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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-III: NIGERIA COUNTRY STUDY

FOR

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION
VIENNA, AUSTRIA
(UNIDO CONTRACT No.91/212)

M.92.629 N/210 AUGUST, 1992

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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 III - NIGERIA 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	37.0	0.0	29.7	0.0	18.3
	:- Total	21.5	82.9	6.7	54.7	0.0	37.0	0.0	29.7	0.0	18.3
NIGERIA	:- New	347	21(	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	3240	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	Manufacturers service network	Manufacturers' service deptt.	Manufacturers' service deptt.
- Mobile Air-conditioners	Garages of various sizes	Big Garages/ agencies	Garages of various sizes
Total Project Investment(inUS$)	173,888	70,360	235,030
Average annual value of CFC saved (in US$)	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 irdicate 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 - I

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 reduction 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.

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
- Identification 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 experts, this report analyses and presents the findings and recommendations in line with the objectives.

1.4.3 A brief resume of the coverage in Nigeria is given below :

a) Useful discussions were held with Ms Mathey-Boo, UNIDO Country Director; Mr Adegboyega Ajani, Programme Officer; Mr Nwabunka G.C, Mr Fela Deh and Mr Ram T Batra of UNDP; Dr Evans A.Aina, Director/Chief Executive, Ms Anne Ena-Ita, Mr Maiwada M. Omar and Prof O.Osibanjo of the Federal Environmental Protection Agency as well as with the local industrialists and consultants.

The role and significance of FEPA is given below :

Federal Environmental Protection Agency (FEPA)

FEPA was established by a decree of the Federal Military Government on 30th December, 1988 and is currently directly under the control of the President.

FEPA has been given the specific mandate to establish national environmental standards and regulations for water quality, effluent limitation, air quality, atmospheric protection, ozone protection, noise control and control of hazardous substances & removal methods.

With respect to ozone protection FEPA has been specifically charged with the following responsibilities :

- to study data and recognise developments in the other countries regarding the cumulative effect of all substances, practices, processes and activities which may affect the stratosphere, especially ozone in the stratosphere.

- to make recommendations and programmes for the control of any substance, practice, process or activity which may reasonably be anticipated to affect the stratosphere especially ozone in the stratosphere, when such affect may reasonably be anticipated to endanger public health or welfare.

FEPA enjoys wide-ranging enforcement powers to ensure compliance with environmental standards and regulations. These powers include powers to inspect, search, carry out tests, seize and also arrest.

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

1.5 STRUCTURE OF THE VOLUME III - NIGERIA 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 Nigeria.

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

Chapter 4 describes the technical options relevant for each of the project countries; 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 levels. This analysis, includes computation of Net National Economic Benefit.

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

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 Nigeria are enclosed at Appendix 2.1 (A)and (B) for ready reference, showing the relative locations of the country and also the important cities/towns in the country. As no one in the country is manufacturing CFCs, and there are no significant exports of CFCs or CFC based products, the consumption 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 teams. 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 Nigeria 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 Sources of Supply and Infrastructure

The entire requirement of refrigerants is met through

imports. The main exporting companies and their relative shares in 1991 were as follows :

-	ICI, UK	:	55%
-	Kali Chemie, Iberia, Spain	:	24%
-	Ausimont	:	10%
-	Montedison, Italy	:	5%
-	Galco, Belgium)	:	6%
-	Allied Signal, USA)		----
			100%

ICI and Hoechst have subsidiary companies viz Chemicals & Allied Products Ltd (CAPL) and Hoechst Nigeria Ltd., while other exporters are operating through private dealers or agents. Only CAPL and Hoechst Nigeria have re-filling and bottling facilities. However, Hoechst Nigeria has discontinued its operations in 1991, as the parent company is getting out of CFC manufacturing activity worldwide.

2.2.2 Past and Present Trend and Future Scenario

The present as well as past level of imports has been summarised in Table - 2.1.

TABLE - 2.1

IMPORTS OF REFRIGERANTS IN TO NIGERIA (MT)

TYPE OF CFC	1985	1990	1991
CFC-11	700	400	350
CFC-12	600	600	700
HCFC-22	300	400	450
CFC-502	10	30	20
CFC-12/11 Mixture	950	Neg	Neg
CFC-12/114 Mixture	70	Neg	Neg
Total :	2630	1430	1520

Source : 1. Food & Drug Administration of Nigeria
2. Importers of Refrigerants in Nigeria

Notes : 1. Imports of CFCs were not separately classified as per Annual Trade Statistics of the Federal Government, hence no secondary data was available.

It can be observed from Table - 2.15 that consumption of CFC-11, CFC-11/12 mix and CFC-12/114 mix has declined sharply. These refrigerants are used in foam (CFC-11) and aerosol (CFC-11/12; CFC-12/114) applications where large scale substitution has taken place by methylene chloride and LPG respectively.

The implementation of Montreal Protocol and phasing out of CFCs in developed countries, especially major exporting countries in Europe, has had its impact on supply of refrigerants, with Hoechst having already closed its operations in Nigeria. On the other hand, overseas manufacturers who have a long term stake in refrigerant manufacturing, such as ICI and Kali Chemie, have already started making their trading partners in the country aware about new substitutes which have been developed by them. On the whole, no shortages are being felt as yet in supply of refrigerants.

2.2.3 Prices

The current prices (CIF as well as retail) of refrigerants along with the custom duty applicable have been indicated as per Table - 2.2 below.

TABLE - 2.2

CURRENT (1991) PRICES OF REFRIGERANTS

REFRIGERANT	CIF* (US$/ Kg)	CUSTOMS DUTY (%)	RETAIL PRICE (EQUIV.US $ PER KG)
CFC-11	1.8-1.5	15	1.8-2.3
CFC-12	1.8-2.4	15	3.0-4.0
HCFC-22	2.2-3.0	15	3.5-4.5
CFC-502	N.A.	15	N.A.

* Range depending on packing and source
N.A. Not Available
Source Importers/Dealers

Discussions with importers revealed that there has only been a slight increase in CIF prices (in dollar terms) during the last 2-3 years.

2.3 OVERVIEW OF THE USER INDUSTRY

2.3.1 Airconditioning and Refrigeration

a) Domestic Refrigerators and Deep Freezers :

There are presently 12 manufacturing/assembly units in the country with a total installed capacity of 600,000 numbers per annum. The largest manufacturers are : Thermocool Engineering Co. Plc and Debo Industries Ltd with installed capacities of 250,000 numbers and 85,000 numbers per annum respectively. Only these two units have the capability for

manufacturing components. The other units are small assembly operations with capacities ranging from 5000 to 40,000 numbers per annum. All the companies are in the private sector and many of them have foreign collaborations with leading international firms such as Zanussi, Whirlpool, Sanyo, etc. The current production (1991) is approximately 84,000 numbers. The current imports (excluding second-hand fridges) are estimated to be approximately 15,000-20,000 numbers per annum. There has been a sharp decline in production since 1983 due to fall in per capita income and spending. The past trend in production & imports is shown as per Table - 2.3.

TABLE - 2.3

PAST TREND IN PRODUCTION & IMPORTS OF REFRIGERATORS & DEEP FREEZERS

('000 nos)

Parameters	1983	1985	1987	1988	1989	1990	1991
1. Production	187	93	59	83	80	72	84
2. Imports	80	10	17	12[a]	10[a]	18[a]	16[a]
Total	247	103	76	95[b]	90[b]	90[b]	100[b]

a. excluding second-hand fridges; imports of second-hand fridges have taken place in the last 4-5 years and are estimated to be in the range of 15,000-25,000 nos per annum.

b. estimate

Source : 1. Federal Government Statistics (till '87)
2. Manufacturers (from 1988 onwards)

Domestic refrigerators & deep freezers are manufactured in various sizes ranging from 140 to 440 litres capacity. Refrigerant used is CFC-12 and the technical norm for compressor charge varies from 100 gms to 280 gms per unit depending on the capacity. Taking into account mix of models used, the average technical norm works out 170 gms/unit across all models. Records of manufacturers/assemblers indicate that actual consumption per unit is approximately 30% higher than the technical norm, i.e. 220 gms/unit. The difference is accounted for by wastages in handling and charging and high rejection levels of compressors in the production line.

The servicing of old equipment is being done both by manufacturers as well as small agencies. However,

bulk of the repair jobs (approximately 75%) are handled by small agencies as they are near to the customer and are more economical. The type of service failures include compressor failure (approximately 40%), leakage (approximately 30%), and Miscellaneous mechanical/electrical defects (approximately 30%)

In case of both compressor failure and leakage cases the per unit recharging quantities include a factor for wastage in flushing, cleaning and leak detection. Most of the smaller agencies (80-85%) use the refrigerant (CFC-12) itself for flushing, cleaning and leak detection. In case of manufacturers' service centres the practice is to use nitrogen or dry compressed air for this activity in bulk (70-75%) of the cases. On the whole, the refrigerant is used for flushing, cleaning and leak detection in nearly 60% of the service jobs. The average refrigerant charge for recharging works out to 300 gms per unit.

All the refrigerators and deep freezers use polyurethane foam as insulation, for which CFC-11 is used as the blowing agent. The average norm of consumption per unit is 600 gms. However, taking into account a wastage of nearly 20% in transport, storage and handling the actual per unit norm of consumption is 720 gms.

b. Commercial & Industrial Refrigeration

i) Cold Stores : There is one large installer of cold rooms viz Alumaco, and 8-10 small installers. The refrigeration system is imported in Semi-Knocked Down (SKD) condition while the fabrication is done locally with indigenously built panels. Sales of cold rooms have been at a very low level since 1984 due to sharp increase in cost of imported components (because of the devaluation of the Naira). Most of the cold room installations were undertaken during the period 1973-82 and thus the average life of cold rooms presently in operation is around 10-15 years. The total number of installations added last year (1991) were about 12, mostly in the range of 6-36 TR (tonnage of refrigeration).

There is no published data available on production/imports of cold rooms. Hence, the population estimates had to be derived from records as well as estimates of leading

installation contractors. The total number of cold rooms till the end of 1991 have been estimated to be in the range of 800 to 1000. Approximately 80% of these cold rooms have a refrigeration tonnage in the range of 6.5 to 36 while balance 20% are mostly in the range of 50 to 100 TR. Almost 100% of the cold rooms are based on CFC-12. Some cold rooms also use CFC-502 but these cold rooms are very few in number. The average life expectancy of these equipment is about 25 years.

Many of the companies which were active during 1973-82 have now discontinued this line of operation because of decline in demand.

ii) Refrigerated Trucks/Vans : Alumaco is the only major installer of refrigeration & air-conditioning systems in Vans/Buses/Trailers accounting for nearly 80-85% of the total installations made till date. The useful service life extends upto 25 years.

The type of units imported by this installer, and their relative proportions are indicated in Table 2.4.

TABLE - 2.4

TYPE & NUMBER OF INSTALLATIONS FOR REFRIGERATED TRUCKS/VANS (INCLUDING A/C UNITS FOR BUSES)

RANGE OF CAPACITY (HP)	REFRIGERANT CHARGE (Kgs) (CFC-12)	APPROXIMATE NO. OF INSTALLATIONS	
		1975-1990**	1991
1.5	3)	230	7
1.5 x 2 *	3)		
4	6	40	1
5	7)		
10	7)	115	3
15	8)		
		385	11

* One stand-by compressor of 1.5 HP with a 3 phase electrical motor

** Assuming life to be nearly 15 years

Source : ALUMACO, NIGERIA

Since the above assembler holds nearly 80-85% of the share of all installations, the population of all refrigerated/ airconditioned commercial vehicles can be estimated to be in the range of 450 to 500 numbers (balance being directly imported).

iii) Industrial Refrigeration

These are generally larger units (from 200 TR to 2000 TR) using reciprocating compressors and mainly HCFC-22 refrigerant (CFC-502 is also used but in very few cases). The number of installations is very few (less than 50) and, hence, the requirement of refrigerants is very low.

The demand for new CFC-12 refrigerant for commercial & industrial refrigeration is very low because very few new units were installed in 1991. The average per unit norm of consumption for various types of cold rooms/refrigerated trucks as well as the weighted average consumption norm for these equipment has been shown in Appendix - 2.2 . The actual per unit norm of consumption is higher by 20% compared to the technical norm due wastages in handling. Recharging requirement exists in case of following categories of service failures :

- Compressor failure
- leakage
- topping up

The recharging norm for compressor failure is almost equivalent to that required for initial charging since this activity is being carried out only by large, organised units who use nitrogen/dry compressed air/electronic leak detectors for flushing/cleaning and leak detection respectively. Because of a slightly higher factor of wastage 25% as against 20% for initial charging the norm has been taken to be 8.5 kgs per unit for refilling in these cases as against 8.2 Kg per unit for initial charging.

In case of leakage approximately 50% of the cases are handled by smaller agencies who use the CFC for flushing/cleaning and leak detection. Therefore, the norm for refilling is 12.8 kg per unit which is much higher than original charge.

CFC-11 is used as a blowing agent for polyurethane foam insulation in cold rooms. The average per unit norm of consumption is 540 kg which is about 20% higher than the technical norm of 450 kg per unit.

c) Domestic and Commercial Airconditioning

Only centrifugal chillers were considered for analysis since all other types of air-conditioning systems (room air conditioners, packaged units, split units,reciprocating chillers) use only HCFC-22, which is not a controlled substance.

The installation of centrifugal chillers (based on CFC-11 and CFC-12) started almost 35 years back and almost all the installations were done in the 1960s and 1970s. About 80% of these installations are CARRIER make. The type/model and number of installations of CARRIER as well as the refrigerant charge have been indicated in Table 2.5.

TABLE - 2.5

TYPE AND NUMBER OF CARRIER CENTRIFUGAL CHILLERS

TYPE/ MODEL	REFRI-FERANT USED	REFRIGE-RATION TONNAGE (TR)	CHARGE OF REFRIGE-RANT (Kgs)	NO.OF INSTALLA-TIONS(END OF 1991)
19 DG 21	CFC-11	210	442.5	5
19 DG 31	CFC-11	310	590.0	10
19 EA 41	CFC-12	410	1248.0	7
19 EA 51	CFC-12	510	1664.0	3
Total				25

Source : Mandilas Enterprises

The above installations represent nearly 80% of installations. Thus, total number of installations was estimated to be 30.

No installations of centrifugal chillers have been made after 1980. Almost all contractors use a number of reciprocating chillers in place of one large centrifugal chiller since reciprocating compressors are easier to maintain and failure of one compressor does not affect the whole system.

The centrifugal installations have a regular six monthly maintenance schedule. During each service

the refrigerant is pumped down and the system is flushed with R-22 or Nitrogen. The lubrication system, electrical and refrigeration system is checked. Normally, there is a requirement of topping up nearly 20% of the refrigerant charge during each service. The representative of Carrier Corporation in Nigeria, M/s Mandilas Enterprises, reported that till date there have been no instances of compressor failure or major leakage in any of the systems.

d) Mobile Airconditioning (Cars)

There are two passenger car assembly plants (Peugeot & Volkswagen). At the same time, a significant number of cars are imported. The total production and imports of cars from 1981-91 has been indicated in Table 2.6.

TABLE - 2.6

PRODUCTION & IMPORTS OF CARS ('000s)

	1981	82	83	84	85	86	87	88	89	90	91
Production	83	75	62	68	52	26	15	15	10	10	18
Imports	102	89	15	6	18	30	18	28	20	20	22
	185	164	77	70	70	56	33	43	30	30	40

Source : 1. Car Assembly Units (from 1988 onwards)
2. Federal Govt. Statistics (till 1987)

Both the production and imports of cars have declined after 1985 due to fall in per capita income and spending.

According to local car assembly units and distributors of foreign cars, a very high proportion of cars (nearly 85%) are sold fitted with air-conditioners. This translated to nearly 34,000 cars in 1991 (indigenous plus imported). The number of cars domestically produced with air conditioners in 1991 was estimated at 15,000 nos. In addition to original fitting, a significant number of cars are also retrofitted with new air-conditioners each year, approximately 10,000 nos in 1991. Thus, total number of car air-conditioners installations in 1991 was estimated at 25,000 nos. The population of air-conditioned cars has been estimated by us to be nearly 7,28,000 at the end of 1991. The average service life of car airconditioners in Nigeria is about 10 years.

The requirement of recharging arises in the following types of service failures :

- topping up
- leakage
- compressor failure

Most car owners do not get their cars topped up unless the decline in cooling becomes noticeable. However, in such cases, the amount of refilling required is greater and the addition compensates for not topping up regularly. Air-conditioning technicians, consulted during the study, indicated that due to vibrations car air-conditioners develop a leak annually to the extent of approximately 10% of the initial charge. Thus, even though the initial topping-up may not be annual, for the purpose of our calculations we have assumed a discharge of 10% per year of initial charge for each car.

Discussions with service mechanics indicated that leakage cases form a very large proportion of service failures. It is estimated that more than 50% of cars have a leakage problem once in their life time (usually after 4-5 years. On the basis of these probability estimates, the proportion of cars with leakage vis-a-vis total population works out to nearly 15%. In almost all leakage cases, the residual gas is very small, and the refrigerant normally is used for cleaning, flushing and testing the system. Thus, on an average, the amount of refrigerant used for refilling is normally higher than the initial charge i.e nearly 2 Kgs per car.

The cases of pre-mature compressor failure are few. Compressors usually fail at the end of their estimated life, taken as 10 years on the basis of field survey. It was estimated that compressor failure cases were around 1% of the total population in 1991, approximately 7300 cases in 1991. The per unit consumption of gas in these cases is equivalent to that for leakage cases viz 2 Kgs per car.

The computation of new and recharging demand for various subsectors of refrigeration and airconditioning is shown 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

a) Pesticides & Household Products : There are

approximately 8-10 large fillers in the country producing aerosol based insecticides, pesticides and household products such as room fresheners. All these products are currently based on unstenched LPG available from the indigenous Nigerian National Petroleum Corporation (NNPC) petroleum refinery in Port Harcourt. These fillers have either set up or modified their filling lines to use LPG.

b) Cosmetics (Body Deodorants) : Besides a few large filling lines (4-5), there are a large number of small and medium sized companies in this area. However, the dominant share is held by the major companies. All major companies have foreign tie-ups or sources for formulations from overseas. Of late, many of the small and medium sized companies have discontinued production due to large scale imports and increase in cost of manufacturing.

The changeover in this sub-sector from CFCs to LPG has only been partial. This is because some of the fillers still feel that even unstenched LPG is not the ideal replacement in case of body deodarants.

2.3.3 Plastic Foams

The most important type of plastic foams produced in Nigeria is flexible polyurethane foam in slabstock form for mattresses, pillows and cushions. There is very little production of rigid polyurethane (except for refrigerators covered earlier) and polystyrene.

There are 84 slabstock polyurethane foam manufacturers registered with the Foam Producers Association. The major units are 12 in number and the rest are in small/mediumm sector. Due to adverse economic conditions many of the small/medium firms have closed down their operations. It was estimated that only 15-20 small/medium firms are currently in operation.

The total quantity of polyurethane foam (polyol + isocyanete + blowing agent) used by the industry was in the range of 20,000 MT in 1991.

2.3.4 Solvents

The main solvents used for industrial applications are tri-chloro-ethylene, carbon tetrachloride and methyl chloroform. Use of CFC-113 for this applicatcn in Nigeria is negligible.

2.4 UTILISATION OF CFCs

Present Consumption of CFCs

The consumption of CFC-11 and CFC-12 by sub-sector has been summarised in Table - 2.7 which also indicates the unit consumption norms as well as the recharging requirement for various air conditioning and refrigeration equipment.

TABLE - 2.7

UTILISATION OF CFCs BY SUB-SECTOR IN 1991

SECTOR	SUB-SECTOR	CFC-11		CFC-12		UNIT CONSUMPTION AND COMMENTS
		QTY(MT)	%	QTY(MT)	%	
Air Conditioning & Refrigeration	Domestic Refrigerators & Deep Freezers					Average of 720 gms of CFC-11 is used per refrigerator/deep freezer in foam insulation. Average charge for CFC-12 per unit is 220 gms, while for recharging the norm is 300 gms/unit..
	- New Demand	60.5		25.3		
	- Recharging	-		52.5		
	- Sub Total	60.5	17.0	77.8	12.5	
	Commercial & Industrial Refrigeration					Per unit consumption norms Charging Norm (CFC-12) - Cold Stores (6-36 TR) - 7.2 kg/unit - Cold Stores (750 TR) -21.6 kg/unit - Ref. Trucks (1.5 HP) - 3.6 kg/unit - Ref. Trucks (4-15 HP) - 8.4 kg/unit
	- New Demand	6.5		0.2		
	- Recharging	-		3.3		
	- Sub Total	6.5	2.0	3.5	0.6	Insulation Foam (CFC-11) Weighted average norm is 540/unit Recharging norm (CFC-12) Compressor failure 8.5 kg/unit, leakage cases 12.8 kg/unit
	Domestic & Commercial Air conditioning					CFC-11 & 12 are used as refrigerants in centrifugal chillers. Average requirement per unit for topping up 260 Kgs for topping up is 260 Kgs for CFC-11 and 660 Kgs for CFC-12.
	- New Demand	-		-		
	- Recharging	4.7		7.3		
	- Sub Total	4.7	1.4	7.3	1.2	

Table-2.7 (Contd...)

SECTOR	SUB-SECTOR	CFC-11		CFC-12		UNIT CONSUMPTION AND COMMENTS
		QTY(MT)	%	QTY(MT)	%	
	Mobile Air Conditioning					Average charge is 1.6 Kgs/Car of CFC-12. Recharging consumption norm is 2 kg/unit.
	- New Demand	-	-	40.5		
	- Recharging	-	-	342.2		
	- Sub Total	-	-	382.7	61.6	
	Total (Airconditioning & refrigeration)					
	- New Demand	67		66		
	- Recharging	4.7		405.3		
	- Sub Total	71.7	20.4	471.3	75.9	
Aerosols	Pesticides	-	-	-	-	Phased out by LPG
	Cosmetics & Household products	-	-	150		Partial substitution by LPG. This trend likely to continue and almost complete substitution envisaged by 1995.
	Total	-	-	150	24.1	
Plastic Foams	Polyurethane	280		-	-	Consumption declining due to substitution by methylene chloride. Average consumption norm for a blowing agent is 35% by weight of total system. Nearly 60% of CFC-11 has been substituted methylene chloride. This trend is likely to continue in the future and almost complete substitution is expected by 1993.
	Polystyrene	-	-	-	-	No production
	Total	280	79.6	-	-	
Solvents	Degreasing	-	-	-	-	Solvents used normally are trichloroethylene and carbon tetrachloride
All Sectors	Grand Total	351.7	100.0	621.3	100.0	

Note : 1. The consumption of CFC-12 is lower than the total import shown in Table 2.1 because approx 10 to 15% of the substance is re-exported (albeit illegally) to neighbouring countries such as Ghana & Cameroon.

Note : There is some use of R 502 in commercial refrigeration applications, but the quantity is very small and hence its contribution to total ODP tonnage is negligible.

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 & population of airconditioning and refrigeration equipment was estimated as explained in Appendix - 2.4.

Step - II : Phase out of CFC based equipment was worked out on the basis of certain assumptions regarding availability of compressors based on substitute refrigerants. On the basis of developments taking place in more advanced countries, ease of changeover as well as expected time lag involved in switching over, we have assumed the following phase-out schedule :

- 20% of all new equipment in 1995
- 60% of all new equipment in 1996
- 100% of all new equipment in 1997

As soon as there is sufficient availability of compressors based on substitute refrigerants, which is likely by 1995, the phase-out would take place within a short period of time, almost two years. This is because most units are carrying out an assembly operation and importing a significant proportion of the components including the compressor. Besides, the basic design of the new CFC free refrigerator is unlikely to change except for change in length of capillary tubes. The manufacturing facilities would, therefore, require only minor changes; primarily new equipment for leak detection, charging and foaming fixtures.

Demand from other sectors such as aerosols and plastic foams would be negligible after 1993/94 since usage of CFCs in these sectors would be completely substituted by LPG and methylene chloride respectively.

Step - III: CFC refrigerant quantities were estimated for both original equipment (new demand) as well as recharging demand. This has been done on the basis of present (1991) unit consumption norms estimated through field survey. An assumption was made that these norms would not change over the next 20 years since these norms are guided by technical considerations (and there are no technology changes

anticipated in CFC based equipment). Detailed workings are shown as per Appendix - 2.5.

2.5.2 The projected demand and population figures for CFC based airconditioning & refrigeration equipment as well as demand for CFC refrigerants (OE and recharging) for each sub-sector are summarised in Tables 2.8 and 2.9.

TABLE - 2.8

FORECAST OF PRODUCTION AND POPULATION OF AIRCONDITIONING & REFRIGERATION EQUIPMENT

EQUIPMENT/SUB-SECTOR		1991	1996	2005	2007	2010
DOMESTIC REFRIGERATORS & DEEP FREEZERS	DEMAND ('000)					
	- Total	115	185	380	435	533
	- CFC based	115	74	0	0	0
	POPULATION ('000)					
	- Total	1646	1858	3267	3603	4061
	- CFC based	1646	1713	542	351	52
COMMERCIAL & INDUSTRIAL REFRIGERATION	DEMAND (Nos)					
	- Total	23	37	63	70	80
	- CFC based	23	15	0	0	0
	POPULATION (Nos)					
	- Total	1400	1504	1523	1559	1639
	- CFC based	1400	1475	1025	925	775
DOMESTIC & COMMERCIAL AIRCONDITIONING (Centrifugal chillers only)	DEMAND (Nos)					
	- Total	-	-	-	-	-
	- CFC based	-	-	-	-	-
	POPULATION (Nos)					
	- Total	30	27	0	0	0
	- CFC based	30	27	0	0	0
MOBILE AIRCONDITIONING	DEMAND ('000)					
	- Total	34	55	129	156	208
	- CFC based	34	22	0	0	0
	POPULATION ('000)					
	- Total	728	582	1029	1172	1421
	- CFC based	728	539	180	118	17

TABLE - 2.9

FORECAST OF DEMAND FOR CFC 11 & CFC 12 IN NIGERIA (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	60.5	25.3	39.0	16.3	0.0	0.0	0.0	0.0	0.0	0.0
	RECHARGING	-	52.5	-	54.6	0.0	17.3	0.0	11.2	0.0	1.7
	SUB-TOTAL	60.5	77.8	39.0	70.9	0.0	17.3	0.0	11.2	0.0	1.7
COMMERCIAL & INDUSTRIAL REFRIGERATION	NEW	6.5	0.2	4.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	RECHARGING	-	3.3	-	3.5	-	2.4	-	2.2	-	1.8
	SUB-TOTAL	6.5	3.5	4.2	3.6	0.0	2.4	0.0	2.2	0.0	1.8
COMMERCIAL AIR-CONDITIONING (CENTRIFUGAL CHILLERS)	NEW	-	-	-	-	-	-	-	-	-	-
	RECHARGING	4.7	7.3	4.2	6.6	0.0	0.0	0.0	0.0	0.0	0.0
	SUB-TOTAL	4.7	7.3	4.2	6.6	0.0	0.0	0.0	0.0	0.0	0.0
MOBILE AIR CONDITIONING	NEW	-	40.5	-	26.1	-	0.0	-	0.0	-	0.0
	RECHARGING	-	342.2	-	253.5	-	84.5	-	55.6	-	8.2
	SUB-TOTAL	-	382.7	-	279.6	-	81.5	-	55.6	-	8.2
SUB TOTAL	NEW	67.0	66.0	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	-	50.3	0.0	11.7
	TOTAL	71.7	471.3	47.4	360.7	0.0	104.2	0.0	50.3	0.0	11.7
II. AEROSOLS		0.0	150.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
III. PLASTIC FOAMS		280.0	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		351.7	621.3	47.4	360.7	0.0	104.2	0.0	50.3	0.0	11.7
		973		408.1		104.2		50.3		11.7	

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-2.3. From the figures 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 2007. The phase-out of CFC based equipment is expected to be completed by 1997 and, therefore, the demand for CFCs after 1997 would be only for recharging (for servicing the remaining population of CFC based equipment). The population of CFC based equipment shows a constant decline after the year 1997 (except for cars where the decline starts even earlier) due to the following factors :

- Sharp decline in demand of all CFC based equipment during the decade 1980-90
- Phase-out of CFC based equipment expected during the period 1995-97

The decline in population of CFC based equipment has a direct impact on CFC recharging demand. The decline in demand of CFC based equipment during the period 1980-90, coupled with phase-out scenario taken, makes the population of CFC based equipment decline continuously after 1997 as also the recharging demand of CFCs. This decline is sufficient to keep the demand of CFCs below Montreal Protocol limits till the year 2007.

