blocks increase recycling efficiency.

Built-in high and low pressure gauges allow continuous monitoring of system pressures during recovery – once the system is completely evacuated, the Sercon 9000 shuts itself off. It has a Cylinder Full Light and Cylinder Level Indicator to show how much refrigerant has been recovered at any time. Meets S.A.E. J-1991 (1989) R-12 purity standards.

An oil sight glass makes the amount of oil recovered easily visible. An external drain on the front of the Sercon 9000 makes it easy to drain.



* Basic Flush kit (Part #S12445) for 9000/9220 systems. Optional adapters are available for use with many auto makes and models.

The Sercon 9000 boasts a unique flush cycle that with the *Basic Flush Kit uses recovered refrigerant to flush the system. It's easy for one person to operate, saves time and material, and is environmentally responsible.

Some commercial equipment contains a large quantity of refrigerant. The transfer capabilities provide the mechanic a method of moving refrigerant in a liquid state at a high rate of up to 25 lbs. per minute. This means substantial time savings to the mechanic.

Sercon 9134

The Sercon 9134* is a dedicated machine for R-134A. It has the same specifications as the 9000, with a synthetic oil in the compressor.

SERCON 9220

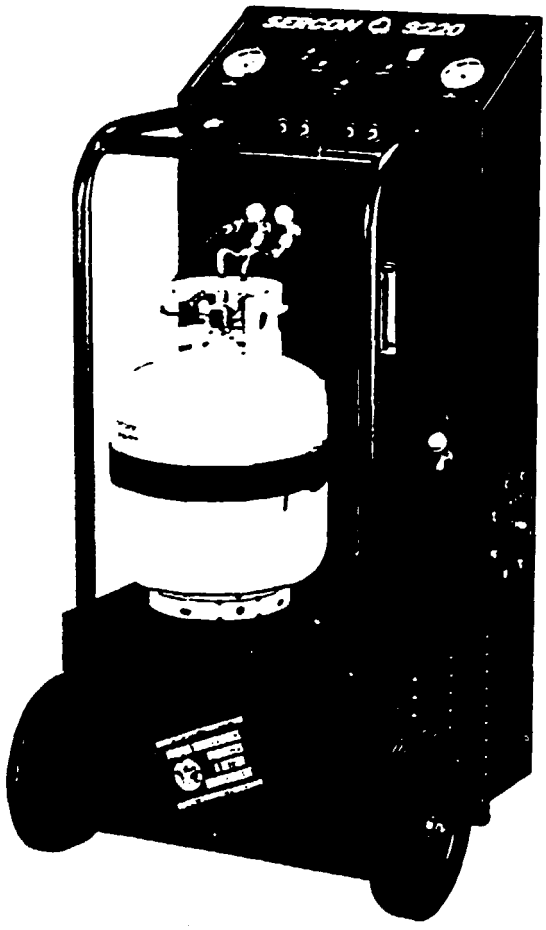
Designed with the world market in mind, the Sercon 9220* offers the same quality, features and performance as the Model 9000, but operates on 220/240 VDC, 50 Hz. And like the Sercon 9000, it is UL listed, easy to operate, efficient and environmentally responsible.

SPECIFICATIONS:

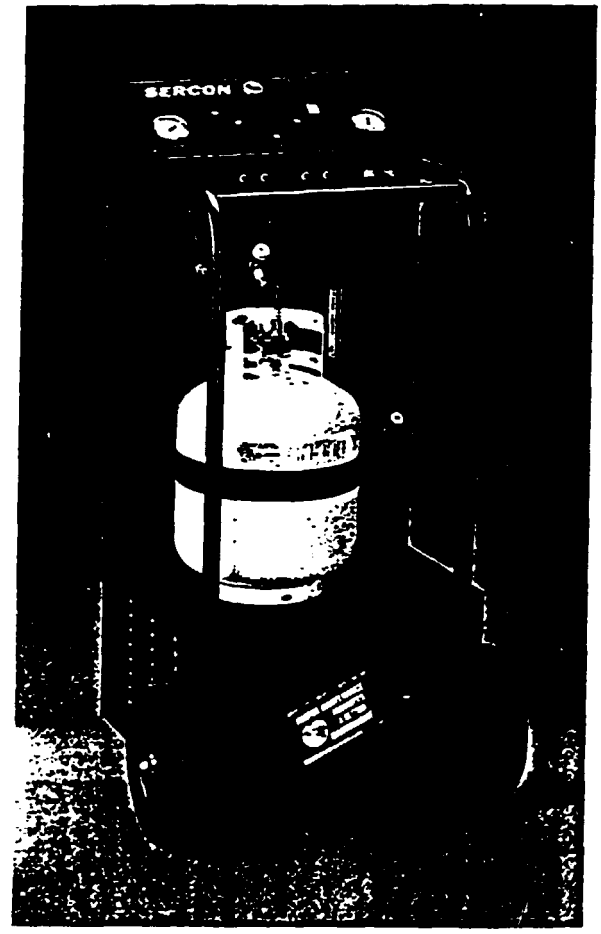
Size: 20" x 20" x 45.5"
Weight: 175 lbs.
Connections: 1/4" flare
Power: 220/240 VDC, 50 Hz Current: 5 amps

Control Lamps: Green-Recovery
Red-Tank Full
Amber-Flush, Recycle

Safety Equipment: Low/high pressure controls, cylinder full shut-off, pressure relief valve, safety valves, check valves, crank case pressure regulator.



SERCON 8000



The Sercon 8000 Single Pass Recovery and Recycling System is U.L. Listed and can be used with R-12, R-22, R-500 and R-502. This system meets S.A.E. J-1991 (1989) R-12 purity standards. The Sercon 8000 is the same quality you have come to expect with all our other equipment.

SPECIFICATIONS:

Size: 20" x 20" x 45.5"
Weight: 160 lbs.
Connections: 1/4" flare
Power: 115/120 VAC, 60 Hz Current: 9 amps

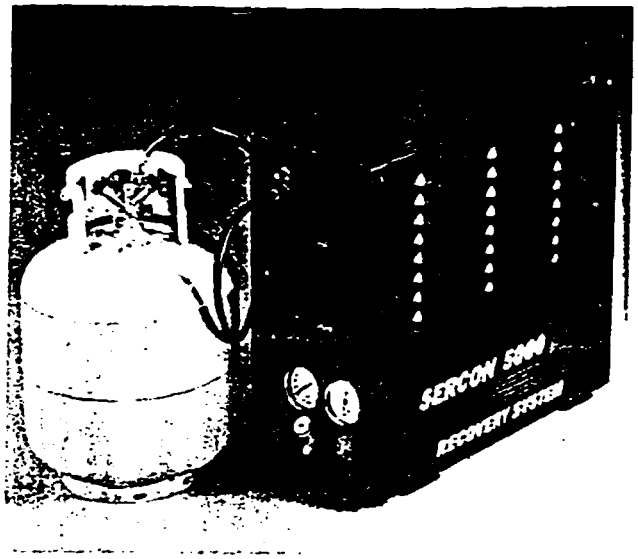
Control Lamps: Green-Recovery
Red-Tank Full

Safety Equipment: Low/high pressure controls/cylinder full shut-off, pressure relief valve, safety valves, check valves, crank case pressure regulator.