The adoption of a recovery and recycling programme would further reduce the demand for imports of CFCs for recharging as explained in later chapters.

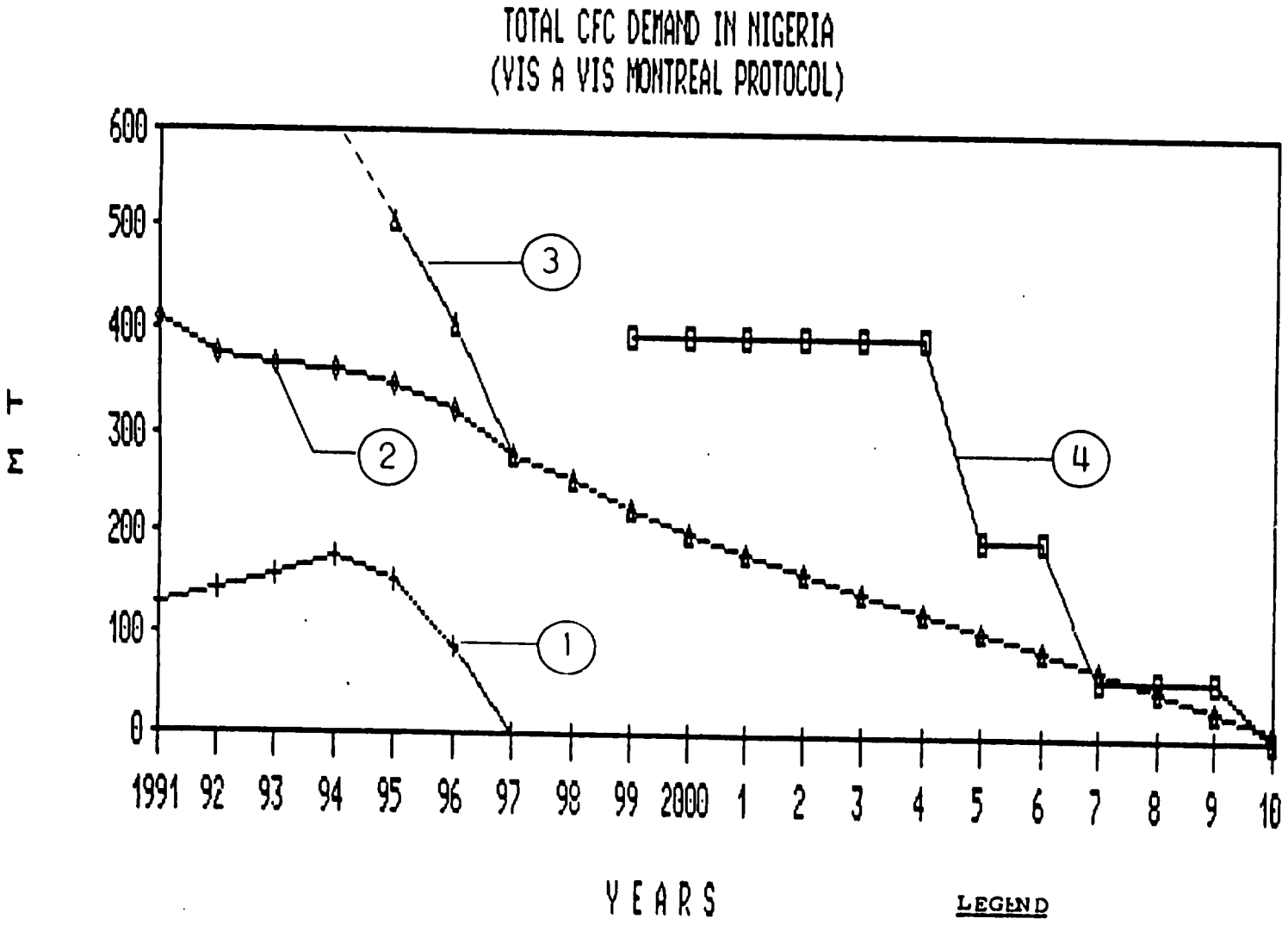
2.7 PHYSICAL DISTRIBUTION OF CFC SUPPLIERS AND USERS

2.7.1 Supply :

As indicated earlier in section 2.4.1 the importers fall into two main categories :

- Subsidiaries/associates of foreign manufacturers, namely
  - * Chemicals & Allied Products Ltd (CAPL) - an associate of ICI, UK.
  - * Hoechst Nigeria Ltd - a subsidiary of Hoechst, Germany.
- Private Agencies/Distributors who import from one or more sources abroad.

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

The major distributors of refrigerants are CAPL and private agencies, namely Ashmina Ltd and OAE Nigeria Ltd. These three organisations hold a share of nearly 75% of total refrigerant supply. Among the three organisations, CAPL has the most extensive infrastructure for distribution comprising of a network of branch offices and depots spread across all major cities and towns in the country. Ashmina deals with only disposable cylinders (of 13.5 Kg each) and its distribution is solely on a cash and carry basis i.e private agents/dealers lift the material from Ashmina on a cash basis and carry it to the other parts of the country. OAE Ltd works on both cash and carry basis as well as authorised dealers spread across the country.

2.7.2 Utilisation

The sub-sector wise utilisation of CFC refrigerants (CFC-11 and CFC-12) in 1991 was as follows :

- Domestic Refrigerators & Deep Freezers : 14.2%
- Commercial & Industrial & Refrigeration : 1.0%
- Domestic & Commercial Air-conditioning : 1.2%
- Mobile Air-conditioning : 39.3%
- Others (Aerosols, Plastic Foams) : 44.2%

i. Domestic Refrigerators & Deep Freezers

Of the 12 manufacturing/assembly units, 10 units are located in and around Lagos. The balance 2 are located in Port Harcourt in the East. The two major units, Thermocool Engineering and Debo Industries Ltd, which together account for nearly 60% of the production, are located in Lagos.

Nearly 75% of the servicing requirement is met through a large number of small private repair agencies, approximately 600-700 in number while the balance 25% is met through service workshops of manufacturers which are spread across the country. The average number of refrigerators handled per agency is in the range of 250-300 refrigerators per annum. The number of service agencies is highest in Lagos, nearly 300-350 in number, while the balance service agencies are spread across 8-10 towns and cities.

ii. Commercial & Industrial Refrigeration

All the large installations of cold rooms, refrigerated trucks and industrial refrigeration equipment are located in Lagos. The number of installations for these equipment has reduced considerably in the last 7-8 years due to sharp decline in demand for these equipment. Currently, there are 5-6 major units engaged in this activity.

The servicing of these refrigeration equipment is done either inhouse by end users themselves or by the installers. The majority of the installations are in Lagos and in the east (Onitsha, Aba, Port Harcourt, Calabar), these cities/towns being the main centres of fishing activity.

iii) Domestic & Commercial Airconditioning (Centrifugal Chillers)

Mandilas Enterprises Ltd., representative of Carrier Corporation, USA, is the only supplier of CFC chillers. Mandilas has both its sales and service headquarters at Lagos. Almost all the installations of centrifugal chillers are being serviced by Mandilas itself from its head quarters at Lagos.

iv) Mobile Airconditioning

There are only two local assembly plants for cars, namely;

- Peugeot Automobiles Nigeria Ltd., which is located in Kaduna in north

- Volkswagen of Nigeria Ltd., which is located near Lagos.

The servicing of airconditioned cars is being carried out by the following types of agencies :

- Large car distributors, who have an extensive sales and service network in all major towns and cities across the country, there are 5 to 6 such distributors and all of them have their headquarters in Lagos.

- Small service workshops which are proprietorship/partnership firms; these service workshops are localised in nature and are spread across all major towns and cities - the number of these agencies is estimated to be 300-350, with maximum concentration in and around Lagos.

Almost 80% of the car airconditioning service jobs are being handled by small localised agencies since these are far more economical. On an average, 250-350 car airconditioning servicing jobs are being handled per agency.

v) Overall Distribution

All major importers of refrigerants are located in Lagos and over 95% of refrigerants are imported through Lagos port. Almost all the manufacturing/ assembly activities relating to airconditioning and refrigeration equipment is concentrated in and around Lagos. Approximately 40-50% of the small service agencies are also located in and around Lagos. Thus, Lagos is the major centre for distribution as well as consumption of refrigerants, accounting for nearly 50-60% of the total CFC consumption in the country. The other major centres of consumption are :

- Onitsha, Aba, Port Harcourt, Calabar and Enugu in East
- Ibadan, Benin and Ilorin in the centre
- Kano, Kaduna, Jos and Maudigiri in the north

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.

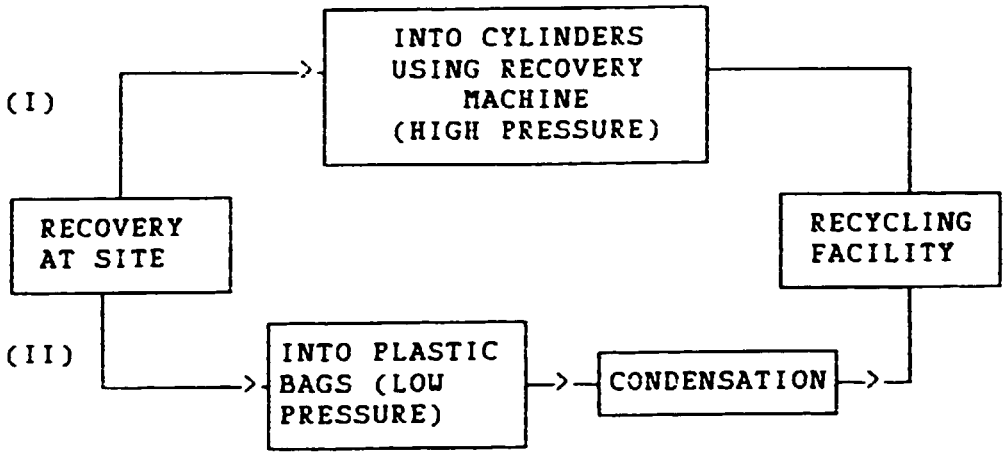
Recovery and re-use of refrigerant has been an established practice for large installations based on CFC-11. This is because CFC-11 at room temperature is a liquid and amenable to recovery and storage at site. It is therefore assumed that such practices will continue.

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 :



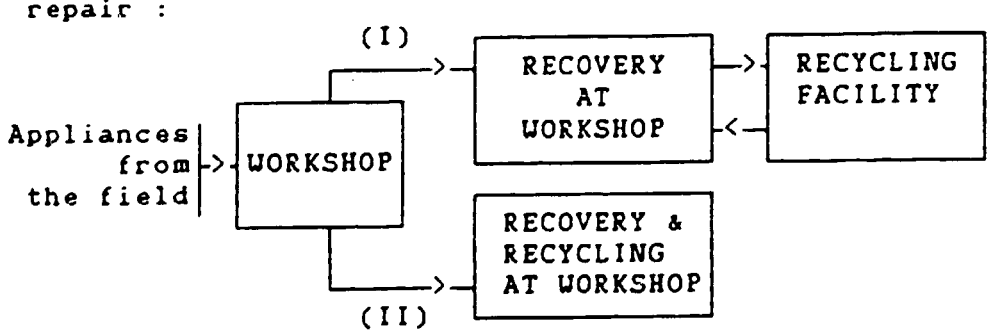
Notes :

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 :

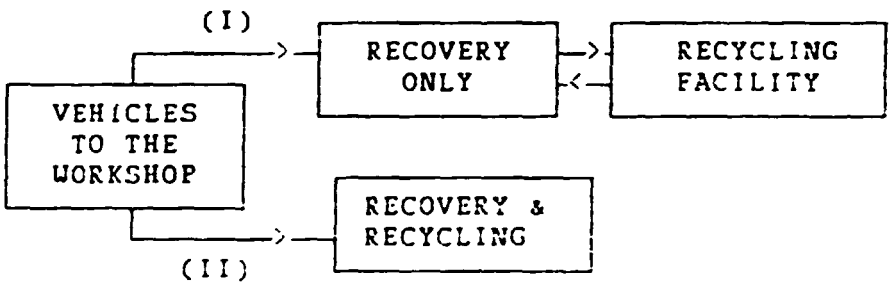
Option (I) : Only recovery done at the workshop and the collected refrigerant is sold for recycling at a separate facility.

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.

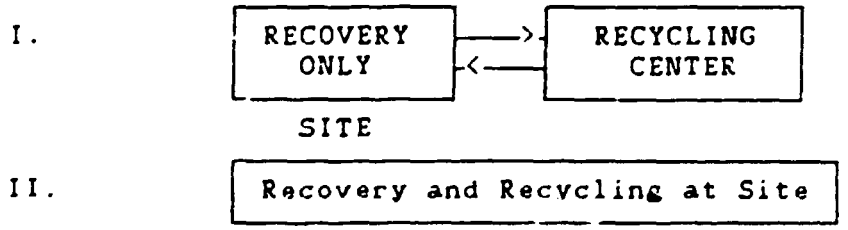
4.3.2 Mobile Airconditioners

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.



4.4 PRESENT SCENARIO IN NIGERIA

4.4.1 Nigeria which is signatory to the Montreal Protocol have per capita CFC-consumption levels as given in Table - 4.1 below :

TABLE - 4.1

PER CAPITA CFC CONSUMPTION IN NIGERIA

TOTAL CFC CONSUMPTION IN 1991 (MT)	ESTIMATED POPULATION IN 1991	PER CAPITA CFC CONSUMPTION
973.0	115 Mn	8.50 gms

This is far lower than the limit of 0.3 Kg per capita, for distinguishing the developed and developing countries, NIGERIA fall 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 are being met through imports which are mainly from France, UK and Germany. Even if these countries stop or curtail the production of CFCs in the next few years, Nigeria 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 governments 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.

An analysis, covering the demand for refrigerant recharging, quantities of CFCs feasible for collection/recovery (based on 1991 data) and feasible technical options for each sub-sector are presented below :

4.5 RECHARGING REQUIREMENTS AND RECOVERY OF CFCs

No recovery or recycling is being carried out of the concerned refrigerants except in case of centrifugal chillers (for CFC-11 as well as CFC-12) where the recovery system is in-built with the equipment.

4.5.1 Demand for Recharging

The sub-sector wise break-up of refrigerant recharging demand in relation to the total CFC 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 NIGERIA

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	0.17	100000	80	13.6	75000	25	3.2	22.8	80	18.2	35
COMMERCIAL AND INDUSTRIAL REFRIGERATION	6.8	130	80	0.7	75	40	0.2	0.8	80	0.6	1.5
DOMESTIC & COMMERCIAL AIRCONDITIONING **											
MOBILE AIRCONDITIONING	1.35	7300	80	7.9	109200	30	44.2	75.7	80	60.6	112.7
TOTAL				22.2			47.6			79.4	149.2

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

**External recovery is nil; refrigerant is recovered through inbuilt recovery system.

4.6 RECOMMENDED TECHNICAL OPTIONS

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	- Plastic bags for recovery at users end and small service agencies	- Recycling stations with CFC suppliers

Sub-Sector	Recovery	Recycling
	- Portable recovery stations at large service agencies (say handling more than 2000 cases per annum)	
B. Commercial and Industrial Refrigeration	- Portable recovery equipment are recommended	- Recycling stations with CFC suppliers
C. Domestic and commercial air-conditioning only.	- In situ-built in with equipment.	- In situ-built in with equipment.
D. Mobile Air Conditioning	- Use of recovery equipment is recommended.	- Recycling stations with CFC suppliers

Besides the technical options suggested above for recovery and recycling, it would be extremely advantageous to inculcate an attitude of conservation among service mechanics through a well-designed awareness-cum-training programme.

Some of the important conservation practices which should be propagated include the following :

- proper accounting and record keeping for refrigerant purchase and utilisation (atleast in all large agencies).
- use of nitrogen and/or dry compressed air in lieu of CFC refrigerant for flushing and leak detection wherever practically possible.
- use of electronic leak detectors in larger service agencies
- care in handling of refrigerants in order to avoid wastage
- installation of refrigerant recovery stations in all manufacturing/assembly units.

4.7 OTHER ASPECTS OF TECHNICAL FEASIBILITY

i) Feasibility of Local Manufacture

Technical capability to assemble recovery and recycling equipment exists in the country. However, since the requirement of such equipment is likely to be small, in number as well as value, it may not be regarded as a commercially attractive opportunity by existing assemblers of refrigeration and airconditioning equipment.

ii) Appropriateness of Technology

Portable equipment and other methods of collection suggested (such as plastic bags) are simple to use and do not require extensive technical inputs. The present practical technical skills available with small service agencies are sufficient for them to get effective working knowledge of collection equipment and methods suggested. The operation of recycling equipment, however, requires skill and experience for its successful operation. These skills and experience are present with many of the larger service agencies in the country where installation of these equipment has been recommended.

On the whole, the successful operation of both collection and recycling technology in the country would require incremental training inputs since the technology suggested is new to the country.

iii) Attainable Level of Reduction in CFC Consumption

The maximum level of reduction attainable is equivalent to the quantity of CFC externally recycled viz 149.2 MT at 1991 levels. This works out to 36% of recharging demand and 27% of overall CFC demand in airconditioning and refrigeration sector at current (1991) consumption levels.

iv) Logistics of Collection for On-site Recycling

In the case of centrifugal chillers, which use CFC-11 as refrigerant, on-site recovery and recycling is feasible and is already being practiced in most of the installations.

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.

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. This is because destruction of CFCs requires high temperature incineration facilities with appropriate treatment of effluent gas. Such facilities cannot be specifically designed 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 Nigeria 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 , 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 has been excluded 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 Monteal 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 ventures 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.

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

TABLE - 5.1

NIGERIA

PARAMETER	RECOVERY ONLY	RECYCLING
Maximum annual qty technically feasible(average for 1993to2010)	60 MT	81 MT
Min.economic qty per venture @	256 Kg	1633 Kg

Table-5.1 (Contd..)

PARAMETER	RECOVERY ONLY	RECYCLING
Max.no.of ventures possible	234	50
Proposed no.of ventures based on industrial Survey *	150	10
Avg.annual qty. per venture		
- Maximum	400 Kg	8100 Kg
- Practical as per field survey +	262 Kg	4540 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 Nigeria is shown at Appendix 5.2 attached, and summarised in the following paragraphs.

5.3.1 Types of Ventures

Types of Ventures selected :

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	35.6
	-Portable recovery machine	Manufacturers and their authorised service agencies	4.0
Commercial & industrial refrigeration	Portable recovery machine	Service agencies of large companies	1.6
Mobile airconditioners	Recovery machine	Garages servicing Car airconditioners	108.8

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.

5.3.2 Institutional Considerations

In Nigeria the economy is driven by market forces of supply and demand, to a greater extent as compared to the other two project countries.

Government intervention is very limited in the price determination process. Thus the institutional mechanism to support prices of recovered/collected CFC may not exist.

On the other hand since the quantities of CFC that could be recovered and recycled are substantial and most of it in the mobile airconditioning sector where recycled CFC-12 could be used, market forces would come into play in terms of evolving a 'fair price' for recovered/recycled CFCs.

The other area where institutional capability is required is in providing technical, financial and management support to the recycling systems.

Given the inputs in terms of training and awareness especially about the financial viability of recycling, any constraints here would be overcome in due course.

As explained in the next chapter, while legislative and regulatory measures are proposed for Nigeria, it will be the financial incentives that would provide the maximum impetus to the CFC recovery and recycling programme.

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

TABLE - 5.3

	VENTURE TYPE	
	RECOVERY	RECYCLING
Equipment Cost	N 20,790	N 49,896
Project Cost	N 24,331	N 58,014
Total Quantity of CFC handled over project life (1993 - 2010)	4,724 Kg	81,721 Kg
Average Annual Quantity (18 years)	262 Kg	4,540 Kg
Annualised operation cost (18 years)	N 4,338	N 365,491
Annualised revenues(value of CFC saved)	N 13,123	N 454,004

Table 5.3 (Contd..)

	VENTURE TYPE	
	RECOVERY	RECYCLING
Operational cost per kg of CFC processed (avg.annual)	N 16.56	N 80.50
Break even volume	205	1306
Payback period for venture - on equity - on total capital	Six months 2 years	Six months One year & 6 months
Internal Rate of Return (IRR) - on equity - on total capital	215.1% 47.2%	325.3% 97.7%

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

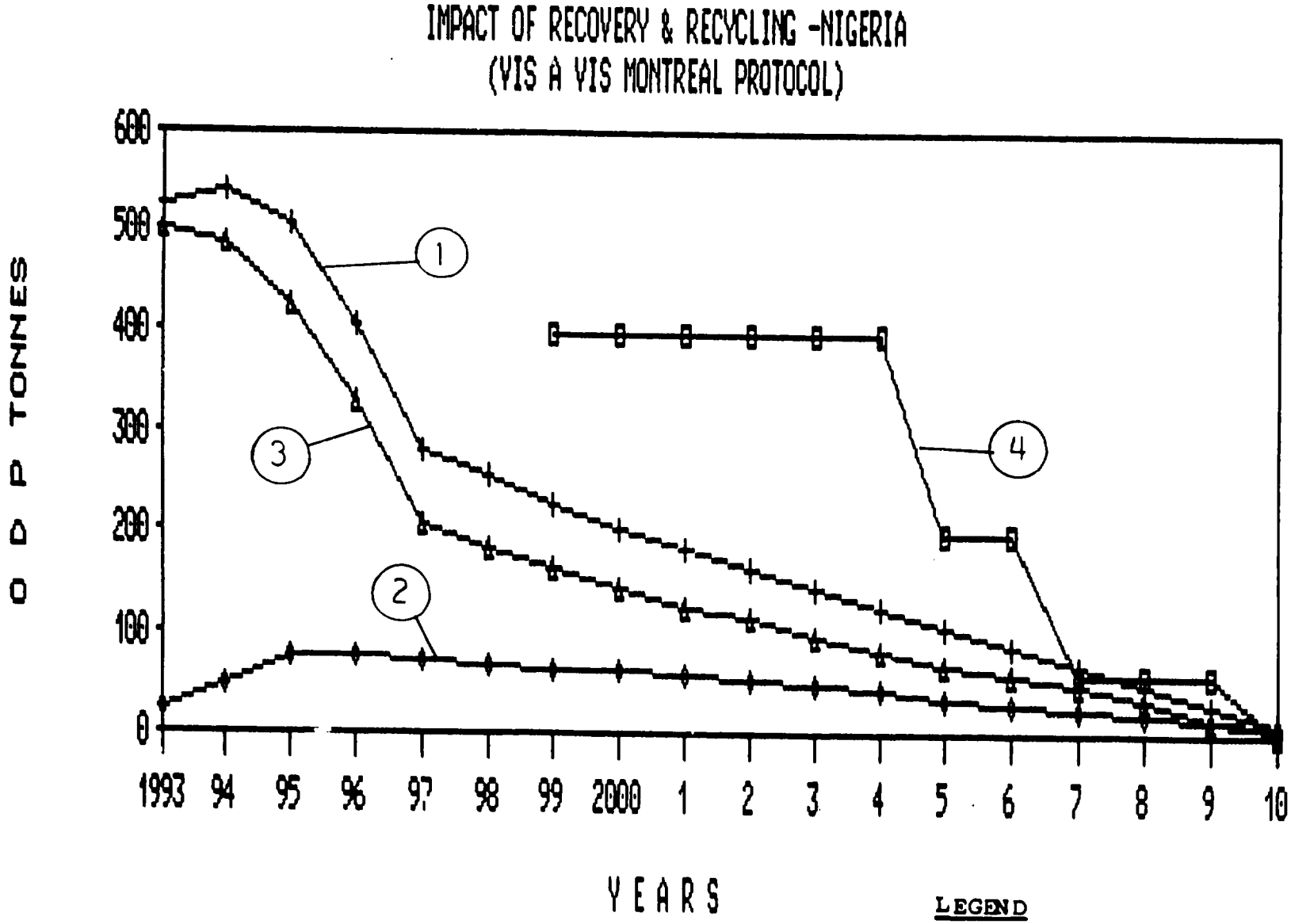
TABLE 5.4

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	215.1%	170.3%	180.1%	464.6%	256.9%
- capital	47.2%	42.6%	41.3%	47.2%	54.2%
RECYCLING					
- equity	325.3%	280.1%	283.9%	583.5%	589.3%
- capital	97.7%	91.2%	88.2%	97.7%	112.0%

The impact of recovery and recycling programme on the total CFC consumption, with respect to the requirements of Montreal Protocol, is presented in Figure-5.1, which shows that recovery and recycling would enable compliance with Montreal Protocol upto 2009.

FIGURE - 5.1


IMPACT OF RECOVERY & RECYCLING -NIGERIA
(VIS A VIS MONTREAL PROTOCOL)
ODP TONNES
600
500
400
300
200
100
0
1
2
3
4
1993
94
95
96
97
98
99
2000
1
2
3
4
5
6
7
8
9
10
YEARS
LEGEND
1. TOTAL PROJECTED CFC DEMAND
2. PRACTICALLY 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 for each country 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 currency of the country 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 foe each of the three project countries 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 NIGERIA

(IN Mn OF LOCAL CURRENCY)

YEAR	COSTS	BENEFITS
1993	8.19	5.37
1994	6.74	4.44
1995	9.15	6.44
1996	7.46	6.08
1997	7.04	5.77
1998	6.60	5.45
1999	6.20	5.19
2000	5.86	4.98
2001	5.44	4.60
2002	5.04	4.22
2003	4.70	3.92
2004	4.29	3.55
2005	3.81	3.13
2006	3.30	2.66
2007	2.80	2.20
2008	2.45	1.85
2009	2.07	1.47
2010	1.66	1.07
NPV OF NET BENEFITS (@ 2% DISC.)	N Mn	-17.44
	US$ Mn	-0.97

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 country and

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

6.2 PRESENT LEGISLATIVE AND INSTITUTIONAL FRAMEWORK AND EXTENT OF PUBLIC AWARENESS

The Federal Environment Protection Agency (FEPA) has formulated a comprehensive national policy on environment. By a governmental decree the agency has also been entrusted with the task of making recommendations and programmes for control of Ozone Depleting Substances (ODS). However, as on date no framework exists for regulation or control in this area.

While a beginning has been made in the matter of 'effluent limitation' and 'pollution abatement in industries and facilities generating wastes', CFCs have neither been subject to any specific classification nor is there any control on any of the CFC consuming industries (including aerosols and foams). The shift from CFCs to alternatives such as methylene chloride and LPG in foam and aerosol sectors respectively has taken place mainly due to commercial considerations.

Past experience with regulatory measures in other environmental areas indicates that decrees have not been backed up by enforcement. This is primarily due to the following :

* FEPA and other state level enforcement agencies lack the organisation and in some cases the conviction necesary to enforce legislations.

* Most of the industries and enterprises which are in the private sector operate in a highly 'profit' oriented environment and are not inclined to adopt regulations which adversely affect their commercial interests.

In addition, the socio-political-economic environment has other characteristics which are typical of certain other developing countries.

- Large population and geographical spread

- High degree of economic disparity

- Most of the manufacturing industries are still at the level of component assembly, largely in the hands of private enterprise.

- Economy is under stress due to adverse balance of payments situation and dependence on imports.

- High level of social tension in the large urban centres where the oil boom had raised social expectations which cannot be fulfilled under the present economic conditions.

In respect of CFCs and ozone depletion, the level of awareness is low among the public. There is a total absence of standards for equipment and consumables and likewise for repairs, leading to improper handling and wastage of CFCs.

The data base on CFC consuming industries/entities is grossly inadequate. Much of the servicing related work is carried out by a large number of units in the unorganised sector.

6.3 PROPOSED MEASURES FOR IMPLEMENTING A RECOVERY AND RECYCLING PROGRAMME

The specific measures proposed are based on the present environment depicted above as well as the system of recycling and recovery proposed for the country which is briefly outlined in the table below :

TABLE - 6.1

SYSTEM FOR RECOVERY/COLLECTION & RECYCLING DISPOSAL CFC'S IN NIGERIA

SECTOR	RECOVERY/COLLECTION				RECYCLING	
	COLLECTION AGENCY	COLLECTION METHOD	DELIVER TO	INPUTS FOR ECONOMIC VIABILITY	OPERATING AGENCY	INPUTS FOR ECONOMIC VIABILITY
Car Airconditioners	Service Garages (Large establishments)	Portable recovery equipment	@ Dealers of CFCs	* Suitable price for CFC recovered gas * Cut in duty for equipment	Major whole salers of	*Exemption of duty on equipment *Subsidy on capital investment

SECTOR	RECOVERY/COLLECTION				RECYCLING	
	COLLECTION AGENCY	COLLECTION METHOD	DELIVER TO	INPUTS FOR ECONOMIC VIABILITY	OPERATING AGENCY	INPUTS FOR ECONOMIC VIABILITY
						*Increased price of CFC
Commercial & Industrial Refrigerators.	Equipment suppliers & maintenance agencies	Portable recovery equipment	@ Dealers of CFCs	* Cut in duty on equipment	Major wholesalers of gas	*Exemption of duty on equipment *Subsidy on capital investment *Increased price of CFC
Domestic Refrigerators	Small Service Shops	Plastic Bags	@ Dealers	* Free Bags * Price mechanism	-do-	*Exemption of duty on equipment *Subsidy on capital investment *Increased price of CFC
	Large companies service workshops	Portable recovery equipment	Dealers	Cut in duty of equipment		

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

6.3.1 It may be reiterated that in Nigeria the major area for recycling is the mobile car airconditioners where quantities are significant and which accounts for almost 90% of the CFC recharge requirements, while the domestic refrigerator and the industrial refrigeration sector account for much lower levels of CFCs for recharging. The proposed legislative and institutional policy measures are discussed below :

Command & Control Measures

Legislation related to :

Supply of CFCs

Since all CFC are currently imported,an important step is

to enact legislation to make it necessary to report CFC import and sale.

Secondly CFCs are sold to users through a large number of dealers dispersed across the country.

Thus it would be necessary to have legislation that would make it obligatory for dealers to accept recovered CFC which could be passed back to the main importers. (i.e. agents of overseas manufacturers) for recycling.

The Scope of such legislation would cover

* need to maintain records of imports, by type of CFC, source, quantity, etc.
* need to maintain records of sales - delivery to users if any and to dealers (dealer wise, location/city wise).

* registration of authorised dealers

* obligation for dealers to accept recovered CFCs in cylinders/bags from accredited servicing agencies

* obligation for main importers to accept recovered CFCs from dealers in cylinders/bags

* specifying a standard for recycled CFC and limitations to its use, if any.

* need to maintain records of sale of recycled CFC

While the specific legislation would be tailored to the country's own situation an illustrative provision of such legislation enacted in the State of Victoria in Australia is given in Appendix - 6.1.

Use of CFCs

Legislation is also proposed in respect of use and users of CFCs. The scope of such legislation would be to

* identify all users (i.e. manufacturers, maintenance & servicing agencies for all CFC equipments including Car Airconditioners)

* restrict use of CFCs to persons who are certified or accredited by the concerned Environmental Authority such as FEPA based on their competence and 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 & use

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

* ensure adoption of codes of practice by manufacturers and for service and maintenance of installations which will provide for proper procedures as well as obligation to reclaim CFCs to the extent possible

In fact it could be made obligatory for large users such as manufacturers or assemblers of refrigerators and 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 the above in the State of Victoria, Australia is presented in Appendix 6.4 (Sections 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 reclaimed CFC was brought back and how much fresh CFC supplied.

Illustrative provisions in the Industrial Waste Management Control Policy (for ODs) of State of Victoria covering various points above are shown in Appendices 6.2 to 6.4 enclosed.

Disposal

Nigeria, because of its size and largely unregulated environment in all spheres would seem to be a difficult candidate to have a workable legislation for disposal of used/discarded equipment.

An unorganised secondary market for trading used equipment and as yet low level of penetration for white goods would make it inappropriate to have dealers to take such old equipment when they sell a new one (Appendix 6.5 - Swiss Law for such a mechanism).

The high costs of recovery of CFCs from discarded equipment and/or destruction of CFCs no specific proposal is made on legislation on disposal of CFCs for Nigeria at this stage.

6.3.2 Financial Support Measures

It is clear that for success of any programme the financial incentives must be significant and these should predominate over command and control measures.

From the economic analysis pesented in Chapter - 5, it is clear that a number of financial incentives are needed to make the recovery and recycling enterprises viable.

These are :

* Making equipment available duty-free for the recovery and recycling ventures.
* Providing grants/subsidy for setting up ventures. 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.
* Increasing duties on CFCs which would in turn push up price of recycled CFCs
* meeting cost of plastic bags
* training & accreditation expenses
* meeting expenses for promotion and public awareness

6.3.3 Compliance with Requirements of Montreal Protocol

With recovery and recycling, as well as phase out of CFC based equipment, the total consumption of CFCs in Nigeria would remain within the Montreal Protocol limits upto the year 2009. By the year 2010, "drop-in" substitutes are expected to be commercially available world wide, and hence the recharging demand in Nigeria in the year 2010 onwards (less than 10 MT) would be easily met. The above costs would be best met by a fund created for the purpose. Such a fund could be launched by aid from a multilateral agency.

6.3.4 Measures for increasing public awareness

Given the dispersion of use of CFCs that is mainly in car airconditoners it would be appropriate to direct steps for public awareness mainly to car owners, garages, repair workshops and of course manufacturers. The awareness programme which could be through hand bills and visual display could highlight the economic benefits of recovery and recycling CFCs and the benefits available.

In addition, due publicity should be given to popularise training programme for certification & accreditation of repair agencies and making them aware of codes of practice which could also be for the measures proposed above. In our opinion, FEPA would be the appropriate body to coordinate the design & implementation of an integrated programme.

Institutional Framework

FEPA would have to constitute a set of bodies with involvement of other agencies for dealing with various aspects of the programme on a 'project' basis. Such projects would include

a) Evolving codes for better manufacturing and servicing practices
b) Training the mechanics in better manufacturing and service 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

Some of the key institutions/agencies which could be involved are indicated below :

- Ministries concerned with Industry, Trade and Federal Budget

- State Environment Agencies

- Refrigeration and Air-conditioning Dealers and Manufacturers Association (RADMA), under the aegis of Manufacturers Association of Nigeria (MAN).

- Local manufacturers of Cars : Peugeot and Volkswagen.

6.5 CONCLUSION

6.5.1 The present legislative and institutional framework in the country with respect to CFC use recovery and recycling is limited. The Country lack 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 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 Nigeria, the socio-economic climate suggests that legislation though necessary may not produce immediate results. With mobile airconditioning being the major sector and also it being a logistically 'easier' sector there is a strong case for promoting private enterprises to set up recovery ventures.

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 & Aircon-ditioning	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, on 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%	47.2%
	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

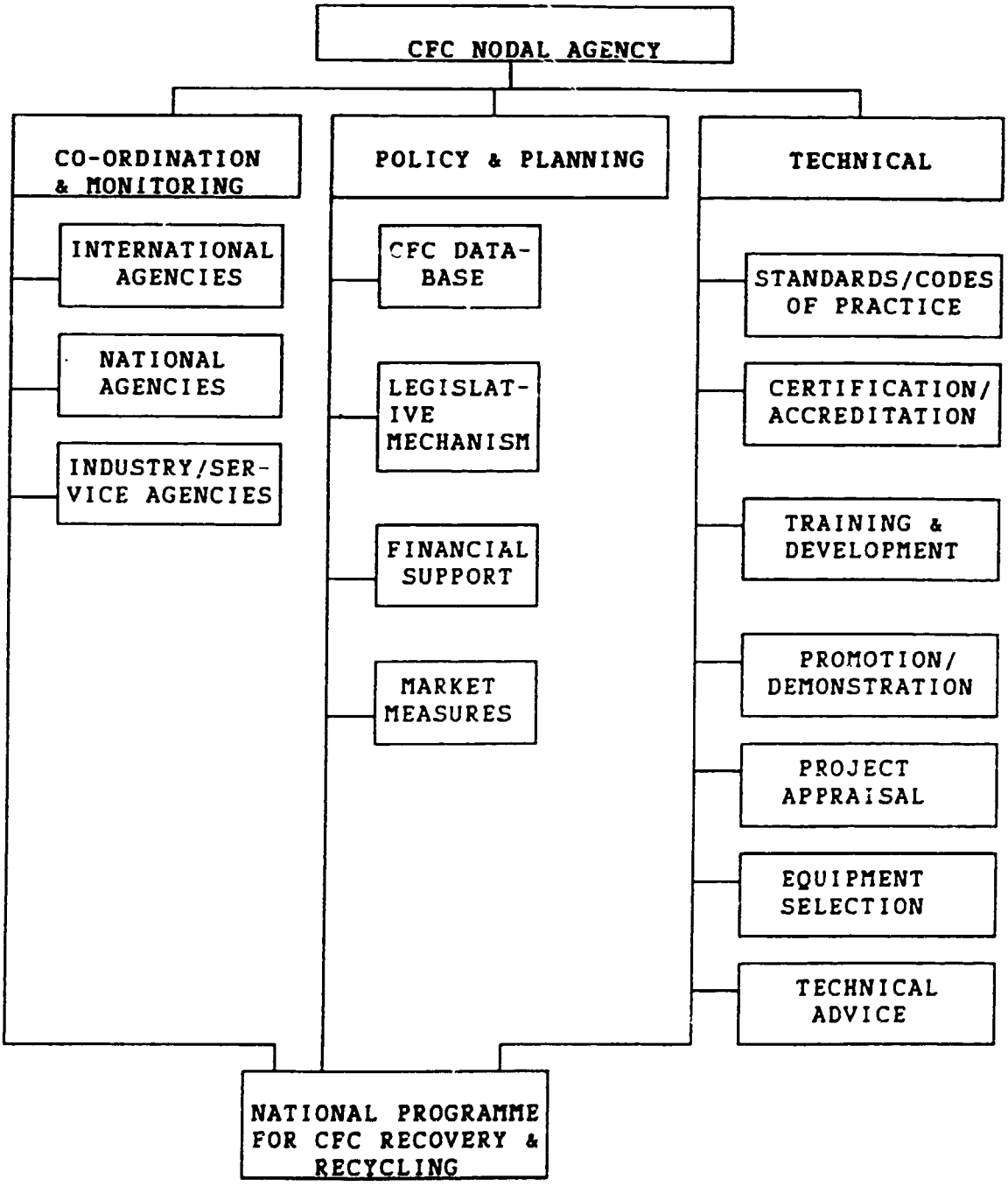
Intervention to raise prices of virgin CFCs, curbing of imports through limited quota allocation, setting up central recycling facilities, creation of public awareness etc.

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

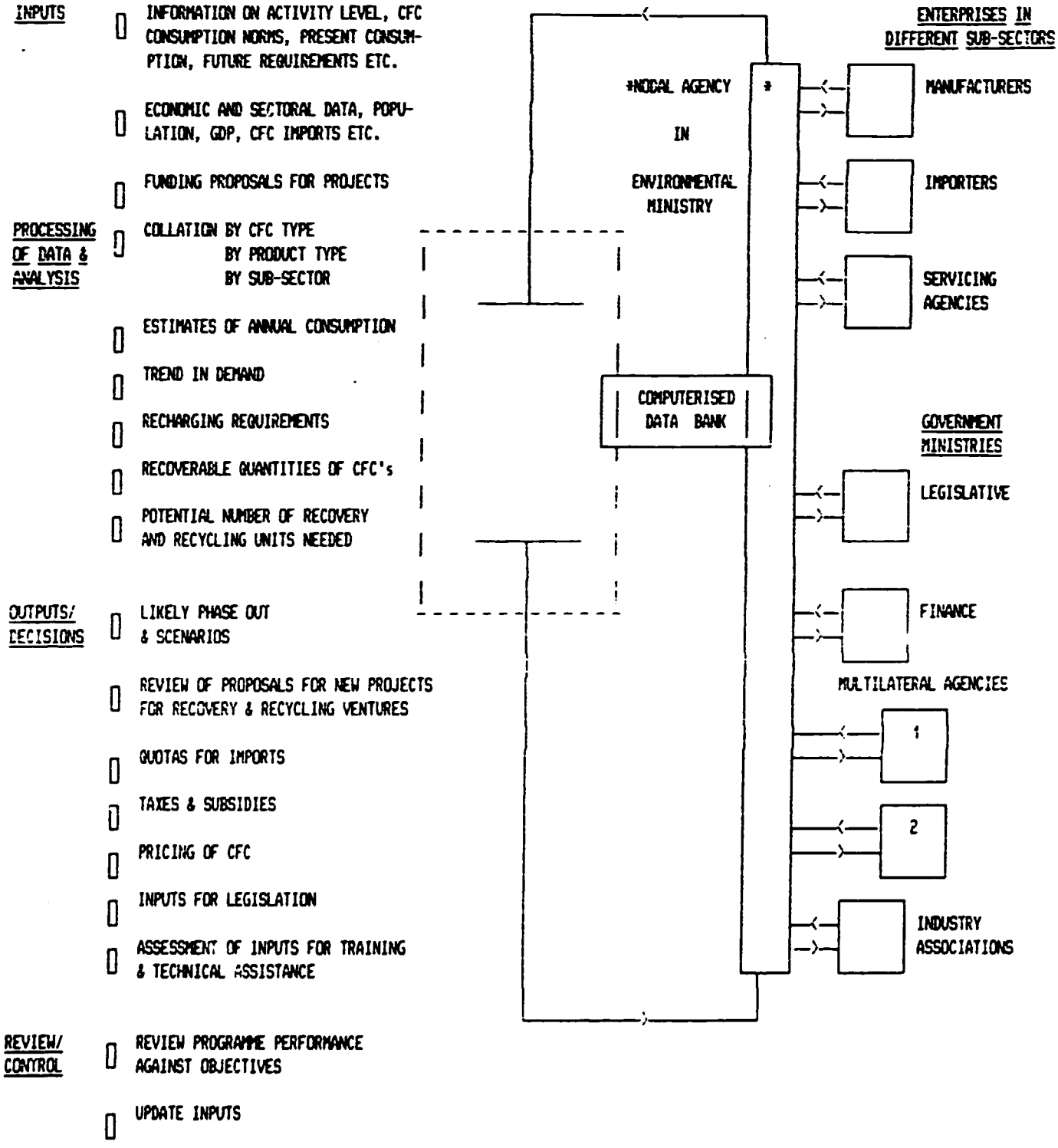
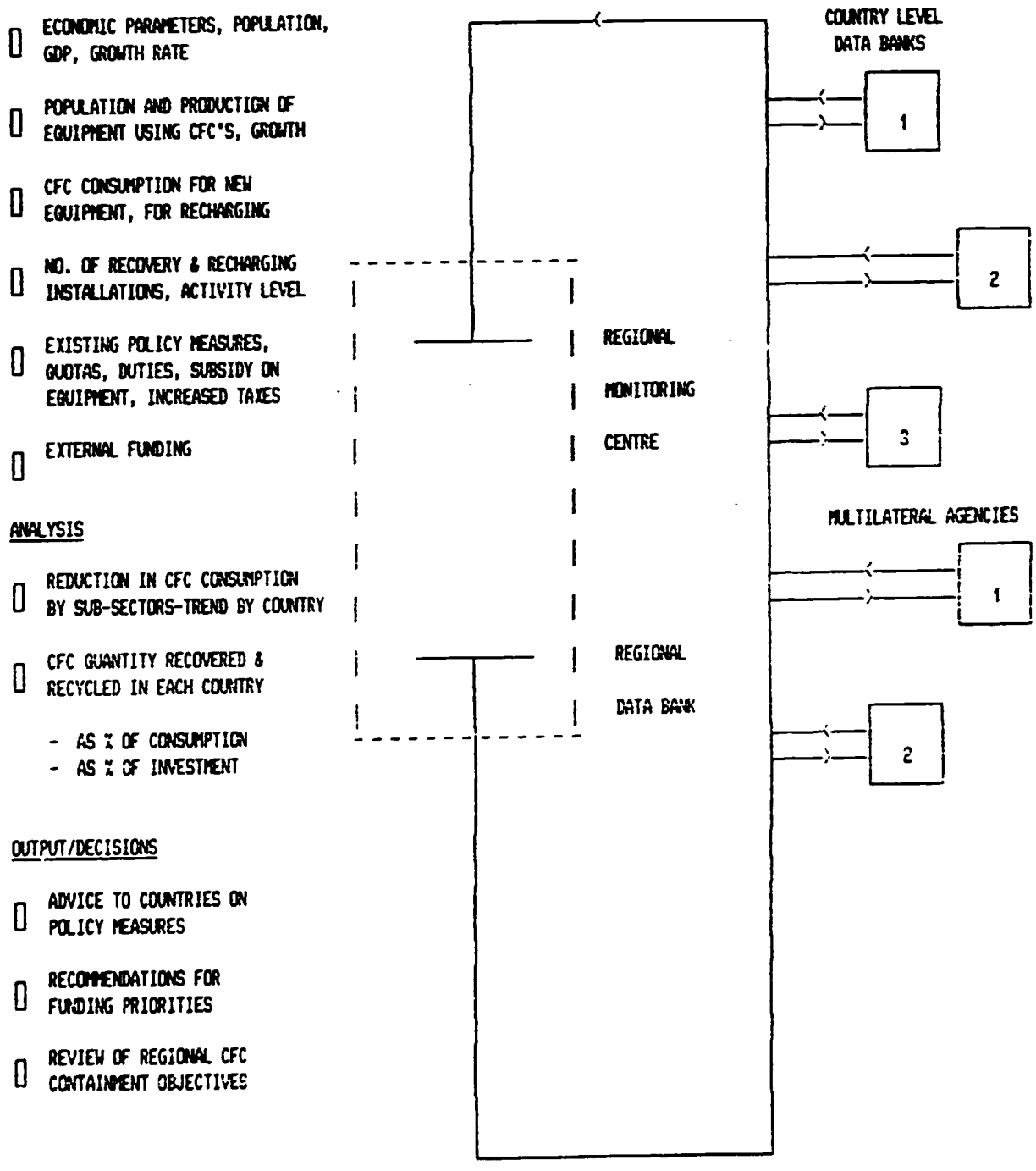


FIGURE - 7.3

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)

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

NIGERIA

SL. NO.	COMPANY	PERSONS
i.	CFC SUPPLY (IMPORTERS)	
01.	CAPL General Chemical Div. 24, Commercial Road P.M.B. 1004, APAPA Lagos, Nigeria. (Associate Company of ICI PLC)	Mr L A Larmie Business Manager (Industrial Chemicals) Mr Yinka Karunwi Marketing Manager
02.	OAE Nigeria Ltd 54 & 59 Ishaga Road Surulere P O Box 6002, Surulere Lagos. (Principals : Kali-Chemie Iberia, S.A, Spain)	Mr Kayode Akinsanya Chief Co-ordinator
03.	Ashmina Limited Great Nigeria House 8th Floor, 47-57, Martins Street Lagos. (Agent : ICI, UK; Ausimont, Europe)	Mr Deepak Roche Director
04.	Nulec Industries Ltd Hassan Transport Building 12, Ijora Causeway, Ijora, Lagos. Post Address : P.O. Box 664, Apapa, Nigeria. (Agent : Allied Signals, USA; Kalichemie, Spain)	Mr Pawan P. Singh Manager
05.	Nigeria Hoechst Plc 144, Oba Akram Avenue P.O. Box 261, Ikeja (Associate Company of Hoechst, Germmany)	Mr P M Palm Exec. Director (Industrial)

06.	OLYMPIC Enterprises (NIG.) Ltd 52, Balogun Street G.P.O. Box 2435 Lagos, Nigeria. General Importer	Mr Shyam A Hathiramani Director
07.	NEVAS Nigeria Ltd 3/4, Abebe Village Road Iganmu Iganm Surulere, Lagos. General Importer	Marketing Manager
08.	Ristian Technical (Co.)Ltd 168, Isolo Road Mushim, Lagos. General Importer	Managing Director

ii. SUPPLIERS OF CFCs (DEALERS)

09.	CAPL Regional Office Aba, Nigeria.	Mr O O Jaiyeola Regional Manager
10.	C C Umeh 19, Park Road Aba, Nigeria	Mr Patrick Ugoh Manager
11.	Hon-Well Technical & Construction Co. Ltd No. 30, Pound Road Box 3371, Aba Aba State, Nigeria	Mr NZE M.O. Ezenobi Chairman & Managing Director
12.	Gas Producers Ltd Jos, Nigeria	Mr U Uwen Ogodoh Area Manager

iii. SUPPLIERS OF POLYOLS (IMPORTERS)

13.	CAPL Apapa, Lagos. (Associate Company of ICI, UK.)	Business Manager (Polyols)
14.	IBAFON Chemicals (Nig) Ltd PLT 248,Muri Okunola St Victoria Island, Lagos (Agent : Dow Chemicals, USA)	Marketing Manager

iv. MANUFACTURERS OF DOMESTIC REFRIGERATORS & DEEP FREEZERS

15.	Thermocool Engineering Co. PLC Planning Office Way Ilupeju Industrial Estate P.M.B. 21132, Ikeja.	Mr R M Rayner Technical Manager
16.	DEBO Industries Limited Adebowale Group of Companies Plot 6, Block H Oshodi Ind. Scheme P M B 1214 Oshodi, Lagos.	Mr Kunle Adebowale Assistant General Manager Mr I E A Pardiwala Factory Manager Mr Macauley Service Manager
17.	Associated Electronic Products (Nig.) Ltd Km. 16, Ikorodu Rd., Ojota, P.O. Box 1921 Lagos, nigeria.	Mr Jide Sogbesan MDA Factory/Service Manager
18.	Nigeria Engineering Works 49, Trans Amadi Industrial Layout P.O. Box 519, Port Harcourt, Nigeria.	Mr S B Bhaiya Managing Director Mr Sharma Technical Manager (Appliances)
19.	Kaycee Refrigeration Industries 66, Trans Amadi Industrial Layout Port Harcourt, Nigeria.	Mr R Singh Factory Manager
20.	Nigerian Sewing Machine Manufacturing Co. Ltd (An Associate of SINGER) Singer Industrial Road, KM 40, Lagos-Abeokuta Express Road Sango Otta, Ogun State Nigeria.	Mr Onyendi A. Nwaguri Factory Engineer
21.	GACOL (Nig.) Ltd KM2, Otta Idiroko Road Sango Otta Ogun State, Nigeria	Chief Fagbeni Production Manager

22.	Cheltex Limited (A Div. of Chellarams) KM 40, Lagos- Abeokuta Express Road Sango Otta, Ogun State Nigeria.	Mr Adeleke Onebanjo Production Engineer

v. ASSEMBLERS OF COMMERCIAL REFRIGERATION EQUIPMENT

23.	Aluminium Manufacturing Company of Nigeria Ltd (ALUMACO) 32, Creek Road P.O. Box 60, Apapa Lagos.	DIPL.-ING AMOS OLU. ADU Product Manager Vehicles & Coldroom Deptt Mr B Tan Refrigeration Engineering Manager
24.	BEAM (A div. of UAC) Plot 6, Akinyemi Crescent Matori Industrial Scheme Matori, Mushin, Lagos	Engr Adebayo-Ise B.B. Cooling Service Manager
25.	Palmer Commercial Refrigeration Services Company Fasakin Food Compound Plot 1, Thomas Laniyan Street Anthony Village Ikorodu Road, Box 4756 Shomolu, Lagos.	Chief Parmer M.I. OTONO Chairman Managing Director

vi. ASSEMBLERS OF REFRIGERATED TRUCKS/VANS

26.	ALUMACO Isolo, Lagos.	Mr Ajala Refrigeration Engineers

vii. CENTRAL AIR CONDITIONING

27.	Mandilas Enterprises Ltd 35, Simpson Street Lagos (Representatives of Camier Corporation,USA)	Mr E U Olobrian Manager - Sales Mr A Lamidi Service Engineer
28.	United Technology Nigeria Ltd Surulere, Lagos.	Mr T. Tobun General Manager

29.	PEUGEOT Automobile Nigeria Ltd Kakuri Indl. Estate PMB 2266, KADUNA	Mrs O E Bello Head of Quality Lab. & Environmental Control Unit
	(Manufacturers of Peugeot Cars)	
30.	Leventis Motors Plc Creek Road, Apapa Lagos	Mr Omana Assistant Service Manager (Cars)
	(Dealers of Mercedes Benz)	
31.	Mandilas Motors Simpson Street Lagos	Mr Okerinde Service Manager
	(Dealers of Volkswagen)	
32.	SCOA Motors Plc Isolo, Lagos	Workshop Manager
	(Dealers of Peugeot & Toyota)	
33.	R T Briscoe (NIG) Ltd Plot 2, Block G Isolo Express Road Isolo, Lagos.	Mr Uguru Service Manager
34.	Cooland Technical (Nig) Ltd 304, Muhammed Way Yaba, Lagos.	Mr Wahid Kaslai Technical Manager
35.	E O Innoma & Co. 90 KiriKiri Road Olodi, Apapa, Lagos	Mr Innocent Okoligive Director
36.	Peerless Technology Ltd 103th Finbori Road Akoka, Lagos.	Mr Lanre Odewume, Project Engineer
37.	Ugo Technical 281 Igboukwer St. (D/Line), Port Harcourt	Mr Ugonna Madaka Technical Officer
38.	Nurigbare Sifous Tech. Refrigeration 2A, Rumneme/Ogbs St., Port Harcourt	Mr Anthony Nuigbara Director

APPENDIX - 1.2(Contd.)