* Patent Pending

SERCON

SERCON 5000



SPECIFICATIONS:

Size: 9" x 19" x 24" Control Lamps: Green-Recovery
Weight: 70 lbs. Red-Tank Full
Connections: 1/4" flare
Power: 115/120 VAC, 60 Hz Current: 9 amps

Safety Equipment: Low/high pressure controls, cylinder full shut-off, pressure relief valve, safety valves, check valves, crank case pressure regulator.

The Sercon 5000* Refrigerant Recovery System allows smaller shops, auto dismantlers, and the HVAC/R Industry to have a portable, well balanced, and easily operated recovery system. A single 9000 and several 5000 systems are an economical option for larger service operations. A 5000 allows the HVAC/R industry access to roof top installations and remote jobs. The 5000 contains a full condensing section with dimensions that make it easily carried.

The UL listed 5000 provides the same efficient recovery capability as the Sercon 9000 without the additional expense of the recycling system. Recovered refrigerant is stored in 30 to 1,000 lb. capacity cylinders. It may then be recycled through a Sercon 9000, or sold to an off-site recovery center.

SERCON 4000

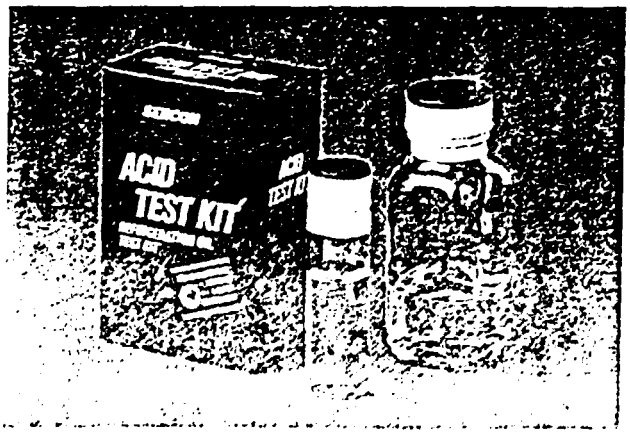
ACID PURIFICATION SYSTEM

The Sercon 4000 is specially designed with the HVAC/R industry in mind, for filtering refrigerant from systems with a high acid or moisture content. It is used in conjunction with the Sercon Refrigerant Recovery Systems.

The 4000 is UL recognized and features a special oil separator/accumulator and filter/drier blocks to remove the acid and moisture from the refrigerant before it enters the recovery system.

SPECIFICATIONS:

Size: 9" x 19" x 24" Weight: 55 lbs. Current: 1 amp
Power: 115/120 VAC, 60 Hz Connections: 1/4" flare



Sercon Acid Test Kit

Features:

- *Simple* – just two bottles to work with
- *Complete* – each kit has everything you need to do the job. After the test just discard the kit.
- *Sure* – no need to guess anymore. Color changes are easy to detect for positive indication of acid level.
- *Convenient* – handy small size package allows easy storage in your tool box.

SERCON 2000

The UL listed Sercon 2000 Flush/Transfer* unit contains a high volume liquid pump that provides the service technician a way to flush an air conditioning system or transfer/off load a large quantity of liquid refrigerant without venting CFC's into the atmosphere. This system weighs only 25 pounds and is contained in a 8" x 9-1/8" x 18" tool box for portability. The Sercon 2000 can be used with all refrigerants.

SPECIFICATIONS:

Size: 8" x 9-1/8" x 18" Control Lamps: Green-On
Weight: 25 lbs. Red-Tank Full
Connections: 3/8" flare
Power: 115/120 VAC, 60 Hz Current: 1 amp

Safety Equipment: Pressure relief valve, check valve

SERCON 1000

The UL listed Sercon 1000 Vapor Recovery System offers the small shop and the appliance industry an affordable, efficient way to recover R-12. The system recovers approximately 1/2 pound per minute utilizing a 1/6 horsepower compressor. The unit weighs only 35 pounds.

SPECIFICATIONS:

Size: 8" x 9-1/8" x 18" Control Lamps: Green-Recovery
Weight: 35 lbs. Red-Tank Full
Connections: 1/4" flare
Power: 115/120 VAC, 60 Hz Current: 3 amps

Safety Equipment: Low/high pressure controls, pressure relief valve, check valves

In addition to Refrigerant Recovery and Recycling equipment, Technical Chemical also offers a complete line of air conditioning supplies and accessories.

COMPARATIVE FEATURES OF REPRESENTATIVE EQUIPMENTS FOR COLLECTION AND RECYCLING OF REFRIGERANT GASES

SL. NO.	EQUIPMENT	APPLICATION AREA	SIZE	WEIGHT	RECOVERY	RECYCLING	REFRIGERANTS HANDLED	FEATURES
1.	REFRIGERANT RECOVERY SYSTEM INC.,USA							
(a)	MODEL RC-1	RESIDENTIAL/COMMERCIAL CONTRACTORS	16"x12"x18"	40 lbs	0.5 lb/min	-	R-12,R-22,R-500,R-502	- RECOVERY UNIT ONLY
(b)	REJUVENATOR'S ST-100 A/1	COMMERCIAL AIR CONDITIONING	29"x32"x14"	105 lbs	2-3lbs/min	-	R-12,R-22,R-500,R-502	- MEETS & EXCEEDS SAE STANDARDS - DESIGNED FOR MOBILE A/C MARKET - RECOVERY UNIT ONLY
2.	SPX CORPORATION,USA (OTA Division)							
(a)	OEM 1380	AUTOMOBILES	45"x23"x25"	150 lbs	0.5 lb/min	2.5 lbs/min	R-12	- RECOVERY & RECYCLING UNIT
(b)	OEM 1396	AUTOMOBILES	45"x21"x24"	115 lbs	0.5 lb/min	.8 lb/min	R-12	- RECOVERY & RECYCLING UNIT
(c)	OEM 1397	AUTOMOBILES	15"x20"x14"	53 lbs	0.5 lb/min	-	R-12	- RECOVERY UNIT ONLY
3.	UNITED TECHNOLOGY CARRIER U.S.A							
(a)	19GA RMS - 20	CHILLERS	4'-9"x3'-8 3/4" x2'-5"	275 kg	LIQUID 14 kg/hr	18 kg/hr	R-11,R-113,R-123	)- INCLUDES RECHARGING OF RECYCLED REFRIGERANT)- RECOVERY & RECYCLING UNIT
4.	ENVIRONMENT PRODUCTS AMALGAMATED PTY LTD,AUSTRALIA "SKYE"							
(a)	EP-3	MOBILE & COMMERCIAL AIR CONDITIONING & REFRIGERATION APPLICATIONS	400x500x 1000 (mm)	56 kg	25 kg/hr	25 kg/hr	R-12,R-22,R-500,R-502	)-PORTABLE MODEL (FILTER & DISTILLATION),RECOVERY & RECYCLING UNIT
(b)	EP-4	-DO-	400x500x 1000 (mm)	20 kg	25 kg/hr	-	R-12,R-22,R-500,R-502	- HAND CARRY,RECOVERY UNIT
(c)	EP-4HC	-DO-	350x220x 440 (mm)	20 kg	35 kg/hr	-	R-12,R-22,R-500,R-502	- HAND CARRY,RECOVERY UNIT
(d)	EP-5	-DO-	400x350x	24 kg	*	22 kg/hr	R-12,R-22,R-500,R-502	- HAND CARRY,RECOVERY &

SL. NO.	EQUIPMENT	APPLICATION AREA	SIZE	WEIGHT	RECOVERY	RECYCLING	REFRIGERANTS HANDLED	FEATURES
5.	JAVAC RECO, AUSTRALIA							
(a)	RECO - 1	COMMERCIAL AIR CONDITIONERS	390x440x 600 (mm)	48 kg	60 kg/hr	-	R-12,R-22,R-502	)-MEETS REFRIGERANT STANDARD AS-1677 & SAE J1991/89/90) RECOVERY UNIT
(b)	RECO-12S	DOMESTIC/AUTOMOBILE	390x440x 600 (mm)	35 kg	33kg/hr	1 lit/min	R-12	)-VAPOUR FORM REFRIGERANT) RECOVERY & RECYCLE
(c)	RECO-134S	DOMESTIC/AUTOMOBILE	390x440x 600 (mm)	35 kg	-	1 lit/min	R-134a	- RECYCLING UNIT ONLY
6.	TECHNICAL CHEMICAL CO., U.S.A							
(a)	SERCON 9000	HIGH VOLUME AIR CONDITIONING/REFRIGERATION EQUIPMENTS	20"x20"x45.5"	175 lbs	25 lbs/min	2.7 lbs/min	R-12,R-22,R-500,R-502	- RECOVERY & RECYCLING UNIT
(b)	SERCON 8000	-DO-	20"x20"x45.5"	160 lbs	25 lbs/min	2.7 lbs/min	R-12,R-22,R-500,R-502	- RECOVERY & RECYCLING UNIT
(c)	SERCON 5000	SMALL SHOPS/AUTO DISHANTLERS/AIR CONDITIONERS & REFRIGERATION EQUIPMENTS	9"x19"x24"	70 lbs	25 lbs/min	-	R-12,R-22,R-500,R-502	- RECOVERY UNIT ONLY

APPENDIX 5.1

FORMAT FOR VIABILITY ANALYSIS FOR COLLECTION USING PLASTIC BAGS
(VENTURE TYPE A)

	1993	1995	1996	1997	1999	2005	2007	2010
Max. collection of CFC 12 using plastic bags (@ 90%)								
Practical qty. recoverable through plastic bags								
- Percentage								
- Quantity (MT)								
Number of plastic bags required (@ 1.2 Kg per bag and 25% wastage)								
Sale price of recovered CFC using bags								
- Per Kg								
- Total sales								
Operating costs for recovering CFC (Labour cost)								
- Per Kg								
- Total cost								
Contibution (per Kg)								
Total operating profit								

APPENDIX 5.2

FORMAT FOR VIABILITY ANALYSIS FOR RECOVERY USING PORTABLE EQUIPMENT
(VENTURE TYPE B)

DESCRIPTION	1993	1995	1996	1997	1999	2005	2007	2013
Quantity of CFC 12 recovered (Kg per annum)								
A. Material Costs								
1. Raw Material (Recovered CFC) @ 0 LE per kg								
2. Spares and Consumables @ 0.31 US$ per Kg								
Total material cost (A)								
B. Power (@ 0.07 LE per KWH & 0.05 KWH per Kg)								
C. Labour								
Wages								
Manhours/Kg								
Wage Rate (per manhour)								
Total Wages								
Supervision salaries								
Manhours/Kg								
Rate (per manhour)								
Total salaries								
Total labour (C)								
D. Overheads								
Repairs & maintenance ' @ 5% of equipment cost)								
Administrative & selling expenses								
Contingencies at 5%								
Total overheads (D)								
E. Estimate of cost of operation (A+B+C+D)								
F. EXPECTED SALES (@ 8 LE /kg)								
G. GROSS PROFIT BEFORE INTEREST & DEP. (F-E)								
H. TOTAL FINANCIAL EXPENSES **								
I. DEPRECIATION & AMORTISATION (@ 10% St. line)								
J. OPERATING PROFIT (G-H-I)								
K. TAX (40%)								
L. NET OPERATING PROFIT (J-K)								
Add: Depreciation								
Minus: Loan repayment								
NET CASH ACCRUALS								

ECONOMIC VIABILITY OF VENTURE FOR COLLECTION/RECOVERY AND RECYCLING IN KENYA

1. ESTIMATED COST OF PROJECT & PROJECT OF FINANCE (for each type of venture)
(in KSH)

Item of cost *	RECOVERY ONLY	RECYCLING
1. Equipment		
(i) Imported		
- FOB Value (US$)	1000	2400 ####
- Insurance and Freight (US$) @ 5% Of FOB Value	50	120
- CIF Value (US$)	1050	2520
- CIF Value (local currency)##	29400	70560
- Import Duty		
in %	0	0
in local currency	0	0
- Port Handling and Inland Shipment @ 10% of cif value (local currency)	2940	7056
Landed Cost of Equipment	32340	77616
(ii) Indigenous	0	0
(iii) Machinery stores & spares @ 5% of cif value	1470	3528
2. Expenses on training of local technicians.###		
Wage Rate (per manday)	160	160
No. of mandays	6	9
Total Training Cost	960	1440
3. Provision for contingencies (@ 10% Of above)	3477	8258
Total Cost	38247	90842
FINANCED BY		
1. Equity	6281	14758
2. Secured medium-term loans	25498	60562
3. Other sources (Subsidy on equipment @ 20% of landed cost)	6468	15523
Total	38247	90842

* Venture type A i.e. collection using plastic bags has not been shown above, as it does not involve any capital investment

EXCHANGE RATE : 1 US$ = KSH 28

Expenses on foreign technicians taken at national level

For recycling venture, cost of equipment includes one equipment for recycling and one for recovering CFC

2. ECONOMIC VIABILITY ANALYSIS FOR COLLECTION USING PLASTIC BAGS
(Venture type - A)

(in KSH)