39.	T N Overandir Refining Company 11 Ojoto St., Mile II, Diobu Port Harcourt	Mr T N Owuanda Director
40.	Asto Technical Co. 36, Aska Road Onitsha	Mr Francies Nwigbo Technician
41.	Super Co. 2 Iboker St., Onitsha	Mr Raphael Ofegeilo Director
42.	Pearl Ind. Engg. Services Ltd 162 Cameroon Road Aba	Mr Raphael Esonwanne, Director
43.	D H Efficient Tech. Co. 135 Cameroon Road Aba	Mr D C Nwoju Director
44.	Refrigeration Co. Ltd 21 Clinic Road Yaba, Lagos.	Mr Abraham Adeaiyz Technician
45.	Al-Aziz Technical Inv. Ltd 4, Ogunyemi Street Pedro Shomulu Lagos	Mr Azeez A.Shofela Managing Director
x.	CAR AIR CONDITIONERS	
46.	Sammmy Oguns & Co. 71, Itire Road P.O. Box 6902, Surulere, Lagos.	Mr S O Ogundipe Managing Director
47.	Havana Smulere, Lagos.	Mr Rufos Proprietor
48.	Simbo Tech. Surulare, Lagos	Mr Simbo Proprietor
49.	Bafos Surulare Lagos	Mr Adebayo Proprietor
50.	Adesoyole Technical Surulare, Lagos	Chief Adesoyole Proprietor

51.	Collstones Technical Co. Ltd 49/53, Queens St. Yaba, Lagos.	Mr Segun Obende Technical Manager
52.	Shamrock (Nig.) Ltd 84, bale St Olodi Apapa, Lagos.	Mr Anthony Paul Tech. Manager
53.	Paul-Ind. Engg. Services Ltd Aba	Mr Esonwanne Director
54.	UTC Nig. Plc P O Box 112 PH	Mr James Osirike Auto Electrician
55.	H.D.L Services & Supply Port Harcourt	Mr Raymond Okolie Technical Officer
56.	Christso & Sons Jos Bauchi Rd.	Mr Jacob M Bello Manager
xi.	COLD ROOM INSULATIONS	
57.	UAC Foods 230, Apapa Road Box 177, Ijora Lagos.	Mr Shim OnaBuk Service Supervisor
58.	Staple Foods Lagos.	Mr Augustus Adevale
59.	Tatasha Coldrooms Port Harcourt.	Mrs Tatasha
xii.	AEROSOL FILLERS	
60.	CYBELE Cosmetics Ltd 98/100, Ladipo St., Mushin P.O. Box 3604 Lagos, Nigeria.	Rida Hachem Production Manager
61.	Hagemeyer (Nig.) Ltd Plot 8, Oregun Village Road Alausa, Ikeja P O Box 179 Lagos.	Femi D Olukoya Production Manager (Cosmetic Factory)

62A.	A J Seward Billingsway, Oregun Industrial Estate P O Box 1063, Ikeja (A Div. of UAC of Nigeria Ltd)	Cliff I. Uhunmwahgho General Technical Manager
62B.	A J Seward Billingsway, Oregun Industrial Estate P O Box 1063, Ikeja (A Div. of UAC of Nigeria Ltd)	Dr Abdulrahman Audu Quality Assurance Manager
63.	S C Johnson Wax 13/14 Abimbola Street, Isolo Industria Estate P.M.B. 21279 Ikeja, Nigeria.	Mr Chukwuji Chizea Operations Manager
64.	PZ Industries Town Planning Way, Ilupeju, Lagos	Dr Alderson Technical Director
65.	Gongoni Company Ltd 89A, Sharada Ind. Estate Phase III, P O Box 6335 Bompai Kano, Nigeria.	Mr M A Ghosn Managing Director
66.	U J Bush & Co. (Nigeria) Ltd 168-169-170 Mission Road Bompai P O Box 350 Kano, Kano State Nigeria.	Dy Managing Director
67.	First Lady Ltd 17 Dantata Road P O Box 934 Kano, Nigeria.	Mr Alwan A Naif Managing Director

xiii. FOAM MANUFACTURERS

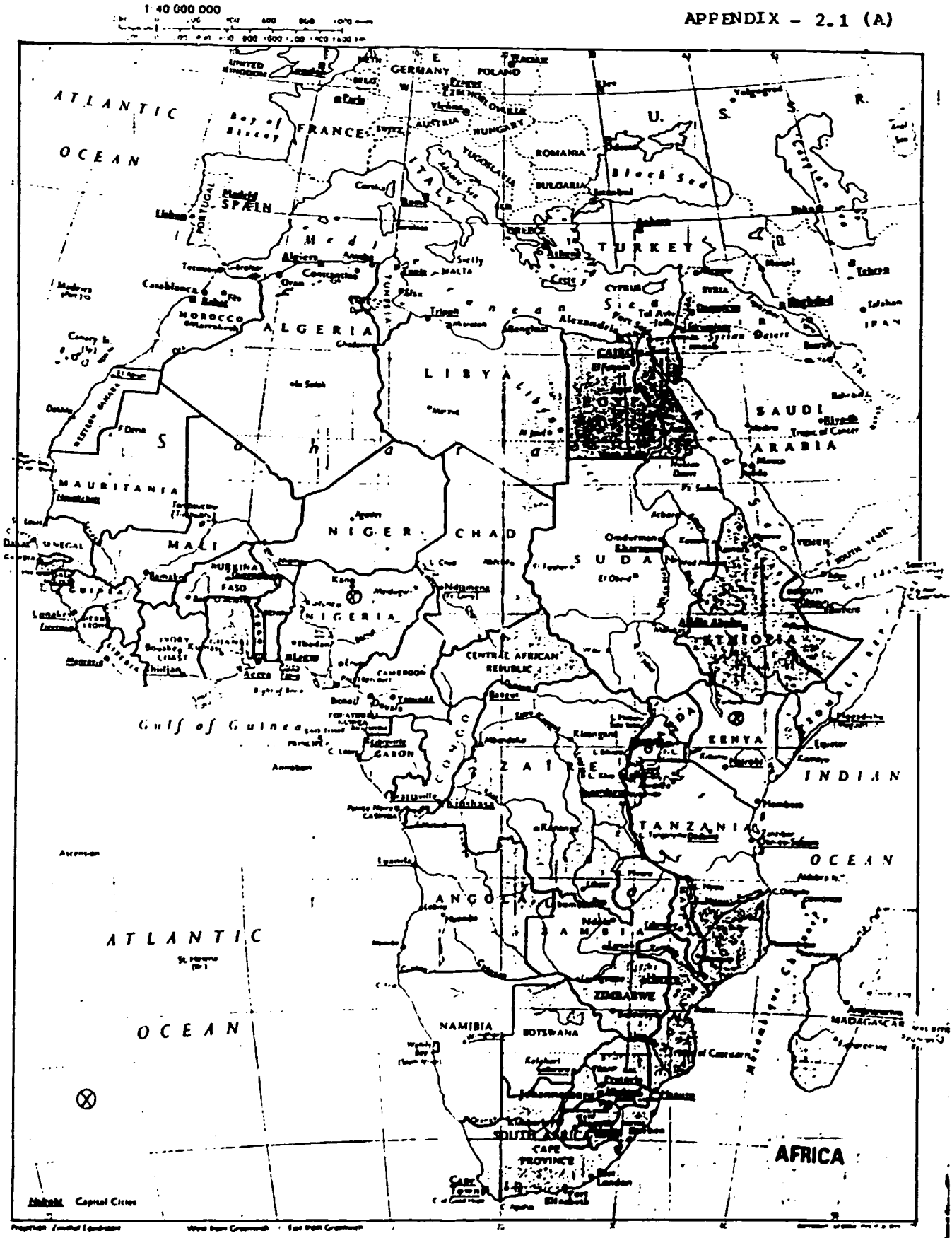
68.	Vitafoam Nigeria Plc Oba Akran Avenue Private Mail Bag 21092 Ikeja.	Mr Bolarinde Managing Director Mr I C Achonu Operations Director
69.	Moukarim Metalwood Factory Ltd Plot M, Awosika Avenue P.O. Box 160 Ikeja, Nigeria.	Mr Talal S Wehbe General Manager

70.	Eleganza Industries Ltd Plot 33, Secretariat Rd Oregun, Ikeja, Lagos.	Mr Tunde Akoya Production Director

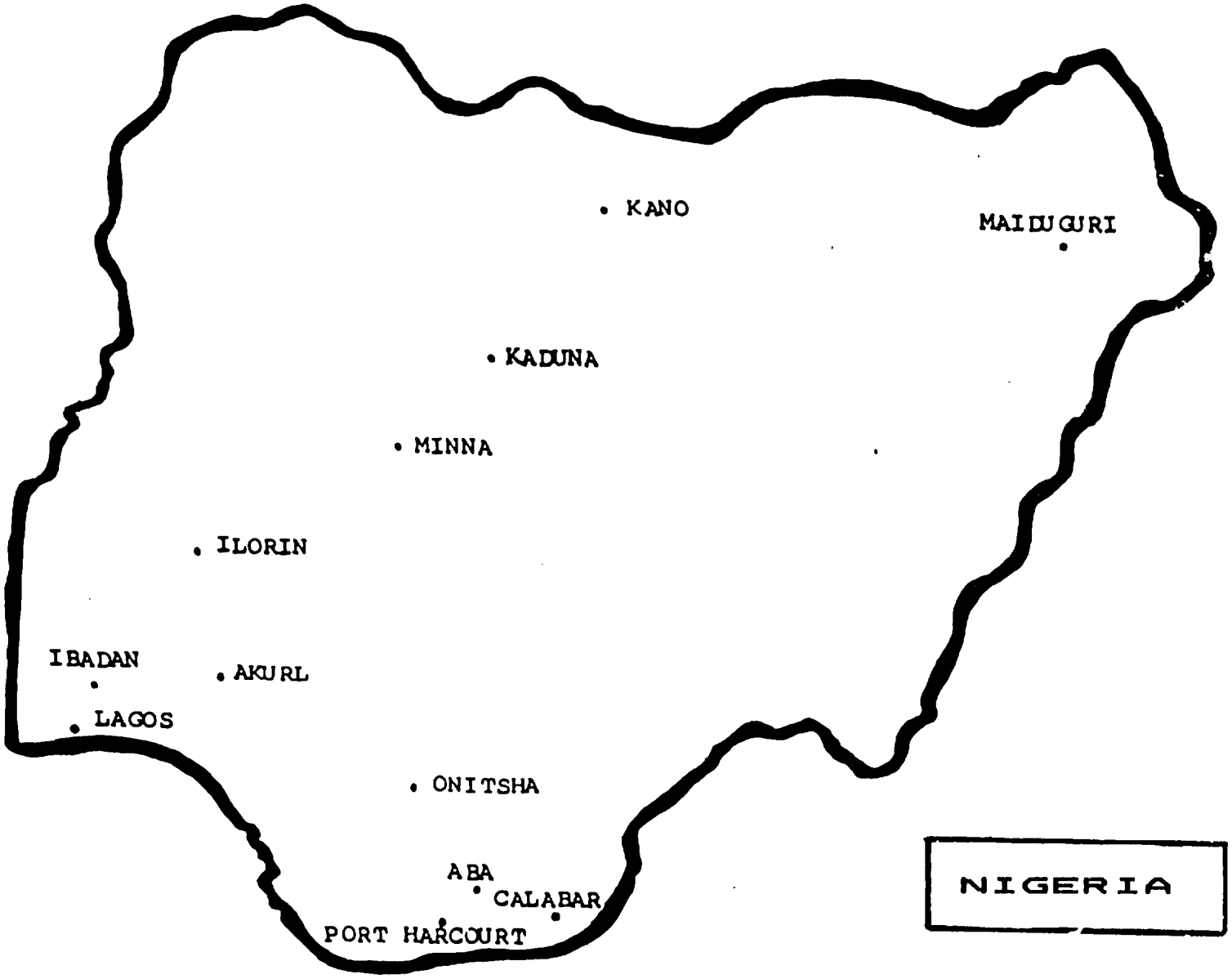
xiv. ASSOCIATIONS & GOVERNMENT AGENCIES

71.	Manufacturers' Association of Nigeria 37, Marina (Unity House) 4th Floor P.O. Box 3835 Lagos.	Mr Uzor E. Okeke Ddirector (Econ.)
72.	Association of Foam Producers C/o Vita Foam, Lagos	Mr Bolarinde Chairman
73.	Domestic Insecticides and Aerosol Manufacturers Group C/o Chemicals Manager 38/39 Marina M B 2052 Lagos.	Mr C E Chizea Head of Group Secretariat
74.	Federal Environment Protection Agency Federal Secretariat Phase II, 1st Floor, Ikoyi, P M B 12620 Lagos, Nigeria.	Dr E.O.A. Aina Director/Chief Executive Ms Anne Ene-Ita Dy General Manager Planning & Evaluation Department
75.	Federal Environment Protection Agency Federal Secretariat Phase II, 1st Floor, Ikoyi, P M B 12620 Lagos, Nigeria.	Mr Maiwada M Omar Asst General Manager Planning & Evaluation Department
76.	United Nations Development Programme 11, Oyinkan Abayomi Drive, Ikoyi, Lagos Nigeria.	Mr Fela Deh Environment Desk
77.	Federal Office of Statistics 36/38, Board Street Lagos.	Statistics Desk

APPENDIX - 2.1 (A)



APPENDIX - 2.1 (B)



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	CFC - 12	0.17	30	0.22	115000	25.3
AND DEEP FREEZERS	CFC - 11	0.60	20	0.72	84000 *	60.5
COMMERCIAL AND INDUSTRIAL REFRIGERATION						
COLD STORES 6.5 - 36 TR **	CFC - 12	6	20	7.2	9	0.06
	CFC - 11	450	20	540	9	4.9
COLD STORES 50-100 TR **	CFC - 12	18	20	21.6	3	0.06
	CFC - 11	450	20	540	3	1.6
REFRIGERATED TRUCKS1.5 HP	CFC - 12	3	20	3.6	3	0.01
	CFC - 11	-	-	-	-	-
REFRIGERATED TRUCKS 4-15 HP	CFC - 12	7	20	8.4	7	0.06
	CFC - 11	-	-	-	-	-
SUB TOTAL	CFC - 12					0.2
	CFC - 11					6.5
COMMERCIAL AIRCONDITIONING	CFC - 12	1248-1664	-	-	-	-
(CENTRIFUGAL CHILLERS)***	CFC - 11	443-590	-	-	-	-
MOBILE AIRCONDITIONING	CFC - 12	1.35	20	1.62	25000	40.5
(CARS)	CFC - 11	-				

* Equivalent to production only (excluding import of pre foamed cabinets)

** Weighted average norm for cold stores from above for cfc-12 is 6.8 Kg/unit

*** No new production of centrifugal chillers

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 PER UNIT (Kgs)	COMPRESSOR FAILURE: TOTAL QTY (MT)	LEAKAGE *: NO OF CASES (NOS)	LEAKAGE *: % OF POPULATION	LEAKAGE *: QTY PER UNIT (Kgs)	LEAKAGE *: TOTAL QTY (MT)	TOPPING UP: % OF POPULATION	TOPPING UP: NO OF CASES (NOS)	TOPPING UP: QTY PER UNIT (Kgs)	TOPPING UP: TOTAL QTY (MT)	TOTAL (MT)
DOMESTIC REFRIGERATION AND DEEP FREEZERS	1646000	CFC-12	100000	6	0.30	30.0	75000	4.5	0.30	22.5	0	0	0	0	52.5
	-	CFC-11	-												
COMMERCIAL AND INDUSTRIAL REFRIGERATION	1400	CFC-12	120	9	8.5	1.1	75	5	12.8	1.0	100	1400	0.85	1.2	3.3
	-	CFC-11	-	-	-										
COMMERCIAL AIRCONDITIONING (CENTRIFUGAL CHILLERS)	13	CFC-12	0	0	0	0	0	0	0	0	100	12	660 **	7.3	7.3
	17	CFC-11	0	0	0	0	0	0	0	0	100	18	260	4.7	4.7
MOBILE AIRCONDITIONING (CARS)	728000	CFC-12	7300	1	2.0	14.6	109200	15	2.0	218.4	100	728,0	0.15	109.2	342.2
	-	CFC-11	-	-	-										

* Quantity of refrigerant per unit for recharging includes the requirement for flushing & leak detection (where ever applicable) as also a factor for wastage

** On the basis that topping up is done tri-annualy to the extent of 20% of original charge each time; rest of the refgrigerant is recoverable through inbuilt system.

C. SUMMARY

SUB-SECTOR	TYPE OF CFC	NEW DEMAND (MT)	RECHARGING DEMAND (MT)	TOTAL DEMAND (MT)
DOMESTIC REFRIGERATION AND DEEP FREEZERS	CFC - 12	25.3	52.5	77.8
	CFC - 11	60.5	-	60.5
		-	-	-
COMMERCIAL AND INDUSTRIAL REFRIGERATION	CFC - 12	0.2	3.3	3.5
	CFC - 11	6.5	-	6.5
		-	-	-
COMMERCIAL AIRCONDITIONING (CENTRIFUGAL CHILLERS)	CFC - 12	Neg	7.3	7.3
	CFC - 11	Neg	4.7	4.7
		-	-	-
MOBILE AIRCONDITIONING (CARS)	CFC - 12	40.5	342.2	382.7
	CFC - 11	-	-	-

APPENDIX - 2.3

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

1. NAME & ADDRESS :
ASSOCIATED ELECTRONIC PRODUCTS (NIG.) LTD, KM. 16, IKORODU ROAD, OJOTA, P.O. BOX 1921, LAGOS, NIGERIA

TYPE OF ENTERPRISE :
Assembler of Refrigerators and Deep Freezers and other Household and Electrical Products.

CONTACT PERSON :
Mr Jide Sogbesan, MDA Factory/Service Manager

ACTIVITY :
Refrigerators and Deep Freezers : Assembly of refrigerators and deep freezers forms a small part of the activity of this organisation. Total installed capacity and production in 1991 was 40,000 and 4,000 nos respectively. The company is a subsidiary of PHILIPS (now WHIRLPOOL). The company has 4 service centres outside Lagos.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Refrigerators and Deep Freezers	0.8	0.2	New	4	1.0
			Recharging	-	1.0*

* estimate

GENERAL :
The company has a technology arrangement with WHIRLPOOL and would, therefore, shift to refrigerators based on substitutes as per directions of WHIRLPOOL.

2. NAME & ADDRESS :
ALUMINIUM MANUFACTURING COMPANY OF NIGERIA PLC (ALUMACO)
32, CREEK ROAD, P.O. BOX 60, APAPA, LAGOS

TYPE OF ENTERPRISE :
Manufacturer of Aluminium Products including Cold Rooms and Refrigerated Vehicles (Trucks/Vans/Trailers).

CONTACT PERSONS :
DIPL.-ING AMOS OLU.ADU, Production Manager, Vehicles & Coldroom Dept
Mr B Tan, Refrigeration Engineering Manager

ACTIVITY :
Cold Rooms & Refrigerated Vehicles : This company is the largest installer/ fabricator of these equipment in Nigeria. The compressors and other parts of the refrigeration equipment are imported while the body of the cold room is fabricated indigenously. The company started operations in 1975 and till date the company has over 120 installations of cold rooms and nearly 385 installations of refrigerated vehicles respectively. The company has its fabrication shop and service facility near Lagos. It has two sales outlets outside Lagos in Kaduna and Enugu. Current sales volume are at a very low level due to depressed demand : 6 cold rooms and 11 refrigerated vehicles in 1991.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Commercial and Industrial Refrigeration (Cold stores and refrigerated vehicles)	333	6-18	New	2.5	0.1
			Recharging	-	2.0

GENERAL :
The company has a staff strength of 18 personnel in fabrication, sales and service of refrigeration equipment.

3. NAME & ADDRESS :
BEAM (A Division of UAC), PLOT 6, AKINYEMI CRESCENT, MATORI INDUSTRIAL SCHEME, MATORI, MUSHIN, LAGOS

TYPE OF ENTERPRISE :
Importer and Assembler of Commercial Refrigeration and Air-conditioning Equipment.

CONTACT PERSON :
Engr Adebayo-Ise B.B., Cooling Service Manager

ACTIVITY :
Cold Stores : The company started installation of cold rooms in 1970 based on imported PRESTCOLD refrigeration units. Bulk of the installations were carried out during the period 1970-75. The company discontinued sales of cold rooms after 1982 due to depressed demand. The company has carried out nearly 200 installations during 1970-82. The company specialised in small cold rooms of upto 10 TR capacity. The company has no sales and service network outside Lagos.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm (Kgs)		Utilisation (Kgs) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Commercial Refrigeration (Cold Rooms)	N.A	3-6	New	Nil	Nil
			Recharging	-	0.8*

* for units under service agreement

GENERAL :
The company has a total technical staff strength of over 200 personnel for all its activities which are presently concentrated mainly in commercial air-conditioning.

4. NAME & ADDRESS :
DEBO INDUSTRIES LTD, PLOT C, BLOCK H OSHODI IND. SCHEME, PMB 1214, OSHODI, LAGOS.

TYPE OF ENTERPRISE :
Manufacturer of Refrigerator, Deep Freezers, Domestic and Multi-Split Airconditioners.

CONTACT PERSONS :
Mr A Adebowale, Deputy General Manager
Mr I.E.A. Pardewala, Factotory Manager

ACTIVITY :
Refrigerators & Deep Freezers : The company is the second largest manufacturer of these equipment in Nigeria. Total installed capacity and production in 1991 was 85,000 nos and 17,000 nos respectively. Market share in 1991 was 20%. The company has a technology tie-up with Industrie Zanussi of Italy. The company has a nationwide sales and service network.

Domestic Air Conditioners & Multi Split ACs. : The company produced approximately 10,000 domestic ACs and 800 multi split ACs in 1991.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Domestic Refrigeration & Deep Freezers	0.66	0.15	New	12.4	2.7
			Recharging	-	3.0*

* estimate

GENERAL :
The manpower of the company comprises of 20 Managers and 241 other employees (including supervisors and workers). The company is a part of Adebowale Group of Companies in Nigeria. The company is planning to set up a new component manufacturing facility.

5. NAME & ADDRESS :
GENERAL APPLIANCES COMPANY LTD (GALCO), KM2, OTTA IDIROKO ROAD, SANGO OTTA OGUN STATE, NIGERIA

TYPE OF ENTERPRISE :
Assemblers of Electrical Domestic Appliances

CONTACT PERSON :
Chief Fagbeni, Production Manager

ACTIVITY :
Refrigerators & Deep Freezers : The company is a small assembler. The 1991 production volume was 2000 nos.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Refrigerators and Deep Freezers	0.5	0.12	New	1.2	0.3
			Recharging	-	Neg

GENERAL :
The company has been in operation for ten years. Production volumes have declined since 1988. The company has a total staff strength of 250.

6. NAME & ADDRESS :
KAYCEE REFRIGERATION INDUSTRIES, 66,TRANS AMADI INDUSTRIAL LAYOUT, PORT HARCOURT, NIGERIA

TYPE OF ENTERPRISE :
Assemblers of Domestic Refrigerators and Deep Freezers

CONTACT PERSON :
Mr R Singh, Factory Manager

ACTIVITY :
Domestic Refrigerators and Deep Freezers : The company is a small assembler with a total production volume of 3000 units in 1991. It has a technical tie-up with Merloni Projecha of Italy. The company has a service wprlshop only in Port Harcourt.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm		Utilisation (MT)		
	CFC-11	CFC-12		CFC-11	CFC-12
- Refrigerators & Deep Freezers	0.4	0.1	New	1.5	0.4
			Recharging	-	0.1*

* estimate

GENERAL :
The company is relatively new (4-5 years old) with a limited distribution network covering only 4 major cities in South & East of the country.

7. NAME & ADDRESS :
MANDILAS ENTERPRISES LTD, 35, SIMPSON STREET, LAGOS
(Representatives of CARRIER CORPORATION, USA)

TYPE OF ENTERPRISE :
Import and Installation of Commercial Airconditioning Chillers

CONTACT PERSONS :
Mr E U Olobrian, Manager - Sales
Mr A Lamidi, Service Engineer

ACTIVITY :
Refrigerators & Deep Freezers : The company is a representative of CARRIER CORPORATION (USA) in Nigeria for their airconditioning chillers. The installation of chillers was started by the company since 1955. Installation of Centrifugal Chillers was mainly during the period 1960-1980. There have been no installations okf Centrifugal chillers after 1980. The company carried out installation of 25 such chillers during this period. Since 1980, the company is only installing reciprocating chillers. The company does not have a sales and service network outside Lagos for this activity.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm (Kgs)		Utilisation (Kgs) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Centrifugal Chillers	400-600	1200-1700	New	-	-
			Recharging	6	8

GENERAL :
The company does not expect any new installation of centrifugal chillers in the future. Since this trend is towards reprocessing chillers based on HCFC-22. The company has a sales & service staff of 100 personnel.