	1993	1995	1996	1997	1999	2005	2007	2010
Max. collection of CFC 12 using plastic bags (@ 90%)	9.43	9.82	9.88	9.50	8.73	6.16	5.22	3.72
Practical qty. recoverable through plastic bags								
- Percentage	10	50	50	50	50	50	50	50
- Quantity (MT)	0.94	4.91	4.94	4.75	4.36	3.08	2.61	1.86
Number of plastic bags required (@ 1.2 Kg per bag and 25% wastage)	982	5115	5144	4950	4546	3210	2719	1935
Sale price of recovered CFC using bags								
- Per Kg	60	60	60	60	60	60	60	60
- Total sales	56551	294615	296292	285095	261860	184889	156597	111465
Operating costs for recovering CFC (Labour cost)								
- Per Kg	40	40	40	40	40	40	40	40
- Total cost	37701	196410	197528	190064	174573	123259	104398	74310
Contibution (per Kg)	20	20	20	20	20	20	20	20
Total operating profit	18850	98205	98764	95032	87287	61630	52199	37155

3.ECONOMIC VIABILITY ANALYSIS FOR RECOVERY USING PORTABLE EQUIPMENTS
(Venture type B)

DESCRIPTION	1993	1995	1996	1997	1999	2005	2007	2010
Quantity of CFC 12 recovered (Kg per annum)	200	192	257	299	342	312	263	168
A. Material Costs								
1. Raw Material (Recovered CFC) @ 0 KSH per kg	0	0	0	0	0	0	0	0
2. Spares and Consumables @ 0.31 US$ per Kg	1736	1667	2227	2599	2970	2706	2286	1458
Total material cost (A)	1736	1667	2227	2599	2970	2706	2286	1458
B. Power (@ KSH 2 per KWH & 0.05 KWH per Kg)	20	19	26	30	34	31	26	17
C. Labour								
Wages								
Manhours/Kg	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Wage Rate (per manhour)	20	20	20	20	20	20	20	20
Total Wages	1000	960	1283	1497	1711	1559	1317	840
Supervision salaries								
Manhours/Kg	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Rate (per manhour)	40	40	40	40	40	40	40	40
Total salaries	200	192	257	299	342	312	263	168
Total labour (C)	1200	1152	1540	1796	2053	1871	1580	1008
D. Overheads								
Repairs & maintenance (@ 5% of equipment cost)	1617	1617	1617	1617	1617	1617	1617	1617
Administrative & selling expenses	2000	2000	2000	2000	2000	2000	2000	2000
Contingencies at 5%	329	323	370	402	434	411	375	305
Total overheads (D)	3946	3940	3987	4019	4051	4028	3992	3922
E. Estimate of cost of operation (A+B+C+D)	6902	6778	7780	8444	9108	8656	7885	6404
F. EXPECTED SALES (@ KSH 100 /kg)	20000	19200	25661	29938	34215	31176	26334	16795
G. GROSS PROFIT BEFORE INTEREST & DEP. (F-E)	13098	12423	17881	21494	25107	22540	18450	10391
H. TOTAL FINANCIAL EXPENSES **	4590	3442	2869	2295	1147	0	0	0
I. DEPRECIATION & AMORTISATION (@ 10% St. line)	3825	3825	3825	3825	3825	0	0	0
J. OPERATING PROFIT (G-H-I)	4684	5156	11188	15375	20135	22540	18450	10391
K. TAX	1874	2062	4475	6150	8054	9016	7380	4156
L. NET OPERATING PROFIT (J-K)	2810	3094	6713	9225	12081	13524	11070	6235
Add: Depreciation	3825	3825	3825	3825	3825	0	0	0
Minus: Loan repayment	0	3187	3187	3187	3187	0	0	0
NET CASH ACCRUALS	6635	3731	7350	9862	12719	13524	11070	6235

** SCHEDULE FOR INTEREST AND REPAYMENT OF TERM LOANS - 18% rate of interest and 8 years repayment period after moratorium of one year

4. SENSITIVITY OF BREAK EVEN VOLUME TO SALE PRICE OF RECOVERED CFC

(Venture type B) (in KSH)

	Scenario 1	Scenario 2	Scenario 3
1. Sale Price of recovered CFC	60.00	100.00	140.00
(as % of selling price of vergin gas)	(30%)	(50%)	(70%)
2. Variable Costs			
- Raw material costs	0.00	0.00	0.00
- Consumables cost	8.68	8.68	8.68
- Utilities cost	0.10	0.10	0.10
- Labour cost	6.00	6.00	6.00
Total variable costs	14.78	14.78	14.78
Contribution	45.22	85.22	125.22
3. Fixed Costs			
- Repairs & Maintenance(Including overheads)	1946	1946	1946
- Selling & Administration expenses	2000	2000	2000
- Financial expenses	4590	4590	4590
- Depreciation	3825	3825	3825
Total Fixed Costs	12360	12360	12360
4. Break-even Analysis			
- Breakeven quantity in Kg	273	145	99
- Breakeven level of sales	16400	14504	13819
- Breakeven level as % of sales	137	73	49

Notes : Scenario 2 has been adopted for economic analysis of the venture viability

5. IMPORTANT PROJECT PARAMETERS

(Venture type B)

		YEAR							
		1993	1994	1995	1996	1997	1998	1999	2002
Total Capital Employed	38247	0	0	0	0	0	0	0	0
Total Equity Employed	6281								
Net Cash Inflows (On Equity) @	-6281	6635	3792	3731	7350	9862	11290	12719	16550
Internal Rate of Return (On Equity)	93.9%								
Pay Back Period (On Equity)	About one year								
Net Cash Inflows (On Capital Cost) #	-38247	9389	9389	8984	12258	14426	15510	16594	16550
Internal Rate of Return (On Capital Cost)	27.9%								
Pay Back Period (On Capital Cost)	About 4 years								

@ Cash Inflows (On Equity) = Net profit + Depreciation - Loan repayment

Cash Inflows (On Capital Cost) = Net profit + Depreciation + Interest * (1-Tax Rate)

6. ECONOMIC VIABILITY ANALYSIS FOR RECYCLING WITH ADDITIONAL RECOVERY UNIT

(In KSH)

	1993	1995	1996	1997	1999	2005	2007	2010
Quantity of CFC 12 recycled (KG per annum)	1628	2518	3041	3345	3610	3110	2629	1715
- Quantity externally recovered (Kg)	1000	1536	2053	2395	2737	2494	2107	1344
- Quantity internally processed (kg)	628	982	988	950	873	616	522	372
A. Material Cost								
1. Raw Material (Recovered CFC 12)								
a) Externally from recovery units @ KSH 100 per K	100000	153603	205290	239505	273720	249405	210673	134361
b) Internally processed @ KSH 111.78 per Kg #	70237	109774	110398	106227	97569	68890	58348	41532
Total Raw Material Cost	170237	263376	315688	345731	371289	318295	269021	175893
2. Spares and Consumables @ US$ 0.41/Kg	18693	28908	34905	38405	41444	35707	30178	19690
Total material cost (A)	188930	292284	350593	384136	412732	354002	299199	195583
B. Power (@ KSH 2 per KWH & 0.05 KWH per Kg)	163	252	304	335	361	311	263	172
C. Labour								
Wages								
Manhours/Kg	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Wage Rate (per manhour)	20	20	20	20	20	20	20	20
Total Wage	8142	12590	15203	16727	18050	15552	13144	8576
Supervision salaries								
Manhours/Kg	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Rate (per manhour)	40	40	40	40	40	40	40	40
Total salaries	6513	10072	12162	13381	14440	12441	10515	6861
Total labour (C)	14655	22663	27365	30108	32491	27993	23658	15436
D. Overheads								
Repairs & maintenance (@ 5% of eqipment cost)	3881	3881	3881	3881	3881	3881	3881	3881
Administrative & selling expenses	30000	30000	30000	30000	30000	30000	30000	30000
Transportation & Storage (@ 10% of sales)	32567	50362	60811	66907	72201	62207	52574	34303
Contingencies @ 5%	13510	19972	23648	25768	27583	23920	20479	13969
Total overheads	79958	104214	118339	126556	133665	120008	106934	82153
E. Estimate of cost of operation (A+B+C+D)	283706	419412	496601	541135	579249	502314	430054	293344
F. EXPECTED SALES (@ KSH 200 /kg)	325669	503615	608107	669073	722013	622070	525744	343033
G. GROSS PROFIT BEFORE INTEREST & DEP. (F-E)	41964	84203	111506	127938	142763	119757	95690	49689
H. TOTAL FINANCIAL EXPENSES ##	10901	8176	6813	5451	2725	0	0	0
I. DEPRECIATION & AMORTISATION (@ 10% St. line)	9084	9084	9084	9084	9084	9084	9084	9084
J. OPERATING PROFIT (G-H-I)	21979	66943	95608	113403	130954	110672	86606	40604
K. TAX	8791	26777	38243	45361	52382	44269	34642	16242
L. NET OPERATING PROFIT (J-K)	13187	40166	57365	68042	78572	66403	51963	24363
Add: Depreciation	9084	9084	9084	9084	9084	9084	9084	9084
Minus: Loan repayment	0	7570	7570	7570	7570	0	0	0
NET CASH ACCRUALS	22271	41680	58879	69556	80086	75488	61048	33447

SCHEDULE FOR INTEREST AND REPAYMENT OF TERM LOANS - 18% rate of interest and 8 years repayment period

As per computation provided at page 6 of this appendix

7. COMPUTATION OF COST OF INTERNALLY PROCESSED CFC FOR RECYCLING VENTURE
(FOR CFC RECOVERED THROUGH PLASTIC BAGS)
(Refer item A.1 (b))

	(in KSH)
A. Material Costs	
1. Raw Material (Recovered CFC gas) @ KSH 60 per kg	60.00
2. Spares and Consumables @ 0.31 US$ per Kg	8.68
Total material cost (A)	68.68
B. Utilities	
- Power (@ KSH 2 per KWH & 0.05 KWH per Kg)	0.10
C. Labour	
Wages	
Manhours/Kg	1.50
Wage Rate (per manhour)	20.00
Total Wage	30.00
Supervision salaries	
Manhours/Kg	0.025
Rate (per manhour)	40.00
Total salaries	1.00
Total labour (C)	31.00
D. Transportation cost (@ 20% Of raw material cost)	12.00
Total per Kg cost of liquified gas (A+B+C+D)	111.78

8. SENSITIVITY OF BREAKDOWN VOLUME TO COST OF RAW MATERIALS (Venture type C)

(In KSH)

	Scenario 1	Scenario 2	Scenario 3
1. Sale Price of recycled CFC	200.00	200.00	200.00
2. Variable Costs			
- Raw material costs (recovered CFC)	60.00	100.00	140.00
- (as % of selling price of recycled CFC)	(30%)	(50%)	(70%)
- Consumables cost	11.48	11.48	11.48
- Utilities cost	0.10	0.10	0.10
- Labour cost	9.00	9.00	9.00
- Transportation and Storage	20.00	12.93	9.73
Total variable costs	100.58	133.51	170.31
Contribution	99.42	66.49	29.69
3. Fixed Costs			
- Repairs & Maintenance(Including overheads)	17391	17391	17391
- Selling & Administration expenses	30000	30000	30000
- Financial expenses	10901	10901	10901
- Depreciation	9084	9084	9084
Total Fixed Costs	67376	67376	67376
4. Breakeven Analysis			
- Breakeven quantity in Kg	678	1013	2270
- Breakeven level of sales	135538	202675	453938
- Breakeven level as % of sales	42	62	139

Note : Scenario 2 has been adopted for economic viability analysis of the venture

9. IMPORTANT PROJECT PARAMETERS (Venture type C)

		YEAR							
		1993	1994	1995	1996	1997	1998	1999	2002
Total Capital Employed	90842	0	0	0	0	0	0	0	0
Total Equity Employed	14758								
Net Cash Inflows (On Equity) @	-14758	22271	25745	41680	58879	69556	74832	80086	86106
Internal Rate of Return (On Equity)	179.9%								
Pay Back Period (On Equity)	About eight months								
Net Cash Inflows (On Capital Cost) #	-90842	44871	61097	85474	111960	127574	134189	140765	133819
Internal Rate of Return (On Capital Cost)	75.6%								
Pay Back Period (On Capital Cost)	About two years								

@ Cash Inflows (On Equity) = Net profit + Depreciation - Loan repayment

Cash Inflows (On Capital Cost) = Net profit + Depreciation + Interest * (1-Tax Rate)

NET NATIONAL ECONOMIC BENEFIT

The Net National Economic benefit has been worked out using the principles of social cost benefit analysis, to the extent quantification of various variables has been possible. Th analysis is confined to activities directly associated with the Recovery and Recycling programme.

GENERAL POINTS REGARDING COMPUTATION OF BENEFITS AND COSTS

All items have been measured at constant prices that is those prevailing in the year 1991/92. These items have been initially measured in terms of the local currency and then converted into dollar terms at the exchange rate prevailing at present, i.e. in the year 1991/92. Future benefits and costs have also been measured at the 1991/92 prices and converted at the exchange rate prevailing in this year, since it is extremely difficult to predict accurately, both inflation in the future and future exchange rates.

BENEFITS

Savings in Imports of Refrigerants :

This item is quantified as the quantum of foreign exchange saved through the recycling of CFCs and thereby avoiding the imports of these gases.

Increase in Employment :

Even though most developing ecomomies are faced with under employment or unemployment and though most governments value the creation of employment opportunities, it is difficult to quantity in monetary terms the value of employment generation. Moreover, even though employment generation can be an important objective of government policy, the more basic objective is increasing the welfare of people in the society. A measure of the increase in welfare is obtained by estimating the increase in consumption that comes about through increase in personal disposable incomes generated by employment. It is often the case that one will not be able to observe the exact increase in consumption that will come about through increased personal disposable incomes. In such a case it is necessary to obtain some parameter which will enable to estimate the increase in consumption that comes about. Thus estimating the following regression equation will be useful :

$$PFCE = A' + B' * PDI$$

where,

PFCE = private final consumption expenditures measured at constant prices

PDI = personal disposable income measured at constant prices

A', B' are the parameters to be estimated.