8. NAME & ADDRESS :
NIGERIAN SEWING MACHINE MANUFACTURING CO. LTD,
(An Associate of SINGER), SINGER INDUSTRIAL ROAD, KM 40,
LAGOS-ABEOKUTA EXPRESSD ROAD, SANGO OTTA, OGUN STATE, NIGERIA

TYPE OF ENTERPRISE :
Manufacturer of Domestic Appliances/Refrigerators, Airconditioners, etc.

CONTACT PERSONS :
Mr Onyendi A. Nwaguri, Factory Engineer

ACTIVITY :
Refrigerators & Deep Freezers : The company has discontinued assembly of refrigerators since 1989. It has an installed capacity of 60,000 nos and its production in 1988 was 30,000 nos. Majority of the refrigerators manufactured by it were 180 ltrs units with a unit consumption norm of CFC-12 of 90 gms.

CFC UTILISATION :
No consumption of CFCs in '91 as operations were at a standstill.

GENERAL :
The company is an affiliate of Singer Sewing Machine Company. It plans to restart assembly of refrigerators as and when there is a revival in deamnd. Most of its existing refrigerators are serviced by private agencies.

9. NAME & ADDRESS :
PEUGEOT AUTOMOBILE NIGERIA LTD, KAKURI INDUSTRIAL ESTATE,
PMB 2266, KADUNA

TYPE OF ENTERPRISE :
Assembly of Peugeot Cars

CONTACT PERSONS :
Mrs O E Bello, Head of Quality Lab. & Environmental Control Unit

ACTIVITY :
Refrigerators & Deep Freezers : The company is engaged in the assembly of 504 (saloon), 505 (saloon) and 504 (SW) Peugeot Nodels in Nigeria. Its production in 1991 was 12,714 nos of which 83% were AC Cars. The company has twenty accredited distributors in the country with complete service facilities. The company is an associate of AUTOMOBILE PEUGEOT of FRANCE.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm (Kgs)		Utilisation (Kgs) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Refrigerators and Deep Freezers	-	1	New	-	1.2
			Recharging	-	- *

* servicing done by distributors only

GENERAL :
The company plans to switch over to substitute refrigerant based Car ACs as soon as the advice for the same is provided by its principal in France.

10. NAME & ADDRESS :
THERMOCOOL ENGINEERING CO. PLC, PLANNING OFFICE UAY, ILUPEJU INDUSTRIAL ESTATE P.M.B 21132, IKEJA, LAGOS

TYPE OF ENTERPRISE :
Manufacturers of Refrigerators, Deep Freezers and Domestic Air-conditioners

CONTACT PERSON :
Mr R M Raja, Technical Manager

ACTIVITY :
Refrigerators & Deep Freezers : The largest manufacturer of refrigerators and deep freezers in Nigeria. Total installed capacity and production of these equipment in 1991 was 2,50,000 nos and 32,000 nos respectively representing approximately 42% and 38% of total industry capacity and production respectively. The company has a nationwide sales and service network covering 18 cities/towns. Paterson Zochonis PLC of UK has a 60% shareholding in the company.

Domestic Airconditioners : The company is one of the major manufacturers of domestic airconditioners. Its production of domestic airconditioners was 6000 nos in 1991.

CFC UTILISATION:

Sub-sector	Unit Consumption Norm (Kg)		Utilisation (MT) 1991		
	CFC-11	CFC-12		CFC-11	CFC-12
- Domestic Refrigeration & Deep Freezers	0.57	0.17	New	20	7.0
			Recharging	-	8.0*

* estimate since firm figures were not available

GENERAL :
The manpower available with the company compreses of 37 Managers and 70 Sales & Service Personnel.

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 :

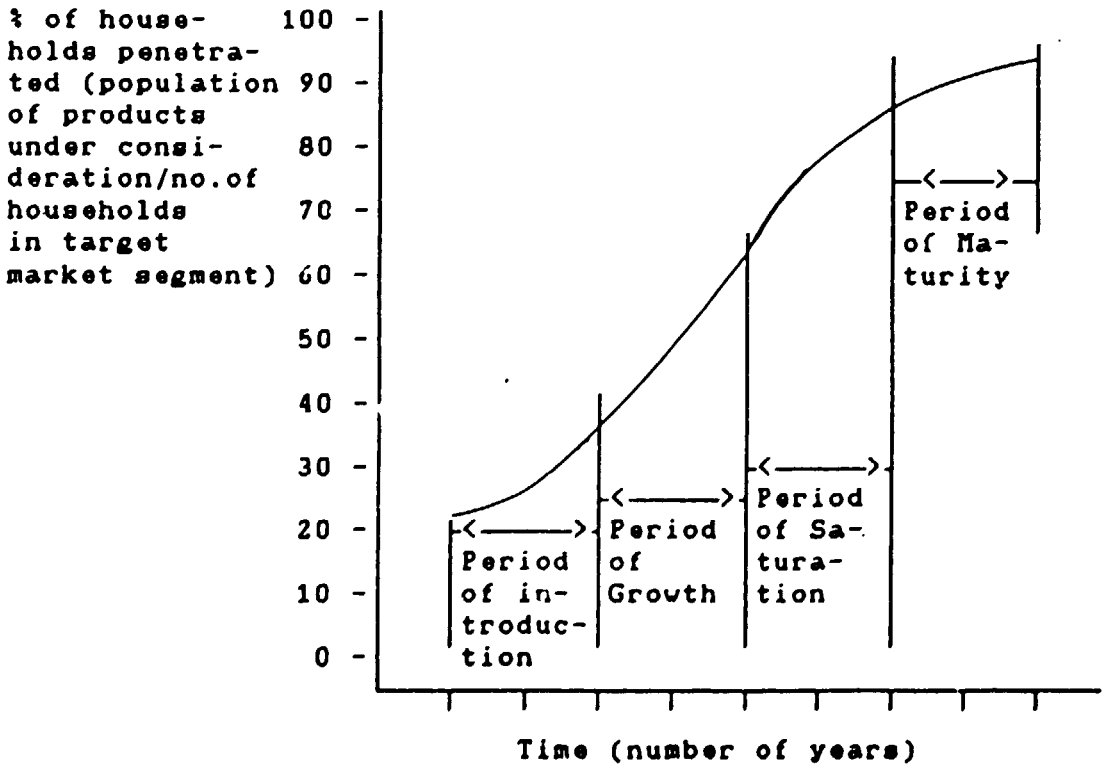
- Consumer Products : Those controlled by consumer driven markets. In case of products under the study, these would be include a domestic refrigerators & deep freezers and car-airconditioners.

- 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.

- Forecast of demand arrived at from judgement of manufacturers and industry experts was then used to compute population of the products under consideration based on their life expectancy. The product population estimates were used to generate alternative penetration curves. The curve which had a reasonable continuity with past trends, as well as was in line with general expectation of experts, was selected to make the final forecast on projected demand. The representative curve for Nigeria is enclosed as Appendix 2.4 (A). This curve shows deviations from the 'S' curve model due to the fact that normative estimates of growth have been taken. This curve is used only as a counter-check.

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.

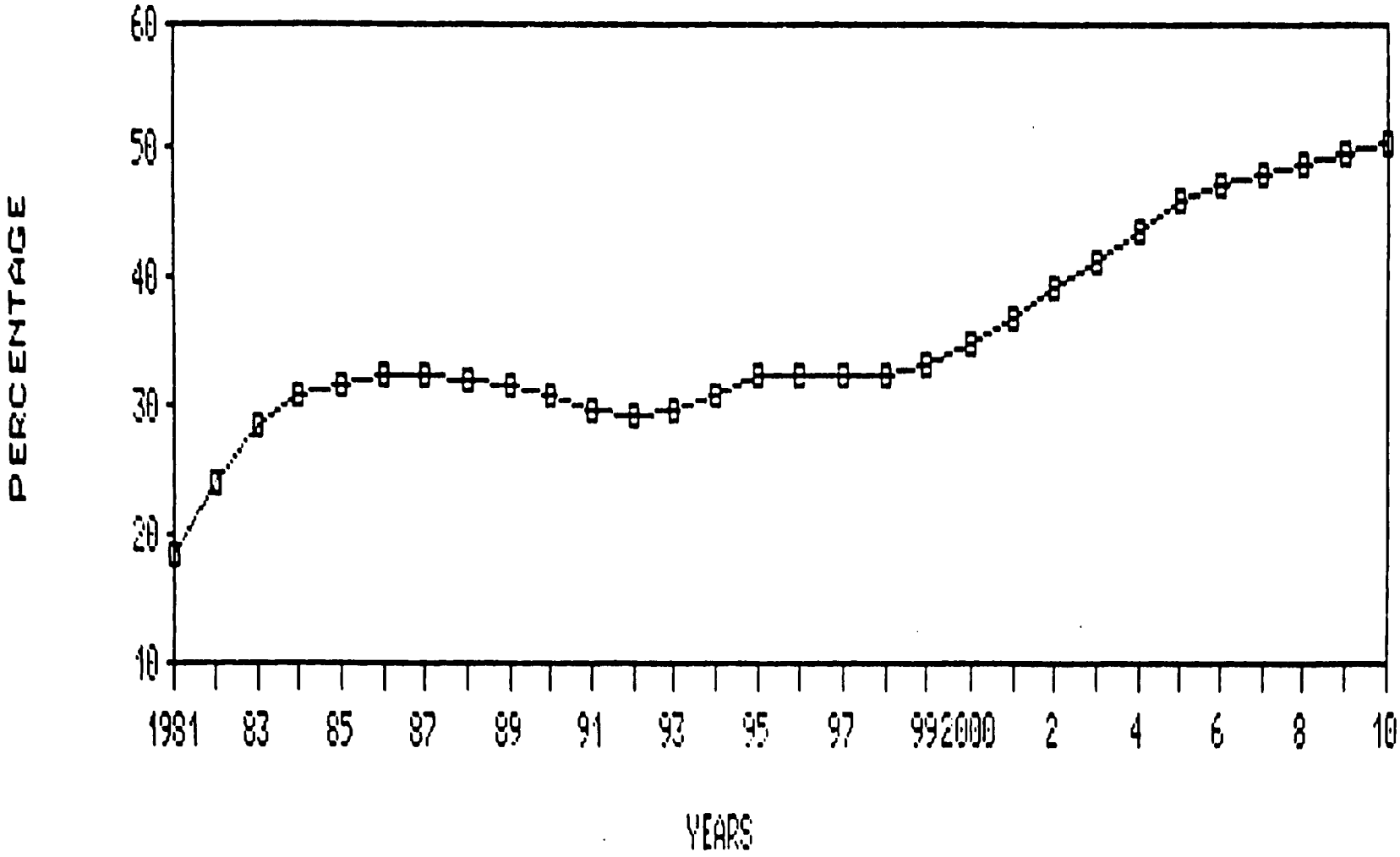
8. Similarly, the ratio of recharging CFC demand to equipment population (CFC based) in 1991 has been used for computation of recharging CFC demand in future years.

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.

PENETRATION OF REFRIGERATORS
URBAN HOUSEHOLD NIGERIA



APPENDIX - 2.5

PROJECTED DEMAND OF CFCs IN AIRCONDITIONING & REFRIGERATION SECTOR IN NIGERIA

		1991	1993	1995	1996	1997	1999	2005	2007	2010
A. DOMESTIC REFRIGERATORS AND DEEP FREEZERS										
1. Total demand ('000)	High	115	139	168	185	204	247	380	435	533
	Low	115	127	140	147	154	170	228	251	291
2. Growth rate of demand (%)*	High		10	10	10	10	10	7	7	7
	Low		5	5	5	5	5	5	5	5
3. Population of Equipment ('000)	High	1646	1649	1805	1858	1894	2034	3267	3603	4061
	Low	1646	1631	1739	1753	1739	1741	2271	2337	2397
4. Phase-out of CFC-12 equipment (%)		0	0	20	60	100	100	100	100	100
5. Number of CFC-12 equipment('000)	High	115	139	135	74	0	0	0	0	0
	Low	115	127	112	59	0	0	0	0	0
6. Population of CFC-12 equipment ('000)	High	1646	1649	1772	1713	1545	1215	542	351	52
	Low	1646	1631	1711	1637	1469	1139	484	301	41
7. No.of aged equipment ('000) @	High	294	247	103	100	95	110	135	0	0
	Low	294	247	103	100	95	110	112	0	0
8. Reconditioned eqpt. (added back) % ß		35	60	70	70	70	70	70	70	70
9. Reconditioned equipment ('000)	High	103	148	72	70	67	77	94	0	0
	Low	103	148	72	70	67	77	78	0	0
10. Scrap %		65	40	30	30	30	30	30	30	30
11. Number scrapped ('000)	High	194	117	85	133	168	149	117	89	94
	Low	194	117	85	133	168	149	111	85	78
12. Demand for CFC-12 (MT)										
- New Demand	High	25.3	30.6	29.6	16.3	0.0	0.0	0.0	0.0	0.0
	Low	25.3	27.9	24.6	12.9	0.0	0.0	0.0	0.0	0.0
- Recharging Demand	High	52.5	52.6	56.5	54.6	49.3	38.7	17.3	11.2	1.7
	Low	52.5	52.0	54.6	52.2	46.8	36.3	15.4	9.6	1.3
- Total Demand	High	77.8	83.2	86.1	70.9	49.3	38.7	17.3	11.2	1.7
	Low	77.8	79.9	79.2	65.1	46.8	36.3	15.4	9.6	1.3
13. Demand for CFC-11 (MT)										
- New Demand	High	60.5	73.2	70.9	39.0	0.0	0.0	0.0	0.0	0.0
	Low	60.5	66.7	58.8	30.9	0.0	0.0	0.0	0.0	0.0
- Recharging Demand	High	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Low	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Total Demand	High	60.5	73.2	70.9	39.0	0.0	0.0	0.0	0.0	0.0
	Low	60.5	66.7	58.8	30.9	0.0	0.0	0.0	0.0	0.0
14. Total CFC Demand (MT)	High	138.3	156.4	157.0	109.9	49.3	38.7	17.3	11.2	1.7
	Low	138.3	146.6	138.0	96.0	46.8	36.3	15.4	9.6	1.3
15. Recoverable Quantity (MT) + (CFC-12)	High	35.0	35.0	37.7	36.4	32.9	25.8	11.5	7.5	1.1
	Low	35.0	34.7	36.4	34.8	31.2	24.2	10.3	6.4	0.9
16. CFC-12 recoverable from ¤ scrapped refrigerators (MT)	High	5.0	4.5	2.7	3.4	4.0	3.8	3.6	1.5	1.6
	Low	5.0	4.5	2.7	3.4	4.0	3.8	3.2	1.4	1.3
17. Total CFC-12 recoverable (MT)	High	40.0	39.6	40.3	39.9	36.8	29.7	15.1	9.0	2.7
	Low	40.0	39.2	39.0	38.2	35.2	28.1	13.5	7.8	2.2

Notes :

* Taken on the basis of industry estimates

@ Number of equipment at the end of their initial life ; Initial life of equipment taken as 10 years

ß Proportion of reconditioned equipment added back to population, life of reconditioned equipment taken as 5 years.

+ As per Table 4.3 for 1991 and proportionate to recharging for future years.

¤ Recovery from scrapped equipment @ 10% of total initial charge contained in scrapped equipment plus reconditioned equipment.

	1991	1993	1995	1996	1997	1999	2005	2007	2010
B. COMMERCIAL AND INDUSTRIAL REFRIGERATION									
1. Total demand (Nos) *	23	28	34	37	41	47	63	70	80
2. Growth Rate (%)									
3. Population for equipment	1400	1453	1517	1504	1495	1487	1523	1559	1639
4. Phase-out of CFC-12 based equip.(%)	0	0	20	60	100	100	100	100	100
5. Number of CFC-12 equipment (Nos)	23	28	27	15	0	0	0	0	0
6. Population of CFC-12 equipment	1400	1453	1511	1475	1425	1325	1025	925	775
7. Number of CFC-12 equipment scrapped @				50	50	50	50	50	50
8. Demand for CFC-12 (MT)									
- New Demand	0.2	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0
- Recharging Demand	3.3	3.4	3.6	3.5	3.4	3.1	2.4	2.2	1.8
- Total Demand	3.5	3.7	3.8	3.6	3.4	3.1	2.4	2.2	1.8
9. Demand for CFC-11 (MT)									
- New Demand	6.5	7.9	7.6	4.2	0.0	0.0	0.0	0.0	0.0
- Recharging Demand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Total Demand	6.5	7.9	7.6	4.2	0.0	0.0	0.0	0.0	0.0
10. Total CFC Demand (MT)	10.0	11.5	11.4	7.8	3.4	3.1	2.4	2.2	1.8
11. Recoverable Quantity (MT) # (CFC-12)									
- From Recharging	1.5	1.6	1.6	1.6	1.5	1.4	1.1	1.0	0.8
- From Scrapped Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Total Recoverable	1.5	1.6	1.6	1.6	1.6	1.5	1.1	1.0	0.9

* Growth rate of demand for equipment taken as 10% for 1991-1998 and 5% for 1999-2010 on the basis of industry estimates;
@ Units scrapped at the rate of 50 per year from 1996 onwards on the basis of life of 25 years
# Including 10% of initial total charge of CFC-12 recoverable from scrapped equipment

C. COMMERCIAL AIRCONDITIONING (ONLY CENTRIFUGAL CHILLERS)									
1. Total demand of centrifugal chillers	0	0	0	0	0	0	0	0	0
2. Population of centrifugal chillers	30	30	30	27	24	18	0	0	0
3. Number of Chillers scrapped *				3	3	3			
4. Demand for CFC-12 (MT)									
- New Demand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Recharging Demand	7.3	7.3	7.3	6.6	5.8	4.4	0.0	0.0	0.0
- Total Demand	7.3	7.3	7.3	6.6	5.8	4.4	0.0	0.0	0.0
5. Demand for CFC-11 (MT)									
- New Demand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
- Recharging Demand	4.7	4.7	4.7	4.2	3.8	2.8	0.0	0.0	0.0
- Total Demand	4.7	4.7	4.7	4.2	3.8	2.8	0.0	0.0	0.0
6. Total CFC Demand (MT)	12.0	12.0	12.0	10.8	9.6	7.2	0.0	0.0	0.0
7. Recoverable quantity @									
- CFC-12	0.0	0.0	0.0	1.1	1.1	1.1	0.0	0.0	0.0
- CFC-11	0.0	0.0	0.0	0.8	0.8	0.8	0.0	0.0	0.0

* Units scrapped at the rate of 3 per year from 1996 onwards on the basis of life expectancy of 25 year (1 CFC-12 AND 2 CFC-11 Based units each year)
@ Only external recovery figures shown on the basis of refrigerant recoverable from scrapped units @ 80% of total charge contained in the system.

		1991	1993	1995	1996	1997	1999	2005	2007	2010
D. MOBILE AIRCONDITIONERS (CAR ACs)										
1. Total demand of cars ('000)	High	40	48	58	64	71	86	152	183	244
	Low		44	49	54	54	59	79	87	101
2. Growth rate of demand (%)^	High		10	10	10	10	10	10	10	10
	Low		5	5	5	5	5	5	5	5
3. Demand for Car ACs ('000)∂	High	34	41	50	55	60	73	129	156	208
	Low	34	37	41	43	45	50	67	74	86
4. Population for Car ACs ('000)	High	728	637	601	582	568	624	1029	1172	1421
	Low	728	632	581	551	522	537	688	702	709
5. Phase-out of CFC-12 Car ACs (%)		0	0	20	60	100	100	100	100	100
6. No of CFC-12 Car ACs ('000)	High	34	41	40	22	0	0	0	0	0
	Low	34	37	33	17	0	0	0	0	0
7. Population of R12 Car ACs ('000)	High	728	637	591	539	465	382	180	118	17
	Low	728	632	573	517	442	359	161	102	14
8. Number of Aged Car ACs ('000)θ	High	175	73	66	53	31	28	40	0	0
	Low	175	73	66	53	31	28	33	0	0
9. Reconditioned Car ACs ♦ (added back)		30	40	50	60	60	70	80	80	80
10. Reconditioned Car ACs ('000)	High	53	29	33	32	19	20	32	0	0
	Low	53	29	33	32	19	20	26	0	0
11. Scrap % of Car ACs		70	60	50	40	40	30	20	20	20
12. No. of CFC-12 Car ACs ('000) scrapped	High	129	61	72	74	74	42	33	30	32
	Low	129	61	72	74	74	42	31	29	26
13. Demand for CFC-12 (MT)										
- New Demand	High	40.5	49.0	47.4	26.1	0.0	0.0	0.0	0.0	0.0
	Low	40.5	44.7	39.4	20.7	0.0	0.0	0.0	0.0	0.0
- Recharging Demand	High	342.2	299.4	277.8	253.5	218.5	179.5	84.5	55.6	8.2
	Low	342.2	296.9	269.4	242.9	207.9	168.9	75.6	47.8	6.5
14. Total Demand of CFCs (MT)	High	382.7	348.4	325.3	279.6	218.5	179.5	84.5	55.6	8.2
	Low	382.7	341.5	308.8	263.6	207.9	168.9	75.6	47.8	6.5
15. Recoverable Quantity (MT) $ (CFC-12)	High	112.7	98.6	91.5	83.5	72.0	59.1	27.8	18.3	2.7
	Low	112.7	97.8	88.7	80.0	68.5	55.6	24.9	15.7	2.1
16. CFC-12 recoverable from ♦ scrapped car ACs (MT)	High	20.9	10.2	12.0	12.1	11.3	6.9	6.6	4.0	4.3
	Low	20.9	10.2	12.0	12.1	11.3	6.9	6.0	3.8	3.6
17. Total CFC-12 recoverable (MT)	High	133.6	108.8	103.5	95.6	83.3	66.0	34.4	22.3	7.0
	Low	133.6	108.0	100.7	92.1	79.8	62.6	30.9	19.6	5.7

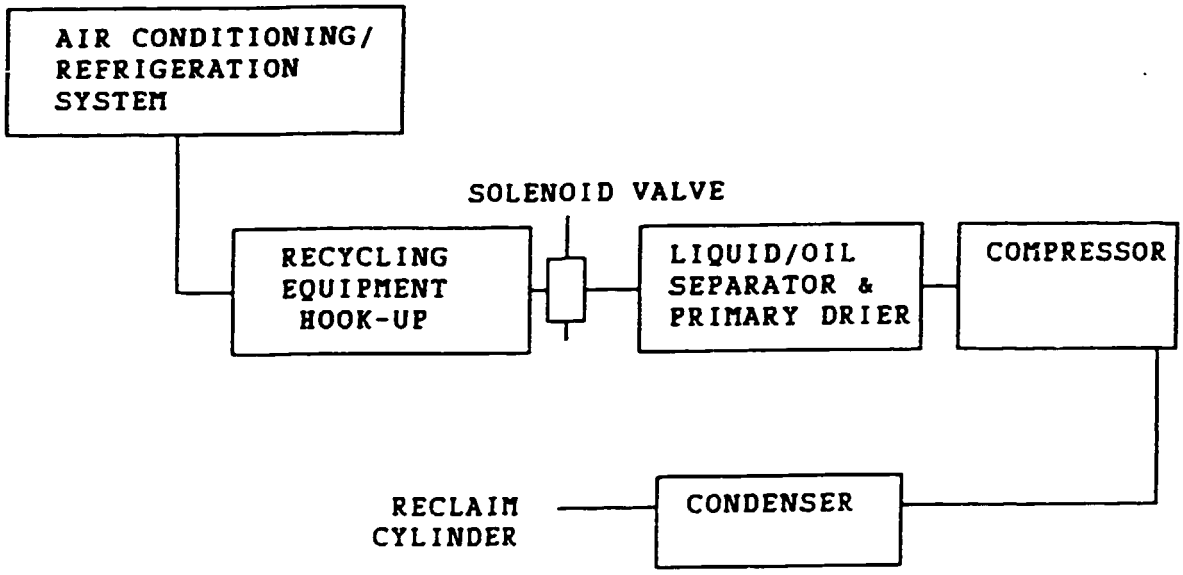
NOTES :

^ Taken on the basis of industry estimates
∂ 85% of all new cars taken to be air-conditioned
θ Number of Car ACs at the end of initial life. Initial life of Car ACs taken as 10 years
♦ 50 % of all aged cars added back to population (after revamping) with a life of 5 years
$ As per table 4.3 for 1991 and proportionate to recharging demand for future years.
♦ 10% of initial charge contained in all CFC-12 Car ACs scrapped and 50% Of car ACs reconditioned.