B' is the marginal propensity to consume and is the parameter of importance. This parameter tells us the amount of additional consumption that will take place for every unit increase in personal disposable income. For the present study A' and B' have been estimated through the regression equation

$$PFCE = A + B * GDP$$

This was done as the UN National Accounts Statistics for the project countries did not provide PDI for sufficient number of years to carry out a regression. Estimating A and B using GDP in the equation was taken as best alternative though this would yield a value of B slightly understated than if PDI were used. The values of B for 3 countries are given in the input tables in Appendix - 3.5 (A), (B) and (C). From the venture level analysis the exact increase in incomes (net of taxes) accruing to the employees can be used with the estimated B to compute the increase in consumption that will occur. The B computed at a national level from the national accounts statistics has been employed to compute the consumption of the owners and employees of the ventures.

In this case however an additional consideration will play a role.

From the point of view of the government, increasing the consumption of the relatively disadvantaged sections of the population has a high social value as compared to increasing the consumption of the relatively better off. Thus the factor by which income levels of the owners exceeds that of the employees is used to adjust the consumption figures of the owners. The consumption of the owners have been given a weight which is the reciprocal of the factor by which the incomes differ.

The other aspect of increased incomes due to the setting up of recovery and recycle ventures, apart from the increase in consumption, is the increase in savings that come about. These savings constitute investible funds.

The relation between savings and investment is set as follows :

$$INV = GS + CI$$

where,

INV = gross domestic capital formation at constant prices
GS = gross savings at constant prices
CI = capital inflows from abroad

Thus there are only two sources of investible funds : domestic and foreign. In the above relation ship both GS and CI appear with weight equal to unity i.e a unit increase in savings will increase investment by the same amount and similarly for capital inflows. In this cost benefit analysis, the focus is only on domestic savings. Since the above equation has to hold, whatever the conditions prevailing in the economy, the savings in the aggregation of benefits has been incorporated with a weight equal to unity.

Government Expenditures related benefits :

Increase in Government expenditures such as publicity, training & administrative expenses generate incomes via the mutliplier, so that

$$d Y = K \; dGE$$

where dY = change in incomes
dGE = change in Government Expenditure
K = Multiplier

K is estimated as the reciprocal of the marginal propensity to save (MPS). MPS to be on the conservative side, the multiplies computed for each country has been halved to take into account leakages prevailing in a economy. MPS was computed as the difference of I-B* (computed earlier) since B* represents the marginal propensity to consume (MPC), and by the standard rule of economics MPS + MPC = 1.

The incomes so generated are divided by the income-recepient into consumption and savings on the basis of their MPC and MPS respectively. These then constitute the consumption and savings benefits of Government expenditure.

Increase in Government Revenues :

The establishment of recovery and recycling programmes

could constribute to increased Government revenues by way of the following :

- Increase in collections of corporate tax which will be payable by the ventures.

- Revenue from duties on imports of Capital equipment and consumables as well as increased duties on CFCs. Both of the above represent inflows to the Government which can be used for welfare activities. In our working we have recommended waiver of duty on all equipment and spares for recovery and recycling. To that extent these will not appear in the computation of benefits.

Salvage value of the equipment :

This item is considered for each type of venture over the time horizon of the project.

COSTS

Outflows on Account of Imports :

This item is quantified on the basis of costs of equipment and consumables.

Increase in Training Costs and Publicity :

This includes training costs at a venture level plus training costs and publicity at national level for each country.

Increase in Wage Costs :

From a social cost benefit analysis point of view, wage cost is understood as the opportunity cost of employing an input (e.g. labour) in a particular project rather than in the next best alternative project. The 'cost' is the amount of output sacrificed in the other alternative by employing the unit of input in the project of interest. This estimation of costs is crucially dependent on the extent of unemployment in the economy. If there is no involuntary unemployment in the economy then employment of the input in the project of interest necessarily takes place at the cost of lost production elsewhere. Under the assumption of perfectly competitive markets the per unit cost to the society of employing the input is the market wage rate that is earned. If markets are not perfectly competitive or, more importantly, if there is unemployment then the market wage rate does not correctly indicate the cost per unit of the input. A shadow wage rate (SWR) for labour will have to be estimated. If a previously unemployed person is given a job in the project then, since there is no loss of production in any other line of

activity,the opportunity cost to society of employing this unit of labour is zero, i.e. its SWR is zero. Generally, however,the SWR is not set equal to zero and a postive value is attached to it. In the case of the recovery and recycle units, it is anticipated that an existing employee will take on additional work that will be involved at the venture level.The assumption here is that this employee is underemployed at the current job, i.e. if the duty of the employee is set at 8 hours,he may be productively employed for only 6 hrs. In this case,therefore, by working productively for an additional two hours, no loss of production occurs in any other line of activity. Hence from the point of view of society there is no opportunity cost inolved here and the shadow wage rate should be zero.However,so as not to underestimate the social cost,a weight of 0.2 on the wage bill of the ventures has been considered reasonable.

Increase in Cost of Operating Costs (Utilities) Overheads, Maintenance etc. :

This item is computed by aggregating the venture level costs.

Decrease in Government Duties and Taxes :

The reduction in the imports of CFCs, while it results in savings of foreign exchange, at the same time reduces the import duties that will be collected by the government. Thus government welfare activites will be curtailed to the extent that revenues fall off. Thus in summary the following benefits and costs have been considered in computing the Net National Economic Benefit.

BENEFITS

- Savings in imports of refrigerants
- Employement related benefits in terms of increased consumption and savings
- Government expenditure related benefits in increased consumption and savings.
- Increase in Government in revenues

COSTS

- Outflows on account of equipment & consumables imports
- Training costs and publicity at venture and Government level
- Increase in wage costs
- Increased operating costs
- Duties and taxes foregone by the government on imports of CFC saved.
- Subsidies on equipments

The above benefits and costs have been estimated annually till the year 2010 and discounted to present value.

APPENDIX 5.5

NET NATIONAL ECONOMIC BENEFIT ANALYSIS
(For Kenya)

	1993	1995	1996	1997	1999	2005	2007	2010
TOTAL NUMBER OF VENTURES								
- Recovery only	15	40	40	40	40	40	40	40
- Recycling only	3	5	5	5	5	5	5	5
A. BENEFITS								
1. Savings in import of CFC refrigerants								
- Quantity (in MT ; equal to recycled quantity)	5	13	15	17	18	16	13	9
- CIF price (in KSH per MT)	70000	70000	70000	70000	70000	70000	70000	70000
- Value saved (in KSH ; quantity * CIF price)	341953	881326	1064188	1170877	1263522	1088623	920053	600307
2. Employment related benefits								
- Increase in consumption	121991	435504	484629	504847	513030	413769	349932	234764
- Increase in saving	77341	276104	307248	320066	325254	262324	221853	148837
- Total increase	199332	711608	791878	824913	838284	676093	571785	383602
3. Government expenditure related benefits								
- Increase in consumption	3287972	614703	529979	529979	529979	529979	529979	529979
- Increase in saving	2084531	389714	336000	336000	336000	336000	336000	336000
- Total increase	5372504	1004417	865979	865979	865979	865979	865979	865979
4. Increase in government revenues								
- Increase in duties on equipments	0	0	0	0	0	0	0	0
- Increase in corporate taxes								
- Series 1 Ventures *	54478	111266	181857	228331	277956	268045	214624	111070
- Series 2 Ventures	0	37185	47409	82994	119899	141659	122300	76668
- Series 3 Ventures	0	36895	47700	57712	137609	196878	179507	125760
- TOTAL INCREASE IN TAXES	54478	185347	276957	369038	535463	606583	516431	313498
TOTAL BENEFITS (A)	5968267	2782698	2999002	3230807	3503249	3237278	2874248	2163386

	1993	1995	1996	1997	1999	2005	2007	2010
B. COSTS								
1. Additional outflows on account of imports (net of duties and taxes)								
- Capital equipment (including machine spares)	685314	537138	0	0	0	0	0	0
- Consumables	82120	211201	263622	295969	326012	286776	242321	156763
- Plastic bags (@ 1.2Kg per bag; US$ 8.25 per bag; 25% wastage)	226794	1181529	1188253	1143351	1050168	741481	628019	447022
2. Capital investment (excluding (1) above)	160918	127409	0	0	0	0	0	0
3. Government expenditures								
a. Training cost incurred in foreign currency	840000	0	0	0	0	0	0	0
b. Training cost incurred in local currency	68531	53714	0	0	0	0	0	0
c. Publicity expenses	2868531	53714	0	0	0	0	0	0
d. Administrative Expenses	1232000	672000	672000	672000	672000	672000	672000	672000
e. Subsidy on equipments	130536	102312	0	0	0	0	0	0
4. Increase in wage costs (total wages and salaries weighted by 0.2)	9668	34513	38406	40008	40657	32791	27732	18605
5. Increase in operating costs (excluding raw material,consumables and labour)								
- Series 1 Ventures *	245591	318528	361872	387153	409098	367592	327618	251799
- Series 2 Ventures	0	93122	107886	122605	134971	128902	118377	95010
- Series 3 Ventures	0	85350	94865	109595	133371	134867	126955	105470
- TOTAL OPERATING COST	245591	497000	564623	619353	677441	631361	572949	452279
6. Decrease in government duties on import of CFCs								
- Rate of duty (%)	65	65	65	65	65	65	65	65
- Quantity of CFC import reduced (in MT)	5	13	15	17	18	16	13	9
- Value of reduced duties	222269	572862	691722	761070	821289	707605	598034	390199
TOTAL COSTS (B)	8004273	4715392	4090626	4203752	4259567	3744044	3413055	2808848
NET NATIONAL ECONOMIC BENEFIT								
- ANNUAL KSH	-2036006	-1932694	-1091624	-972945	-756318	-506736	-538807	-645482
- PRESENT VALUE (@ 2.0% discounting) KSH	-13518737							
US $	-482812							

* Series 1 Ventures - Those starting in 1993
Series 2 Ventures - Those starting in 1994
Series 3 Ventures - Those starting in 1995

APPENDIX - 5.6

EXPLANATORY NOTE FOR NATIONAL ECONOMIC ANALYSIS

BENEFITS :

1.	Employment related benefits (Item 2)	: Refer Appendix - 5.4
2.	Government expenditure related benefits (Item 3)	: Refer Appendix - 5.4 The Govt. expenditure which will result in benefits are the items 3 (b), (c) and (d) under costs.

COSTS

3.	Additional outflows : on account of imports	
	- Capital equipment	: CIF value of equipment including spares
4.	Capital Investment (Item 2)	: Local currency part of the project cost, including port & handling charges, training & contingency provision.
5.	Govt. expenditures	:
	a) Training cost in foreign currency	: One time expense on foreign experts @ 30 man-days and US $ 1000 per manday
	b) Training cost in local currency	: @ 10% of value of equipment
	c) Publicity expenses	: One time expense of US $ 100,000 in the first year Recurring annual expense @ 10% of value of equipment
	d) Administrative expense	: One time expense of US$ 20,000 in first year for infrastructure creation Recurring annual expense of US$ 24,000 for staff and other regular expenses
	e) Subsidy on	: @ 20% of landed value of equipment
6.	Increase in wage costs	: Refer Appendix - 5.4
7.	Increase in operating costs	: Operating costs of the various types of ventures as per working sheets in Appendix - 5.3

8. Decrease in Govt. duties on import of CFCs	: Due to decrease in import of CFC resulting from recovery & recycling programme
NET NATIONAL ECONOMIC BENEFITS	: Discounting rate for computation of Net Present Value (NPV) of net benefit is taken @ 2% based on reference provided in Background Analysis (UNIDO Project No. US/RAF/90/173, Page 37).

APPENDIX 6.1

ILLUSTRATIVE PROVISIONS OF THE INDUSTRIAL WASTE MANAGEMENT POLICY (CONTROL OF OZONE DEPLETING SUBSTANCES) NO. 1W.1B

PROVISIONS RELATING TO SALE OF CFCs

1. Any distributor or wholesaler selling chlorofluorocarbons or halons must keep written records of sales.

2. Any distributor or wholesaler of chlorofluorocarbons must-

   a) accept, wherever practicable, all reclaimed chlorofluorocarbons returned for reprocessing.

   b) Keep written records of quantities of chlorofluorocarbon returned for reprocessing.

3. Accurate information on chlorofluorocarbon and halon consumption will be achieved as follows :

   a) All records must include the name and address of the purchaser, the end use category, the quantity of ozone-depleting substances supplied and the quantity of ozone-depleting substances returned. The end use categories which must be recorded are -

      - foam production
      - solvents use
      - dry cleaning
      - vehicle air conditioning
      - commercial/industrial air conditioning and refrigeration
      - domestic refrigeration
      - domestic air conditioning
      - portable fire extinguishers
      - halon fire suppression systems
      - miscellaneous (if none of the above, specify the application or activity)

   b) Written records must be sent to the authority no later than 14 days after each of the quarters ending 31 March, 30 June, 30 September and 31 December and must be available for inspection at any time by an authorised officer upon request.

APPENDIX 6.2

ILLUSTRATIVE PROVISIONS OF THE INDUSTRIAL WASTE MANAGEMENT POLICY (CONTROL OF OZONE DEPLETING SUBSTANCES) NO. 1W.1B

PROVISIONS RELATING TO ACCREDITATION OF USERS OF CFCs

1 On and from 1 January 1991 any person who uses any ozone-depleting substance for or with respect to any industry or activity listed in Schedule C must be accredited by -

1) an appropriate Industry Board : or

2) by the Authority :

a) where there is no appropriate Industry Board; or
b) following a successful application for accreditation made under clause 26.

2. Accreditation shall be granted where the appropriate Industry Board or the Authority, as the case requires, is satisfied that the applicant has -

1) an adequate appreciation of -

a) the role of ozone-depleting substances in depleting stratospheric ozone; and
b) the consequences of the depletion of stratospheric ozone; and

2) a proven ability to take effective measures to minimise emissions of any ozone-depleting substances.