		1991	1993	1995	1996	1997	1999	2005	2007	2010
TOTAL DEMAND FOR CFC-12 (MT)										
1. New Demand	High	66.0	79.9	77.3	42.5	0.0	0.0	0.0	0.0	0.0
	Low	66.0	72.8	64.2	33.7	0.0	0.0	0.0	0.0	0.0
2. Recharging Demand	High	405.3	362.7	345.2	318.2	277.0	225.7	104.2	69.0	11.7
	Low	405.3	359.6	334.8	305.2	264.0	212.7	93.4	59.6	9.7
3. Total CFC-12 Demand	High	471.3	442.6	422.5	360.7	277.0	225.7	104.2	69.0	11.7
	Low	471.3	432.4	399.0	338.9	264.0	212.7	93.4	59.6	9.7
4. Total Recoverable	High	175.2	150.0	145.4	138.2	122.8	98.3	50.6	32.3	10.6
	Low	175.2	148.7	141.4	133.1	117.7	93.2	45.5	28.5	8.8
TOTAL DEMAND FOR CFC-11 (MT)										
1. New Demand	High	67.0	81.1	78.5	43.2	0.0	0.0	0.0	0.0	0.0
	Low	67.0	74.6	66.4	35.1	0.0	0.0	0.0	0.0	0.0
2. Recharging Demand	High	4.7	4.7	4.7	4.2	3.8	2.8	0.0	0.0	0.0
	Low	4.7	4.7	4.7	4.2	3.8	2.8	0.0	0.0	0.0
3. Total Demand	High	71.7	85.8	83.2	47.4	3.8	2.8	0.0	0.0	0.0
	Low	71.7	79.3	71.1	39.3	3.8	2.8	0.0	0.0	0.0
4. Total Recoverable	High	0.0	0.0	0.0	0.8	0.8	0.8	0.0	0.0	0.0
	Low	0.0	0.0	0.0	0.8	0.8	0.8	0.0	0.0	0.0

APPENDIX - 3.1

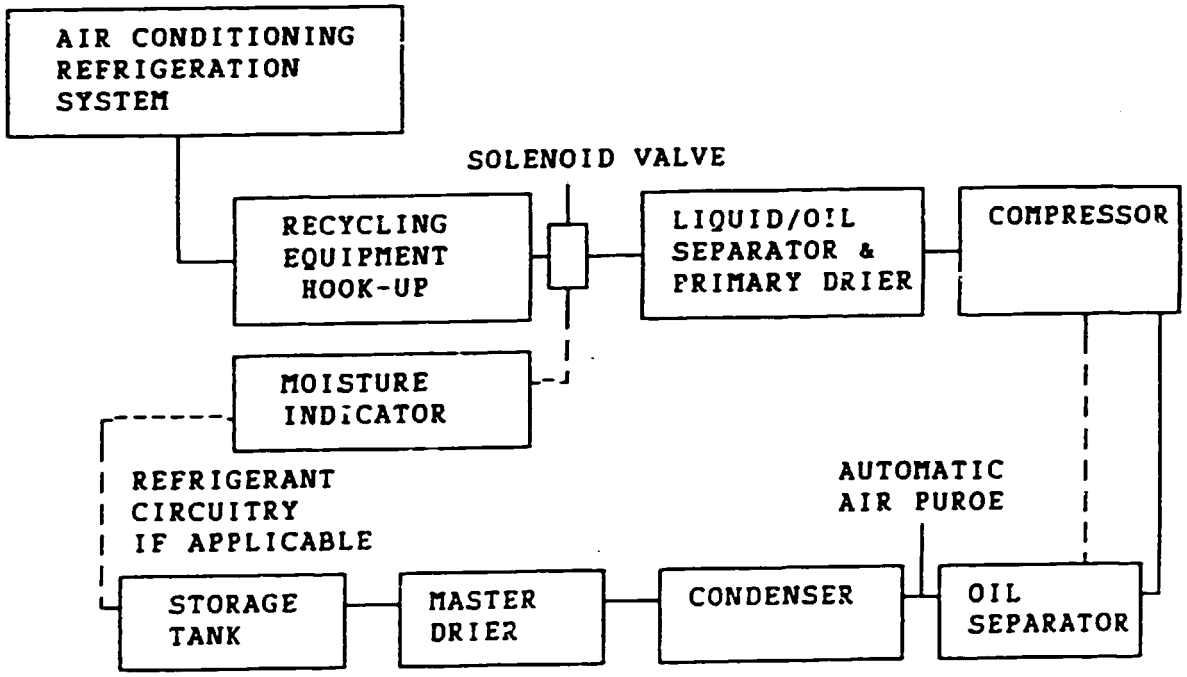
SCHEMATIC FOR REFRIGERANT RECOVERY EQUIPMENT



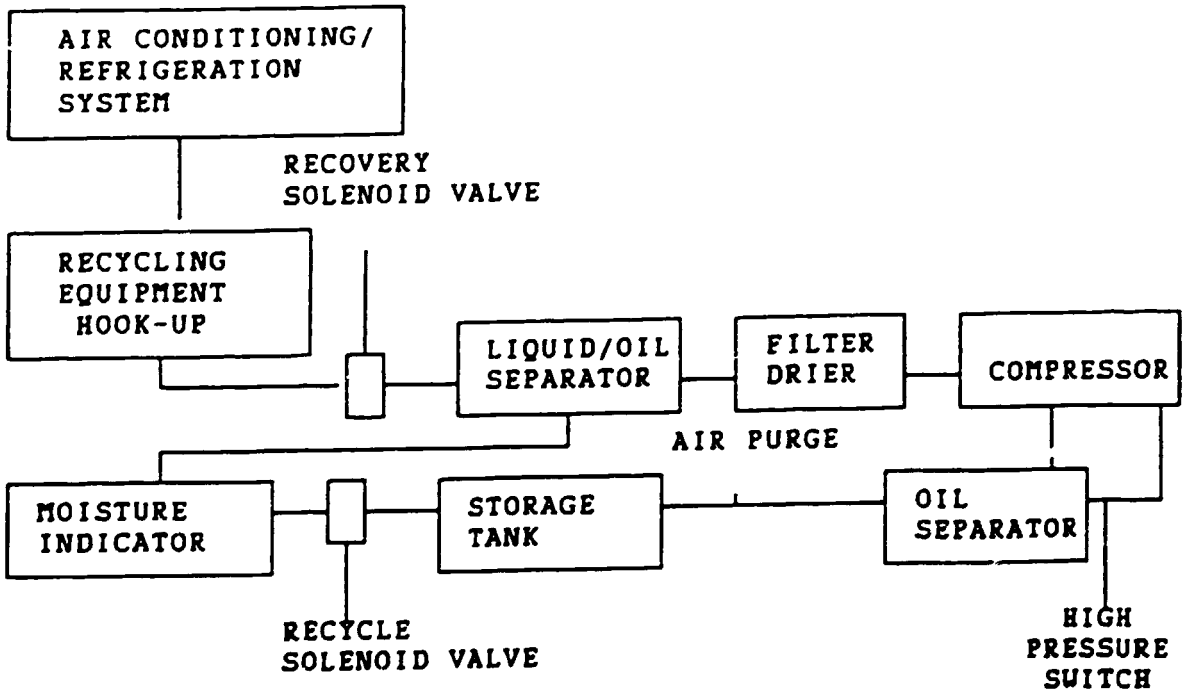
APPENDIX - 3.2

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 Peco, Australia

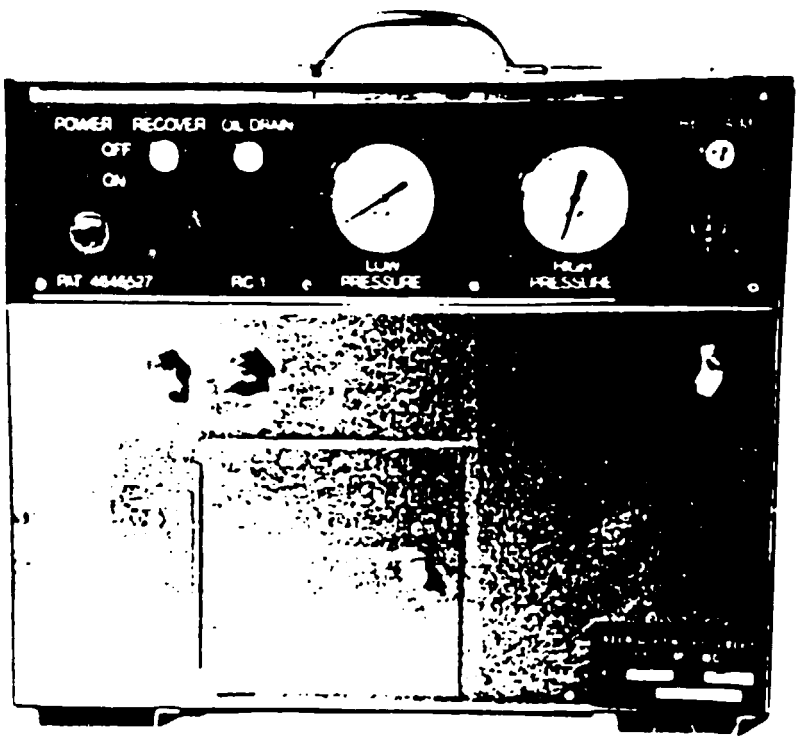
   - Model Reco - 1 (Recovery Unit)
   - Model Reco - 12S (Recovery & Recycling Unit)
   - Model Reco - 134S (Recycling Unit)

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

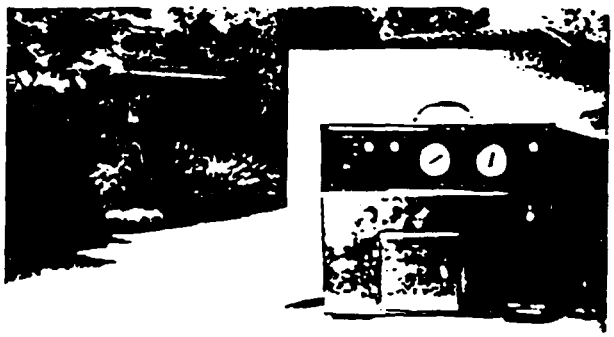
Refrigerant Recovery Systems, Inc., realizing the very special needs of the residential/commercial contractor is proud to present the RC-1.

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.

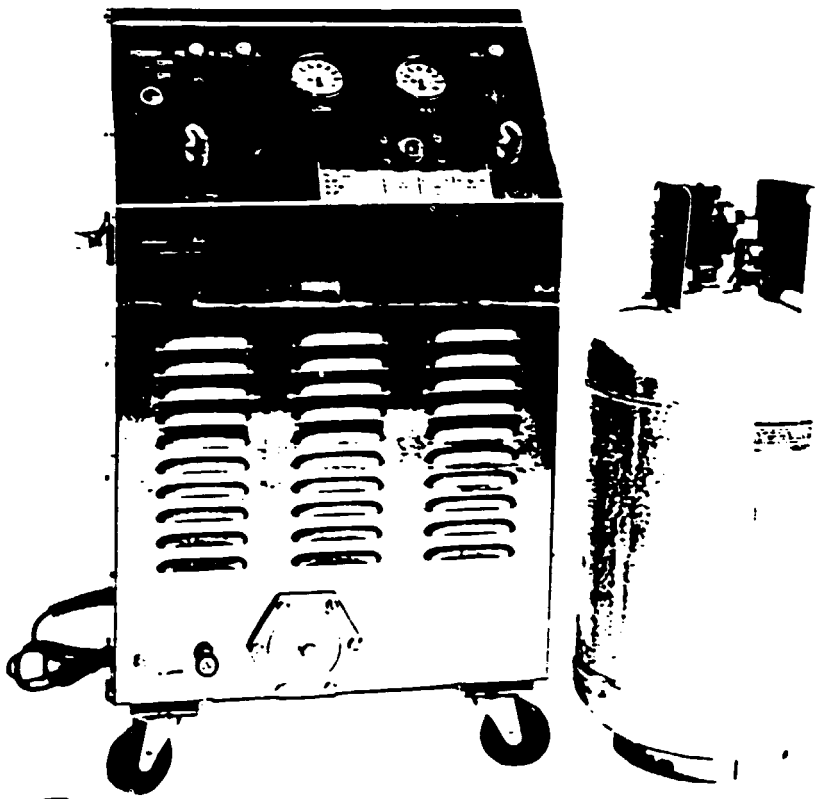
For Information On How To Order, Call Your Local Dealer or Call Toll-Free Numbers: Florida Wats - 1-800-533-2845
Outside Florida - 1-800-327-9142 • Local - (813) 237-1266

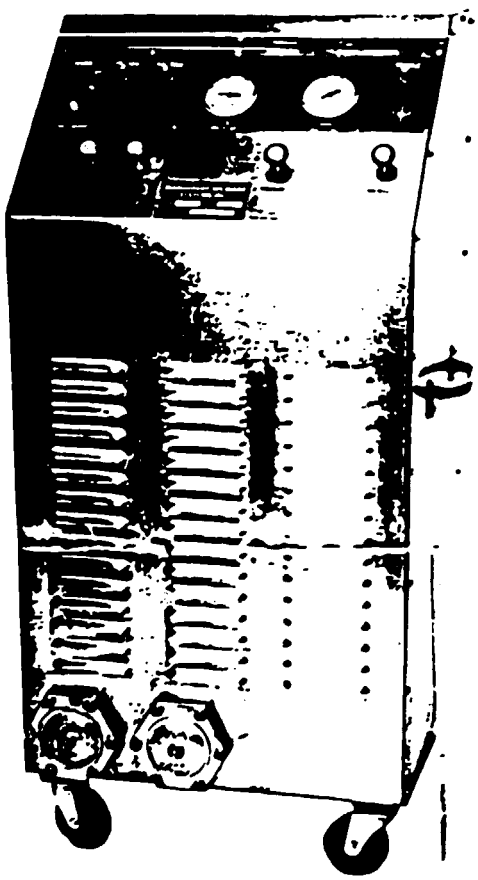
WARRANTY THE RC-1 HAS A 1 YEAR WARRANTY
Contact your distributor for full warranty information

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.*

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.

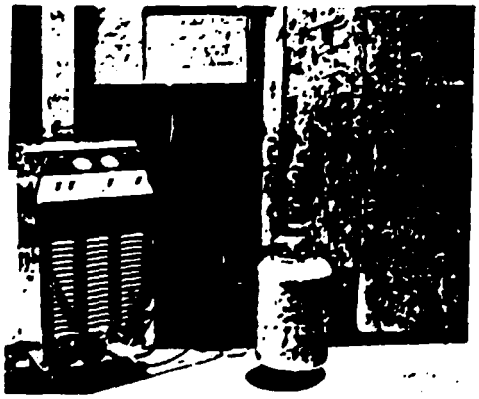
Join with Refrigerant Recovery Systems, Inc., the Company with the technology and experience to make a difference, in helping to eliminate this threat to the entire world.

INTRODUCTION:

Refrigerant Recovery Systems, Inc. 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"*.

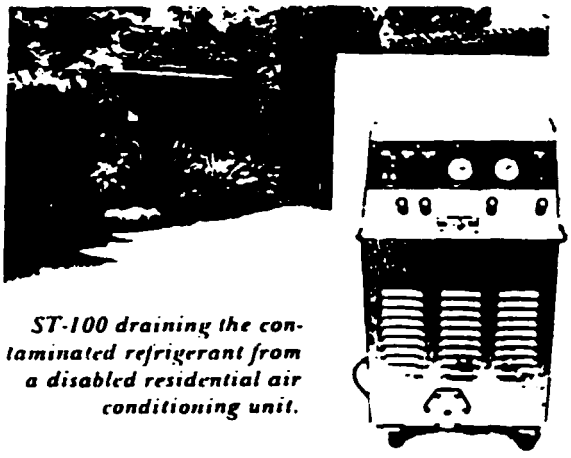
- UL Certified to meet SAE Standards.
- Using a patented distillation process, the Rejuvenator will recover refrigerants at a rate of 3-6 lbs. per minute for the ST-1000 and 2-3 lbs. per minute for the ST-100, depending on the amount of liquid available and the ambient temperature.
- Pre-wired and pre-piped 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!

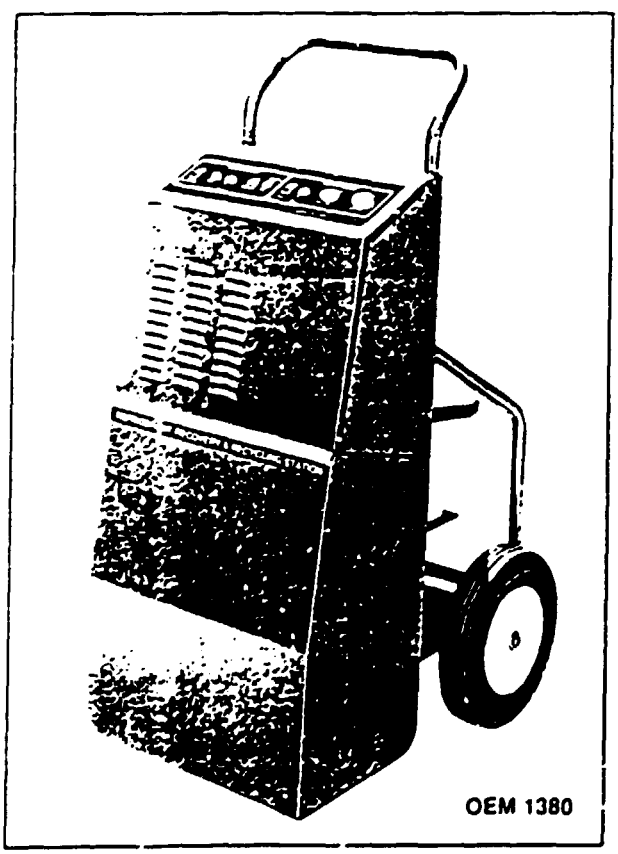
They can be used on cars, trucks, tractors, and RV's (using R-12 refrigerant), so your service potential isn't limited. The speed of recovery of both units means less chance of tying up your shop with vehicles just waiting to be serviced.

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.

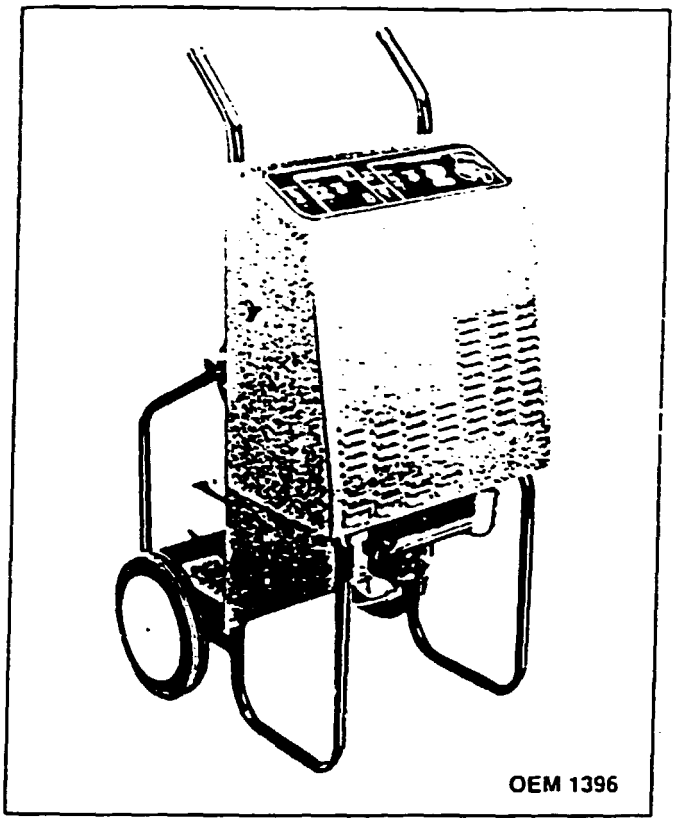
PLUS, these other features:

OEM 1380:

- U.L. approved.
- Ideal for high-volume shops. Recovers ½ lb. per min.; recycles 2½ lbs. 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" wide x 25" deep. Weight: 140 lbs.



OEM 1380



OEM 1396

OEM 1396:

- U.L. approved.
- Lower-cost model 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.

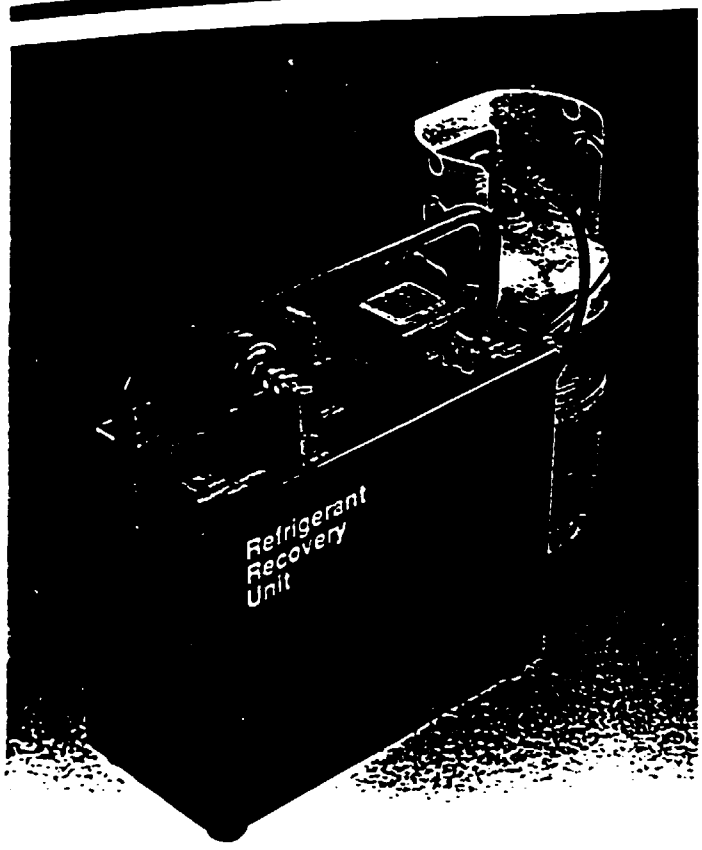
So why recycle? Because of the current agreement to cut CFC production, limited supply of refrigerants means limited availability. And that's practically a guarantee the price will go up. Plus, a new Federal tax of $1.37 per pound of Freon has been imposed, applying to all existing stock and new purchases. 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



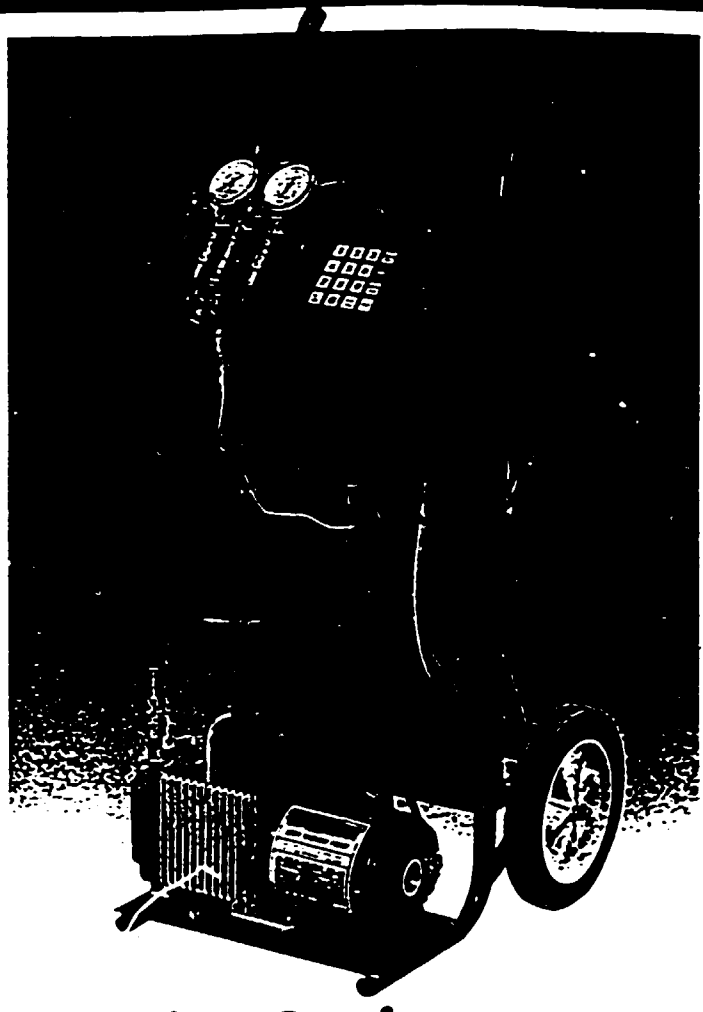
Portable Recovery Station

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

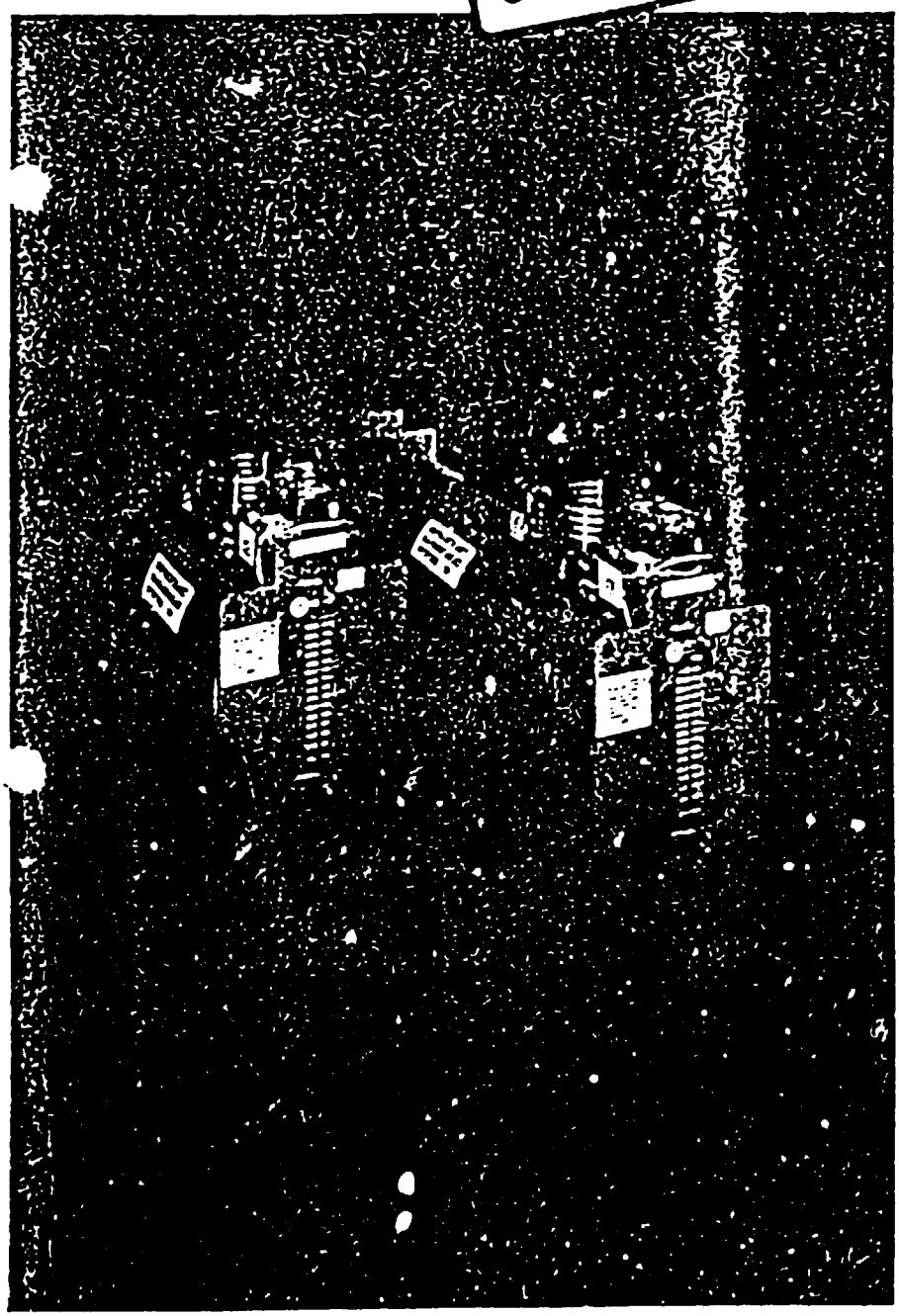
LEGISLATION ENVIRONMENT PROFITS

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.

Copyright 1990 Carrier Corporation

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 liquid 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 swivel 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 over-pressurization. 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.

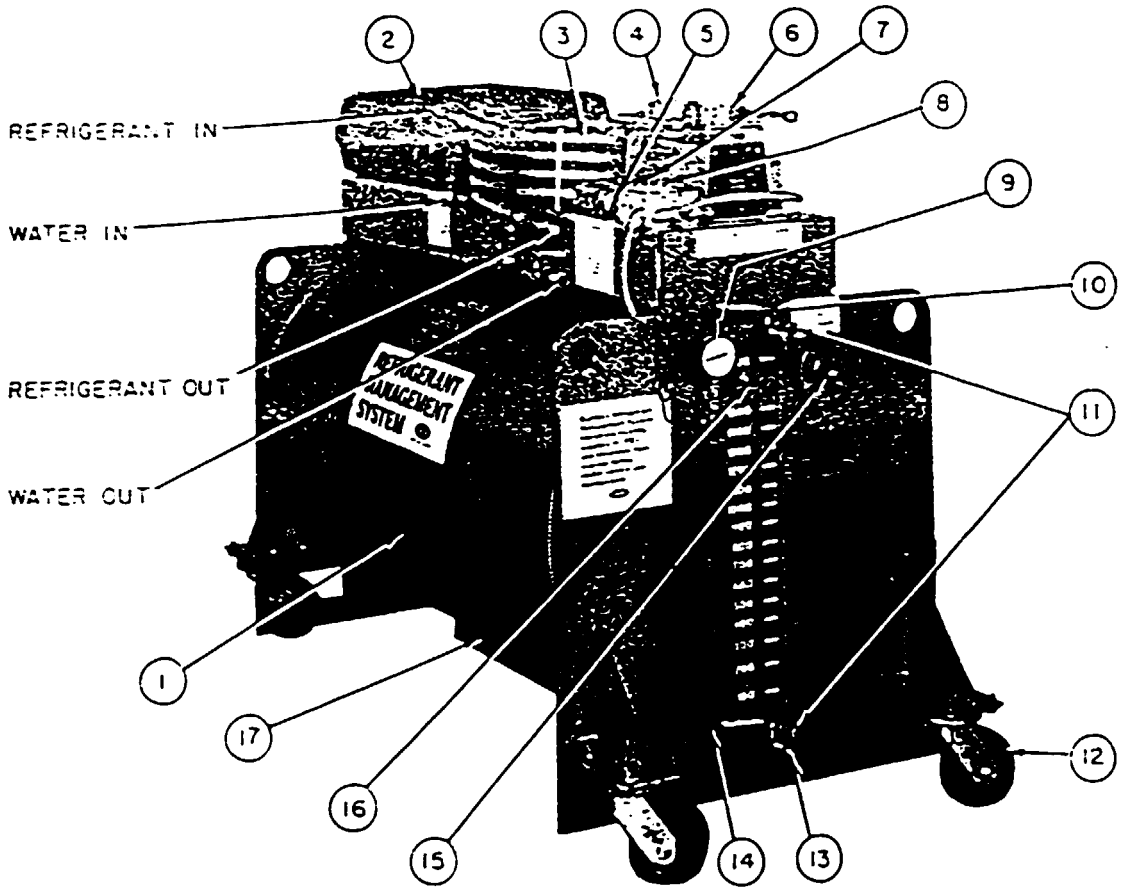
Table of contents

Physical data

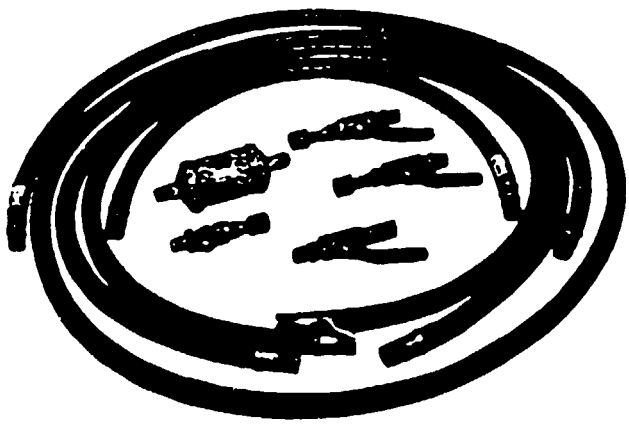
19QA	ENGLISH			SI		
	Size	020	040	Size	020	040
DRY WEIGHT	lbs	605	820	kg	275	370
TANK SIZE	cu ft	20	40	cu meters	57	1.13
TANK STORAGE CAPACITY R-11 Liquid	lbs	1600	3300	kg	725	1500
DESIGN PRESSURE	psig	15		kPa	103	
MAX. OPERATING PRESSURE	psig	10		kPa	69	
CONNECTION SIZES	in.	½		in.	½	
HIGH PRESSURE 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



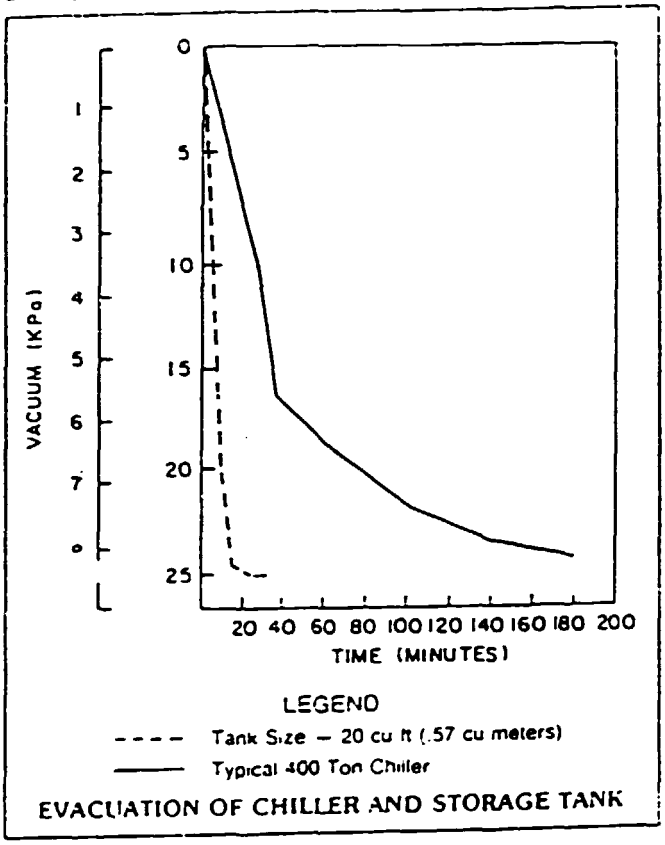
NO.	ITEM
1	— Storage Tank
2	— Accessory Case Charging Hose, 3 ft Charging Hose, 6 ft (2) Charging Hose, 12 ft Valve With Coupler (2) Chiller Vapor Valve Liquid Ind. With Coupler Filter-Oner ½-in. Flare ¾-in. MPT x ½-in. Male Flare
3	— Tube-In-Tube Condenser
4	— Vacuum Pump
5	— Heater High Pressure Switch
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

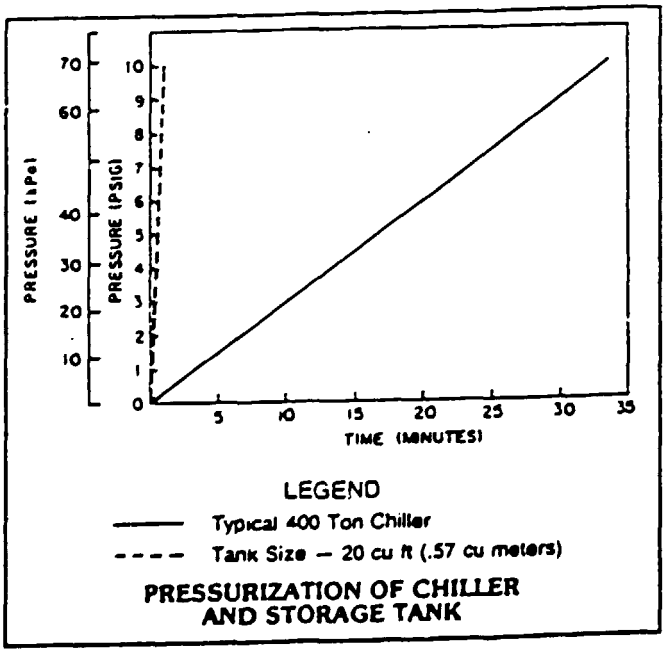
The 19QA RMS provides complete refrigerant management

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.



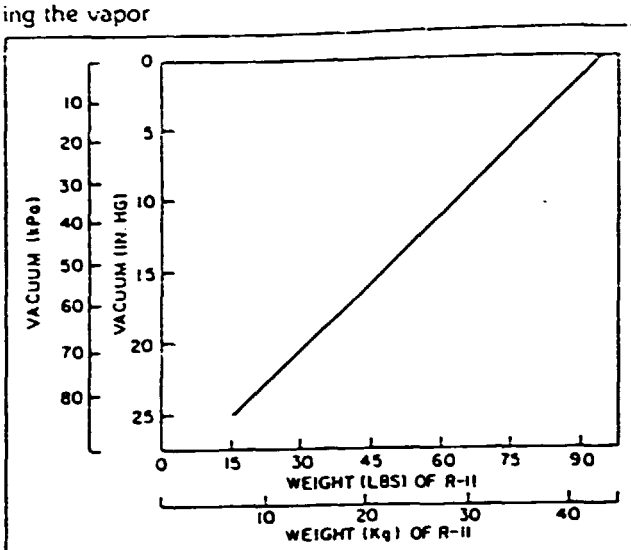
EVACUATION OF CHILLER AND STORAGE TANK

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.

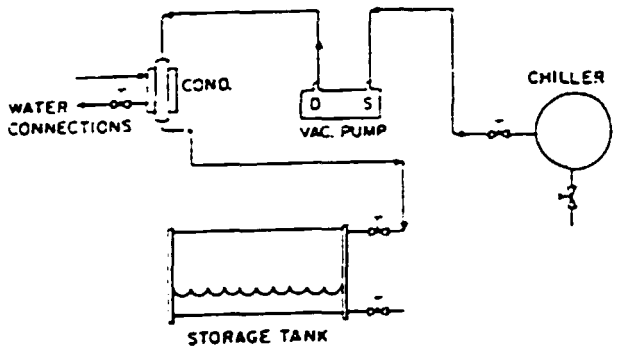


PRESSURIZATION OF CHILLER AND STORAGE TANK

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.

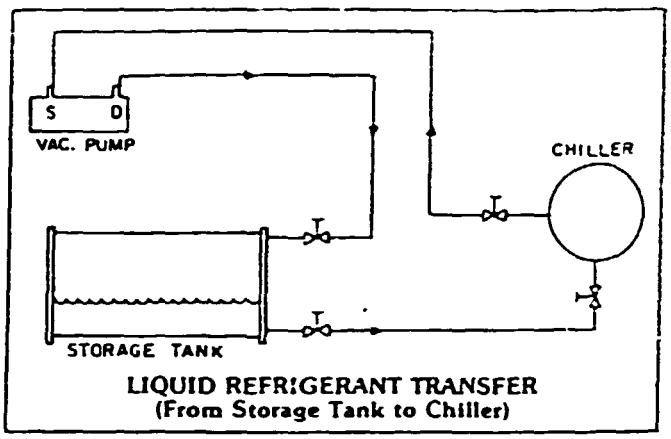


REFRIGERANT VAPOR REMAINING IN CHILLER AFTER REMOVAL OF LIQUID REFRIGERANT (400 Ton Unit)



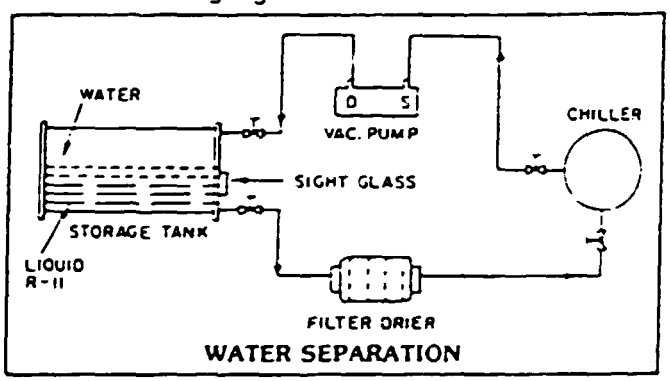
REFRIGERANT VAPOR TRANSFER/EVACUATION

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.



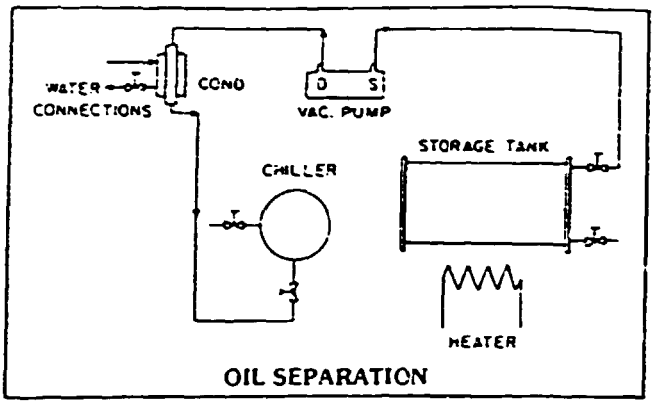
LIQUID REFRIGERANT TRANSFER
(From Storage Tank to Chiller)

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

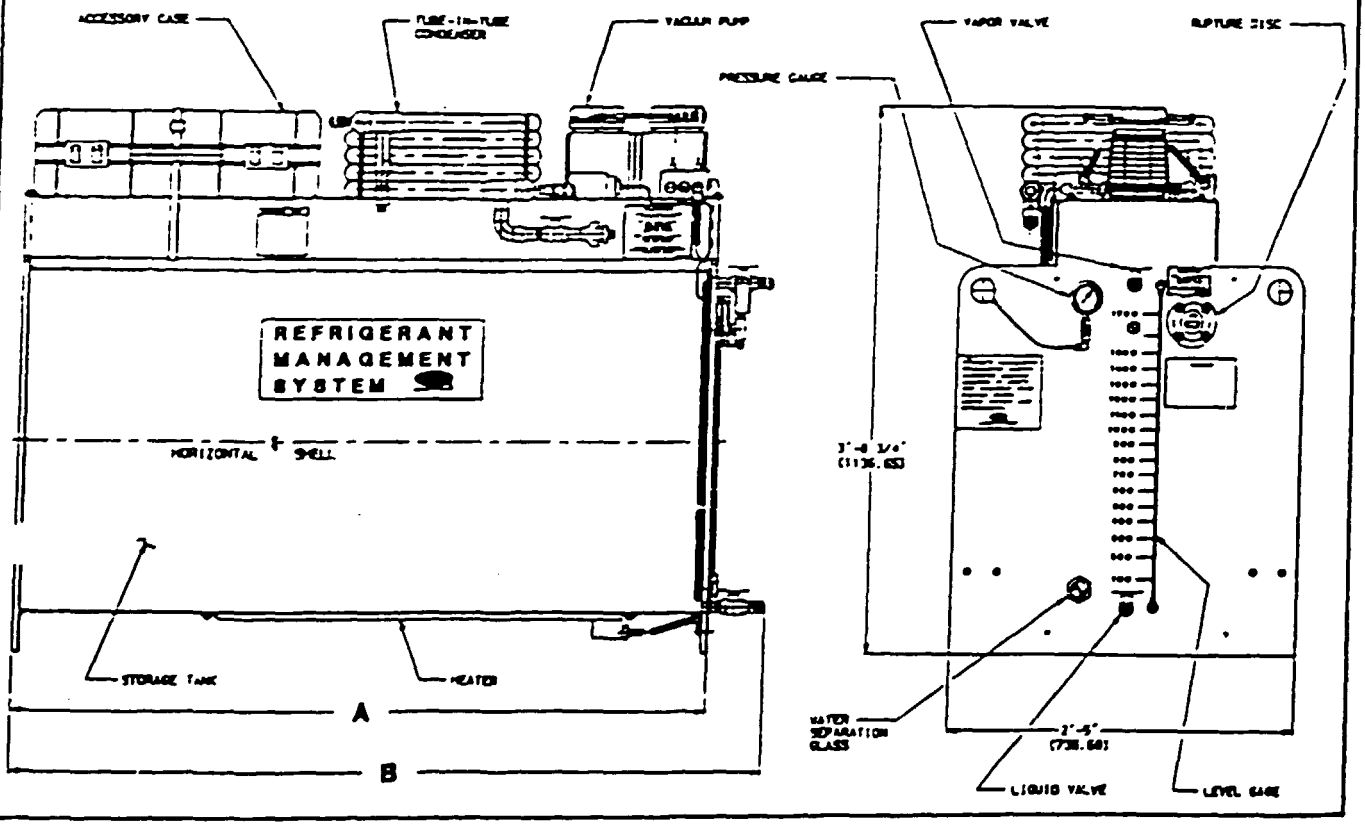
Vacuum pump — The diaphragm-type vacuum pump design reduces the probability of refrigerant leaks. The flow rate for this pump (free air) is 3.6 cfm (.0017 m^3/s) for 60 Hz and 3.0 cfm (.0014 m^3/s) for 50 Hz. The approximate maximum vacuum is 25.5 in. Hg (86 kPa) for a single pump and 29 in. Hg (98 kPa)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



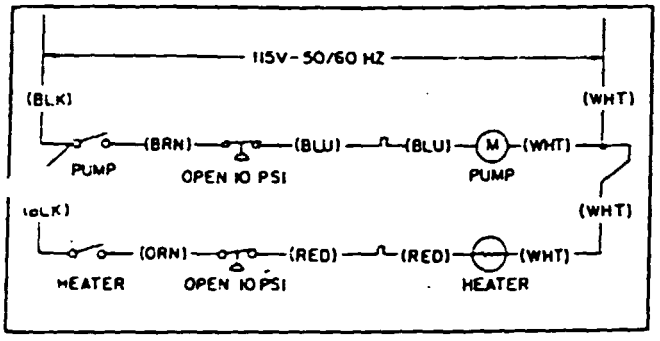
Electrical data

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 dryer, 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.

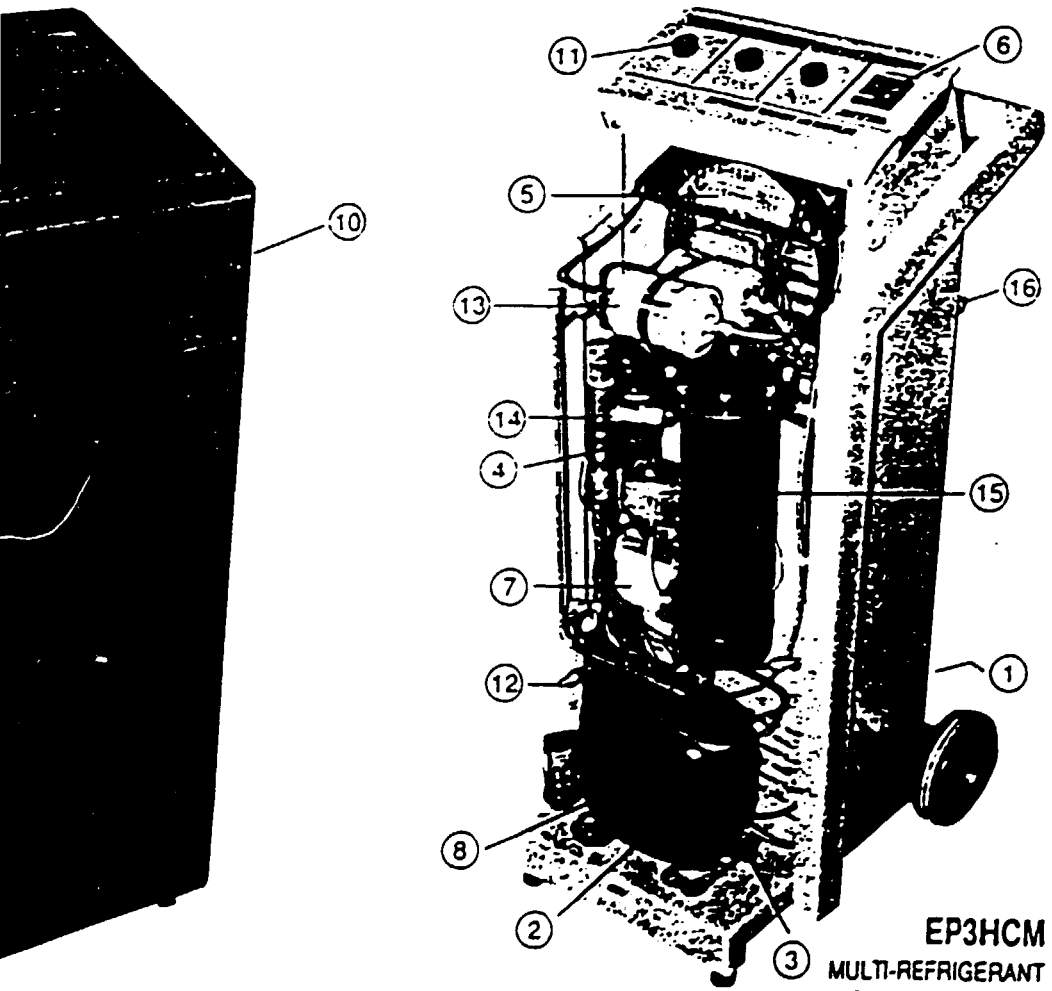

Cooling
EP3HC Fans.

THE NEW

I — CAPACITY

RIGERANT RECOVERY & RECYCLING

MACHINES



EP3HCM
MULTI-REFRIGERANT
ONE PASS SYSTEM

LE & COMMERCIAL AIR CONDITIONING AND REFRIGERATION APPLICATIONS
, TRUCKS, TRAINS, AIRCRAFT, REFRIGERATED TRANSPORT

EP3HC — 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 minutes 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.*
ltage	*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 effectively.*

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:

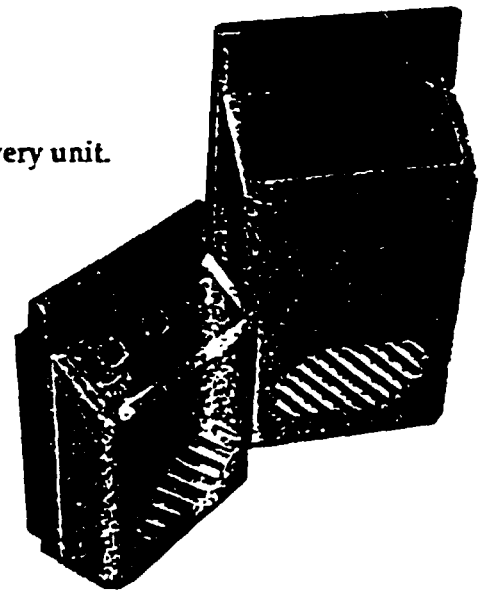
MADE IN AUSTRALIA BY:
ENVIRONMENTAL PRODUCTS AMALGAMATED
P.O. Box 190, Shepparton, Victoria, Australia, 3630
Phone: (058) 31 2912 – Fax: (058) 21 0172
International: 61 5831 2912 – Fax: 61 5821 0172

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

d to your

JAVAC RECO

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

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
Minimum 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 flow/moisture indicator				
HP safety cutout manual reset		•	•	•
LP cutout auto reset				
Adjustable at LP Control		•	•	•
Oil check facility drain/refill				
Quick fill capacity (oil)		•	–	–
Electrical approval SEC/clock				
Status indicator lamps		•	•	•
Circuit breaker manual reset				
Proximity switch		•	–	–
Thermal overload device		Manual	Auto	Auto
Hour run meter		•	–	–
Meets refrigeration standards				
Meets SAE standards SAE J1991/1989/1990*		•	•	•
MVRIC Approval**				
	MC2	NA	•	TBA
Hose/cable sets				
Hoses supplied		2	2	2
Cylinder adaptor				
Hansen quick release safety couplings		2	2	2
Warranty compressor/system		1/2	1/2	1/2
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*
***MVRIC 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

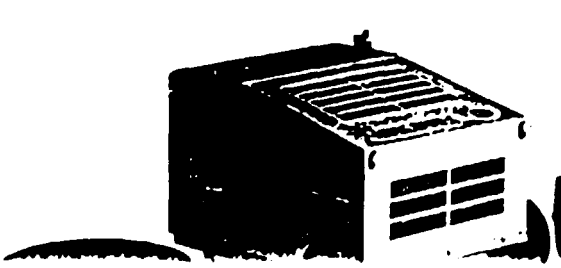
The Javac Wombat series of high vacuum pumps are designed to be used in conjunction with Javac RECO units at the last stage of recovery. By using appropriately, evacuation and final recovery of up to 100% can be achieved in the one operation.The Wombat is available in single or double stage.
Cat. No. ODS040H (single stage)
Cat. No. ODD040H (double stage)

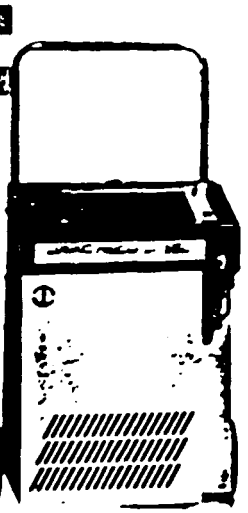
Analyser

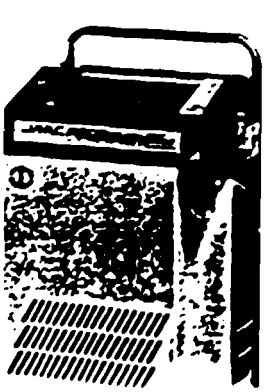
The Javac manifold/analyser can be optioned on a Javac high vacuum pump, or as an option for use with any refrigeration system. The analyser incorporates HP and LP gauging, valves, plus a vacuum pump valve.

Custom manufacture

Javac also offer custom designed and manufactured recovery, recycling and charging facilities. Information on request.







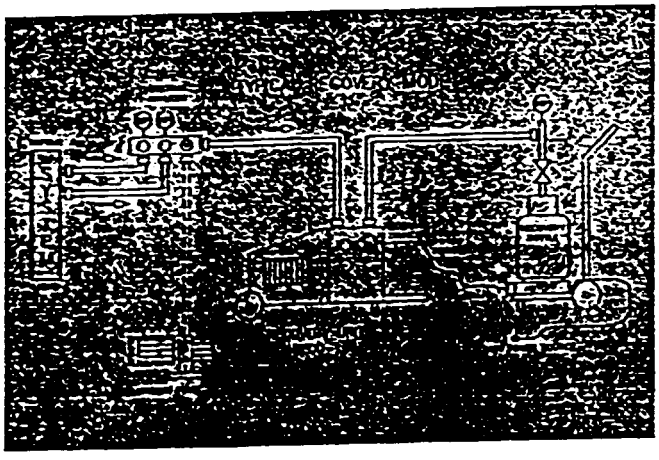
JAVAC RECO

Designed and Manufactured in Australia by
Javac Pty Ltd
A.C.N. 004 477 543

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.