3. Where the appropriate Industry Board receives an application for accreditation, the appropriate Industry Board must not later than 60 days after receiving the application -

1) refuse to grant accreditation; or
2) grant accreditation subject to such conditions, if any, as the appropriate Industry Board considers appropriate.

4. A person who has been refused accreditation by the Industry Board may apply to the Authority for accreditation.

5. Where the Authority receives an application for accreditation, the Authority must, not later than 60 days after receiving the application -

1) refuse to grant accreditation; or
2) grant accreditation subject to such conditions, if any, as the authority considers appropriate

6. On and from 1 January 1991, any person who purchases any ozone-depleting substance for or with respect to any industry or activity listed in Schedule C must be registered by -

1) an appropriate Industry Board; or
2) by the Authority :

a) where there is no appropriate Industry Board; or
b) following a successful application for registration made under Clause 4.

7. Registration shall only be granted where the appropriate Industry Board or the Authority, as the case requires, is satisfied that -

1) any ozone-depleting substance purchased will only be supplied for use by an accredited person; and
2) the person applying for registration has access to the necessary equipment to minimise the emissions of any ozone-depleting substance.

APPENDIX 6.3

ILLUSTRATIVE PROVISIONS OF THE INDUSTRIAL WASTE MANAGEMENT POLICY (CONTROL OF OZONE DEPLETING SUBSTANCES) NO. 1W.1B

PROVISIONS RELATING TO PURCHASE OF CFCs

1. Any person who purchases any ozone-depleting substance must maintain, in respect of each purchase, written records which must -

   1) contain the following details :

      a) the quantity of the ozone-depleting substance;
      b) the name of the ozone-depleting substance; and
      c) the name and address of the person from whom the ozone-depleting substance was purchased.

   2) be made available for inspection upon request at any time by an authorised officer.

APPENDIX 6.4

ILLUSTRATIVE PROVISIONS OF THE INDUSTRIAL WASTE MANAGEMENT POLICY (CONTROL OF OZONE DEPLETING SUBSTANCES) NO. 1W.1B

PROVISIONS RELATING TO ADOPTING PROPER PRACTICES IN USE OF CFCs

Domestic Refrigeration

1. From the date of declaration of this policy, any person who designs or services domestic refrigeration units must comply with the "Code of Practice for the Design and Service of Domestic Refrigeration Units" endorsed by the Authority.

Motor Vehicle Air Conditioning

2. To reduce the emission of chlorofluorocarbons from motor vehicle air conditioning units -

   1) on and from the date of declaration of this policy, any person who designs or services motor vehicle air conditioning units must comply with the "Code of Practice for the Design and Service of Motor Vehicle Air Conditioning Units" endorsed by the Authority; and

   2) on and from 1 January 1991, services or maintains motor vehicle air conditioning units must reclaim chlorofluorocarbons whenever units are being serviced and maintained; and

   3) any chlorofluorocarbons reclaimed must be returned to the distributor or wholesaler for reprocessing, or recycled on-site or securely stores pending destruction.

Industrial/Commercial Air Conditioning and Refrigeration

3. To reduce the emission of chlorofluorocarbons from industrial and commercial air conditioning and refrigeration units -

   1) on and from the date of declaration of this policy, any person who designs or services industrial and commercial air conditioning and refrigeration units must comply with the Code of Practice for the Design and Service of Industrial and Commercial Air Conditioning and Refrigeration Units" endorsed by the Authority.

2) on and from 1 January 1991, any person who services or maintains industrial and commercial air conditioning and refrigeration units must reclaim chlorofluorocarbons whenever units are being serviced, maintained and decommissioned; and

3) Any chlorofluorocarbon that is reclaimed must be returned to the distributor or wholesaler for reprocessing, or recycled on-site or securely stores pending destruction.

4. On and from the date of declaration of this policy refrigeration and air conditioning units containing chlorofluorocarbons must be labelled in such a manner that the refrigerant can be identified by service personnel at all times.

Domestic Air Conditioning

5. To reduce the emission of chlorofluorocarbons from domestic air conditioners -

1) on and from the date of declaration of this policy, any person who services or maintains domestic air conditioners must reclaim chlorofluorocarbons whenever units are being serviced and maintained at a central service premises; and

2) any chlorofluorocarbon that is reclaimed must be returned to the distributor or wholesaler for reprocessing or recycled on-site or securely stored pending destruction.

South Coast Air Quality Management District, California, has introduced the following rules which are indicative of the requirements in the USA.

a) Rule 1411: Recovery or Recycling of Refrigerants from Motor Vehicle Air-conditioners

This rule prohibits, w.e.f. 1/1/92, release or disposal of refrigerants used in Motor Vehicle .PA Air-conditioners and prohibits the sale of refrigerant in containers carrying less than 20 pounds of refrigerant. This rule is applicable to any person engaged in installation, replacement and servicing of Motor Vehicle Air-conditioners or any other vehicle repairs that could cause release of refrigerants. This rule also applies to refrigerant retailers.

Certified recovery/recycling equipment is required to be installed and the technicians operating the machines required certification from competent authorities regarding adequate training for proper use of the equipment.

The Mobile Air Conditioning Society (MACS) have devised a program to impart proper training to technicians for proper use of equipment, understanding of the recovery process, equipment servicing requirements. A written test is administered (at a nominal cost of $ 20 per person) and certificate issued to successful technicians.

b) Rule 1415 : Reduction CFC Emission from Stationary Refrigeration and Airconditioning Systems

The purpose of this rule is to reduce CFC emission from Stationary Emission and Air-conditioning Systems by requiring the owners or operators of such systems to reclaim recover and/or recycle the refrigerants and minimize leakages. This is also applicable to any persons who replace, service or relocate a refrigerant system.

On or after 1st January, 1992, persons covered under this rule are required to recover or recycle the refrigerant using approved equipment and employ specified procedures for the use of equipment. All installations of refrigerant systems require an inspection by a certified auditor to determine that the system is operating as per specifications and there are no refrigeration leakages. Such an inspection is required every 12 months.

The full text of the rules are available with us and the above is an extract to indicate the nature and coverage of the legislation in force regarding the recovery and recycling of refrigerants.

APPENDIX 6.5

PROVISIONS IN SWISS ORDINANCE ON ENVIRONMENTALLY HAZARDOUS SUBSTANCES

DISPOSAL OF EQUIPMENT CONTAINING CFCs

1. The regulation interalia contains special provisions for disposal, which means e.g. that refrigerants must be removed from discarded refrigerators and properly disposed of. On January 1st 1992, a concept for the elimination of used refrigerators and deep freezers, elaborated by the concerned industry, has become operational nationwide. According to this scheme, the consumer will give his old refrigerator back to the supplier, against a unit fee. The supplier will-then pass on the refrigerator to a specialised elimination unit, that recovers the CFC from the refrigeration circuit and the insulating material.

   Source : Ordinance of 9 June, 1986 relating to Environmentaly Mazardous Substances (Ordinance on Substances; Rs 814.013).