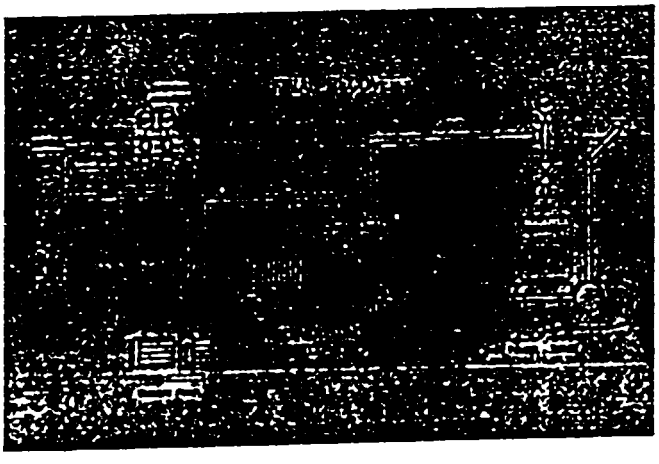


Final evacuation/ recovery (optional)

(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.

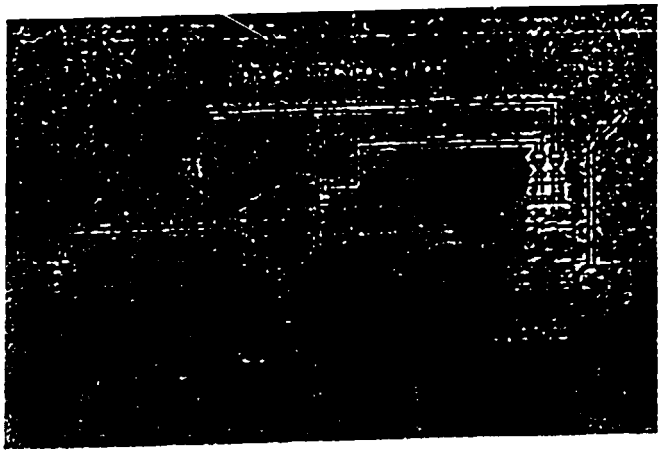
Always use an empty cylinder or a Javac AUTOFF during this optional final recovery.

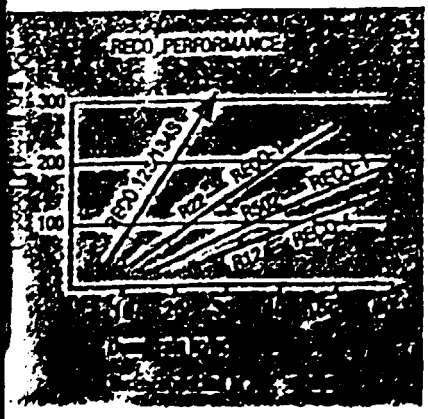


Typical recycle

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.





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

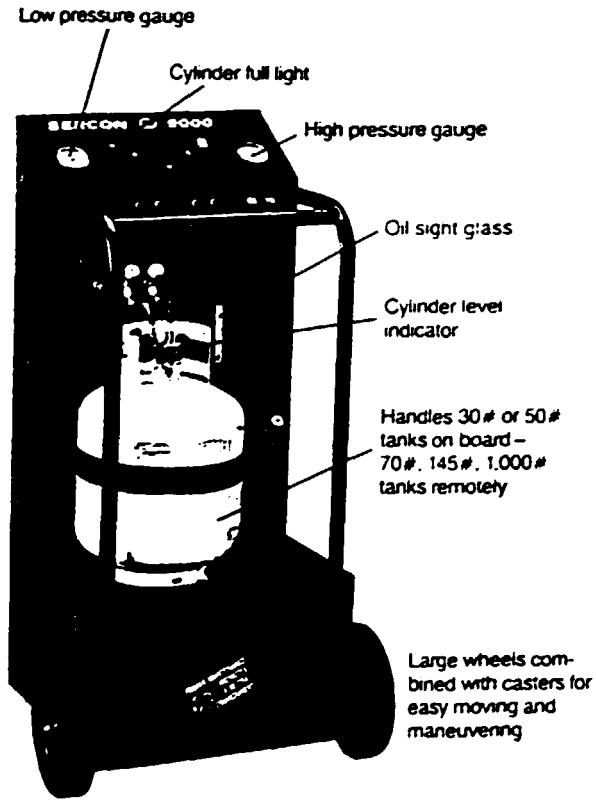
AUSTRALIAN MADE


SERCON 2000

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" Control Lamps: Green-Recovery
Weight: 175 lbs. Red-Tank Full
Connections: 1/4" flare Amber-Flush, Recycle
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

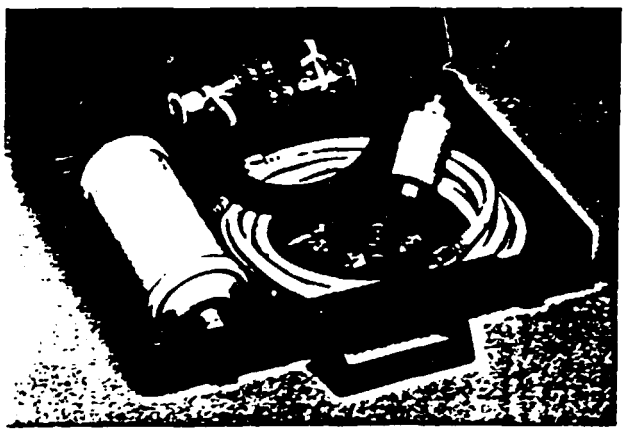
SERCON 9000

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.

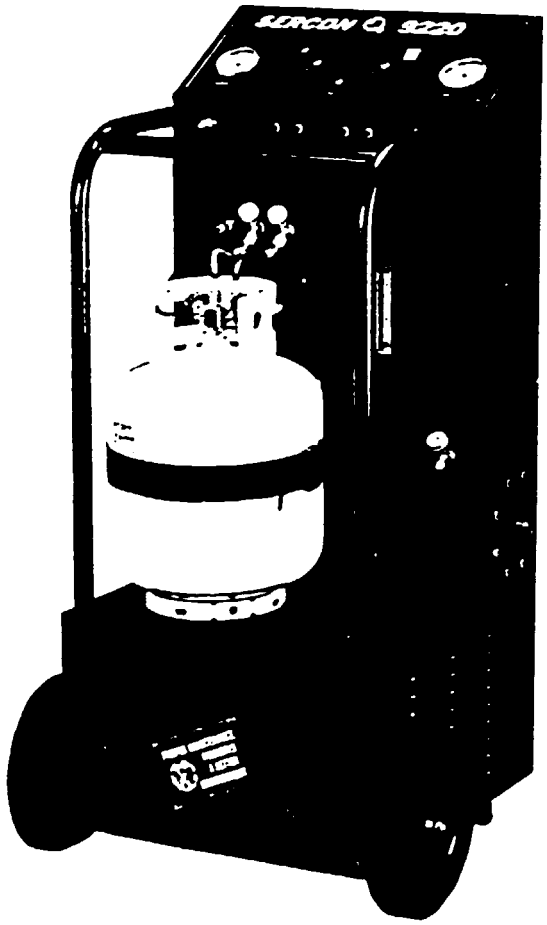
SERCON 9220

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.

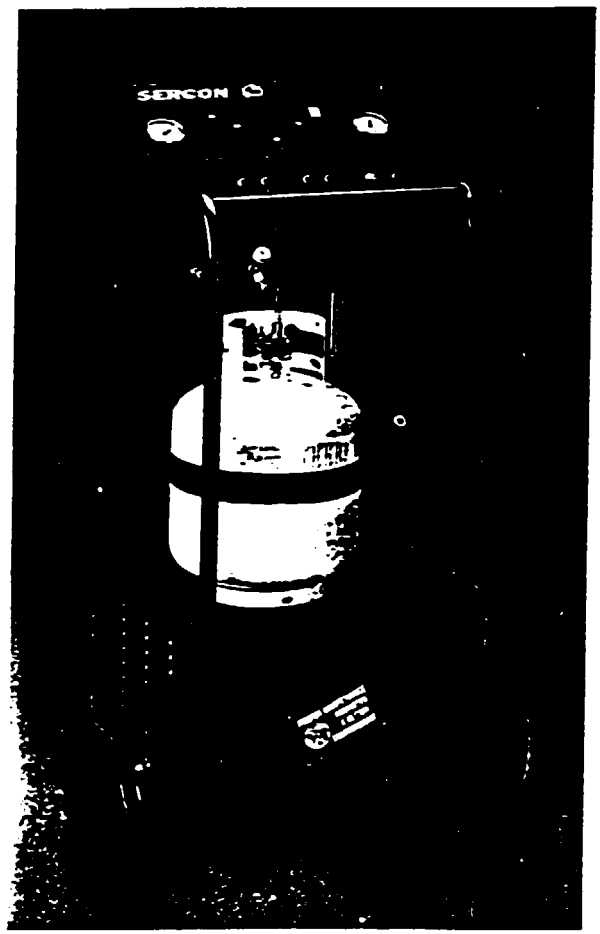
SPECIFICATIONS:

Size: 20" x 20" x 45.5" Control Lamps: Green-Recovery
Weight: 175 lbs. Red-Tank Full
Connections: 1/4" flare Amber-Flush, Recycle
Power: 220/240 VDC, 50 Hz Current: 5 amps

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:

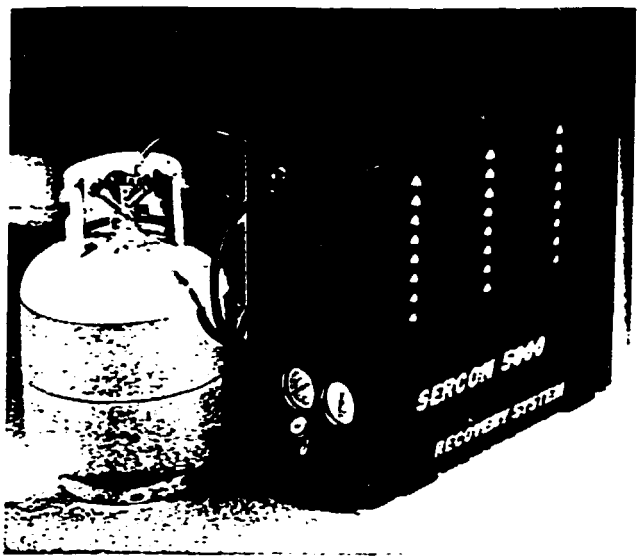
Size: 20" x 20" x 45.5" Control Lamps: Green-Recovery
Weight: 160 lbs. Red-Tank Full
Connections: 1/4" flare
Power: 115/120 VAC, 60 Hz Current: 9 amps

Safety Equipment: Low/high pressure controls/cylinder full shut-off, pressure relief valve, safety valves, check valves, crank case pressure regulator.

* 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 approved recovery center.

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.

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

- *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

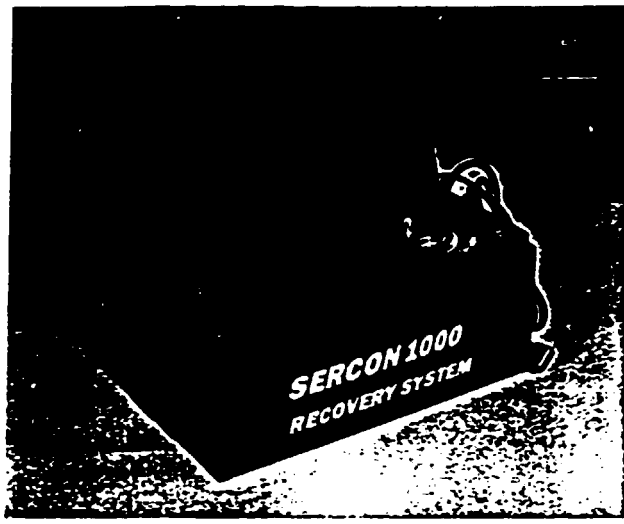
The UL listed Sercon 2000 Flush/Transfer* unit contains a high volume liquid pump that provides the service technician a way to flush an air conditioning system or transfer/off load a large quantity of liquid refrigerant without venting CFC's into the atmosphere. This system weighs only 25 pounds and 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

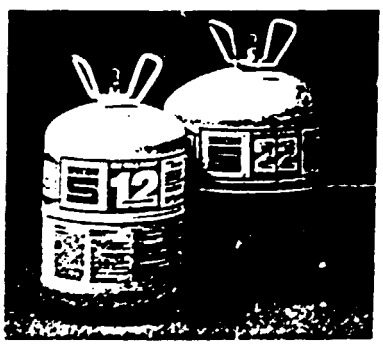


The UL listed Sercon 1000 Vapor Recovery System offers the small shop and the appliance industry an affordable, efficient way to recover R-12. The system recovers approximately 1/2 pound per minute utilizing a 1/6 horsepower compressor. The unit weighs only 35 pounds.

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.

APPENDIX 3.4

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)	19DA 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	390x440x600 (mm)	48 kg	60 kg/hr	-	R-12,R-22,R-502	1)-MEETS REFRIGERANT STANDARD AS-1677 & SAE J1991/89/90 2) RECOVERY UNIT
(b)	RECO-12S	DOMESTIC/AUTOMOBILE	390x440x600 (mm)	35 kg	33kg/hr	1 lit/min	R-12	1)-VAPOUR FORM REFRIGERANT 2) RECOVERY & RECYCLE
(c)	RECO-134S	DOMESTIC/AUTOMOBILE	390x440x600 (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 DISMANTLERS/AIR CONDITIONERS & REFRIGERATION EQUIPMENTS	19"x19"x24"	70 lbs	25 lbs/min	-	R-12,R-22,R-500,R-502	- RECOVERY UNIT ONLY

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	2010
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								

APPENDIX 5.3

ECONOMIC VIABILITY OF VENTURE FOR COLLECTION/RECOVERY AND RECYCLING IN NIGERIA

1.ESTIMATED COST OF PROJECT & SCHEME OF FINANCE (for each type of venture)

(in Naira)

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)**	18900	45360
- Import Duty		
in %	0	0
in local currency	0	0
- Port Handling and Inland Shipment @ 10% of cif value (local currency)	1890	4536
Landed Cost of Equipment	20790	49896
(ii) Indigenous	0	0
(iii) Machinery stores & spares @ 5% of cif value	945	2268
2. Expenses on training of local technicians.***		
Wage Rate (per manday)	64	64
No. of mandays	6	9
Total Training Cost	384	576
3. Provision for contingencies (@ 10% Of above)	2212	5274
Total Cost	24331	58014
FINANCED BY		
1. Equity	3952	9359
2. Secured medium-term loans	16221	38676
3. Other sources (Subsidy on equipment @ 20% of landed cost)	4158	9979
Total	24331	58014

* 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$ = 18 NAIRA

*** 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 Naira)

	1993	1995	1996	1997	1999	2005	2007	2010
Max. collection of CFC 12 using plastic bags (@ 90%)	35.60	36.30	35.88	33.15	26.71	13.61	8.06	2.43
Practical qty. recoverable through plastic bags								
- Percentage	10	50	50	50	50	50	50	50
- Quantity (MT)	3.56	18.15	17.94	16.57	13.35	6.80	4.03	1.22
Number of plastic bags required (@ 1.2 Kg per bag and 25% wastage)	3708	18907	18687	17265	13911	7088	4200	1268
Sale price of recovered CFC using bags								
- Per Kg	30	30	30	30	30	30	30	30
- Total sales	106798	544524	538178	497244	400633	204125	120969	36522
Operating costs for recovering CFC (Labour cost)								
- Per Kg	20	20	20	20	20	20	20	20
- Total cost	71199	363016	358785	331496	267089	136083	80646	24348
Contibution (per Kg)	10	10	10	10	10	10	10	10
Total operating profit	35599	181508	179393	165748	133544	68042	40323	12174

3. ECONOMIC VIABILITY ANALYSIS FOR RECOVERY USING PORTABLE EQUIPMENT
(Venture type B)

DESCRIPTION	1993	1995	1996	1997	1999	2005	2007	2010
Quantity of CFC 12 recovered (Kg per annum)	400	400	393	373	343	189	125	42
A. Material Costs								
1. Raw Material (Recovered CFC) @ 0 N per kg	0	0	0	0	0	0	0	0
2. Spares and Consumables @ 0.31 US$ per Kg	2232	2232	2194	2079	1915	1057	696	234
Total material cost (A)	2232	2232	2194	2079	1915	1057	696	234
B. Power (@ 0.33 N per KWH & 0.05 KWH per Kg)	7	7	6	6	6	3	2	1
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)	8	8	8	8	8	8	8	8
Total Wages	800	800	786	745	686	379	249	84
Supervision salaries								
Manhours/Kg	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Rate (per manhour)	15	15	15	15	15	15	15	15
Total salaries	150	150	147	140	129	71	47	16
Total labour (C)	950	950	934	885	815	450	296	100
D. Overheads								
Repairs & maintenance (@ 5% of equipment cost)	1040	1040	1040	1040	1040	1040	1040	1040
Administrative & selling expenses	1000	1000	1000	1000	1000	1000	1000	1000
Contingencies at 5%	261	261	259	250	239	177	152	119
Total overheads (D)	2301	2301	2298	2290	2278	2217	2191	2158
E. Estimate of cost of operation (A+B+C+D)	5490	5490	5433	5260	5013	3726	3185	2493
F. EXPECTED SALES (@ 50 N /kg)	20000	20000	19660	18628	17155	9467	6232	2098
G. GROSS PROFIT BEFORE INTEREST & DEP. (F-E)	14510	14510	14227	13368	12142	5741	3047	-395
H. TOTAL FINANCIAL EXPENSES **	3893	2920	2433	1946	973	0	0	0
I. DEPRECIATION & AMORTISATION (@ 10% St. line)	2433	2433	2433	2433	2433	0	0	0
J. OPERATING PROFIT (G-H-I)	8184	9158	9361	8988	8736	5741	3047	-395
K. TAX (20%)	1637	1832	1872	1798	1747	1148	609	-79
L. NET OPERATING PROFIT (J-K)	6548	7326	7489	7191	6989	4593	2438	-316
Add: Depreciation	2433	2433	2433	2433	2433	0	0	0
Minus: Loan repayment	0	2028	2028	2028	2028	0	0	0
NET CASH ACCRUALS	8981	7732	7895	7596	7394	4593	2438	-316

** SCHEDULE FOR INTEREST AND REPAYMENT OF TERM LOANS - 24% rate of interest and 8 years repayment period

4. SENSITIVITY OF BREAK EVEN VOLUME TO SALE PRICE RECOVERED CFC
(Venture type B)

(in Naira)

	Scenario 1	Scenario 2	Scenario 3
1. Sale Price of CFC	30.00 (30%)	50.00 (50%)	70.00 (70%)
2. Variable Costs			
- Raw material costs	0.00	0.00	0.00
- Consumables cost	5.58	5.58	5.58
- Utilities cost	0.02	0.02	0.02
- Labour cost	2.38	2.38	2.38
Total variable costs	7.97	7.97	7.97
Contribution	22.03	42.03	62.03
3. Fixed Costs			
- Repairs & Maintenance(Including overheads)	1301	1301	1301
- Selling & Administration expenses	1000	1000	1000
- Financial expenses	3893	3893	3893
- Depreciation	2433	2433	2433
Total Fixed Costs	8627	8627	8627
4. Break-even Analysis			
- Breakeven quantity in Kg	392	205	139
- Breakeven level of sales	11749	10263	9736
- Breakeven level as % of sales	98	51	35

Note : Scenario 2 has been adopted for economic viability analysis of the venture

5.IMPORTANT PROJECT PARAMETERS
(Venture type B)

		YEAR							
		1993	1994	1995	1996	1997	1998	1999	2002
Total Capital Employed	24331	0	0	0	0	0	0	0	0
Equity employed	3952								
Net Cash Inflows (On Equity) ∂	-3952	8981	7342	7732	7895	7596	7343	7394	7830
Internal Rate of Return (On Equity)	215.1%								
Pay Back Period (On Equity)	About six months								
Net Cash Inflows (On Capital Cost) ß	-24331	12095	12095	12095	11869	11181	10539	10200	7830
Internal Rate of Return (On Capital Cost)	47.2%								
Pay Back Period (On Capital Cost)	About 2 years								

∂ Cash Inflow (On Equity) = Net profit + Depreciation - Loan repayment
ß Cash Inflow (On Capital Cost) = Net profit + Depriciation + Interest * (1-Tax Rate)

6. ECONOMIC VIABILITY ANALYSIS FOR RECYCLING WITH ADDITIONAL RECOVERY UNIT
(Venture type C)

	1993	1995	1996	1997	1999	2005	2007	2010
Quantity of CFC 12 recycled (KG per annum)	2356	7815	7692	7246	6482	3521	2273	751
- Quantity externally recovered (Kg)	2000	6000	5898	5588	5147	2840	1870	629
- Quantity internally processed (kg)	356	1815	1794	1657	1335	680	403	122
A. Material Cost								
1. Raw Material (Recovered CFC 12)								
a) Externally from recovery units @ 50N per Kg	100000	300000	294901	279415	257330	142009	93483	31469
b) Internally processed @ 53.97 N per Kg @	19214	97963	96821	89457	72076	36723	21763	6570
Total Raw Material Cost	119214	397963	391722	368872	329406	178732	115246	38039
2. Spares and Consumables @ US$ 0.41/Kg	17387	57675	56767	53474	47838	25982	16774	5543
Total material cost (A)	136601	455638	448488	422345	377244	204714	132020	43582
B. Power (@ 0.33 N per KWH & 0.05 KWH per Kg)	39	129	127	120	107	58	38	12
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)	8	8	8	8	8	8	8	8
Total Wage	4712	15630	15384	14492	12964	7041	4546	1502
Supervision salaries								
Manhours/Kg	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Rate (per manhour)	15	15	15	15	15	15	15	15
Total salaries	3534	11723	11538	10869	9723	5281	3409	1127
Total labour (C)	8246	27353	26922	25360	22687	12322	7955	2629
D. Overheads								
Repairs & maintenance (@ 5% of eqipment cost)	2495	2495	2495	2495	2495	2495	2495	2495
Administrative & selling expenses	20000	20000	20000	20000	20000	20000	20000	20000
Transportation & Storage (@ 10% of sales)	23560	78151	76919	72458	64821	35206	22729	7511
Contingencies @ 5%	9547	29188	28748	27139	24368	13740	9262	3811
Total overheads	55602	129834	128162	122091	111683	71441	54486	33817
E. Estimate of cost of operation (A+B+C+D)	200487	612953	603699	569917	511721	288535	194498	80041
F. EXPECTED SALES (@ 100 N/kg)	235599	781508	769194	724578	648205	352060	227289	75111
G. GROSS PROFIT BEFORE INTEREST & DEP. (F-E)	35112	168554	165495	154661	136484	63525	32791	-4930
H. TOTAL FINANCIAL EXPENSES ++	9282	6962	5801	4641	2321	0	0	0
I. DEPRECIATION & AMORTISATION (@ 10% St. line)	5801	5801	5801	5801	5801	5801	5801	5801
J. OPERATING PROFIT (G-H-I)	20028	155791	153893	144219	128362	57724	26990	-10731
K. TAX (35%)	7010	54527	53862	50477	44927	20203	9446	-3756
L. NET OPERATING PROFIT (J-K)	13018	101264	100030	93742	83435	37520	17543	-6975
Add: Depreciation	5801	5801	5801	5801	5801	5801	5801	5801
Minus: Loan repayment	0	4835	4835	4 35	4835	0	0	0
NET CASH ACCRUALS	18820	102231	100997	94709	84402	43322	23345	-1174

++ SCHEDULE FOR INTEREST AND REPAYMENT OF TERM LOANS - 24% rate of interest and 8 years repayment period after moratorium of one year

7. COMPUTATION OF COST OF INTERNALLY PROCESSED CFC FOR RECYCLING VENTURE @
(FOR CFC RECOVERED THROUGH PLASTIC BAGS)
(Refer item A. 1(b))

	(in Naira)
A. Material Costs	
1. Raw Material (Recovered CFC gas) @ 30 N per kg	30.00
2. Spares and Consumables @ 0.31 US$ per Kg	5.58
Total material cost (A)	35.58
B. Utilities	
- Power (@ 0.33 N per KWH & 0.05 KWH per Kg)	0.02
C. Labour	
Wages	
Manhours/Kg	1.50
Wage Rate (per manhour)	8.00
Total Wage	12.00
Supervision salaries	
Manhours/Kg	0.025
Rate (per manhour)	15.00
Total salaries	0.38
Total labour (C)	12.38
D. Transportation cost (@ 20% Of raw material cost)	6.00
Total per Kg cost of liquified gas (A+B+C+D)	53.97

8. SENSITIVITY OF BREAK EVEN VOLUME TO COST RAW MATERIALS
(Venture type C)

(In NAIRA)

	Scenario 1	Scenario 2	Scenario 3
1. Sale Price of CFC	100.00	100.00	100.00
2. Variable Costs			
- Raw material costs	30.00	50.00	70.00
- (as % of selling price of recycled CFC)	(30%)	(50%)	(70%)
- Consumables cost	7.38	7.38	7.38
- Utilities cost	0.02	0.02	0.02
- Labour cost	3.50	3.50	3.50
- Transportation and Storage	10.00	3.01	3.25
Total variable costs	50.90	63.91	84.15
Contribution	49.10	36.09	15.85
3. Fixed Costs			
- Repairs & Maintenance(Including overheads)	12042	12042	12042
- Selling & Administration expenses	20000	20000	20000
- Financial expenses	9282	9282	9282
- Depreciation	5801	5801	5801
Total Fixed Costs	47125	47125	47125
4. Breakeven Analysis			
- Breakeven quantity in Kg	960	1306	2973
- Breakeven level of sales	95972	130582	297285
- Breakeven level as % of sales	41	55	126

Note : Scenario 2 has been adopted for economic viability analysis of the ventures

9.IMPORTANT PROJECT PARAMETER

		YEAR							
		1993	1994	1995	1996	1997	1998	1999	2002
Total Capital Employed	58014	0	0	0	0	0	0	0	0
Total Equity Employed	9359								
Net Cash Inflows (On Equity) @	-9359	18820	58009	102231	100997	94709	88505	84402	68476
Internal Rate of Return (On Equity)	325.3%								
Pay Back Period (On Equity)	About six months								
Net Cash Inflows (On Capital Cost) #	-58014	24853	68122	111591	109603	102560	95602	90745	68476
Internal Rate of Return (On Capital Cost)	97.7%								
Pay Back Period (On Capital Cost)	About one and half years								

@ Cash Inflow (On Equity) = Net profit + Depreciation - Loan repayment
# Cash Inflow (On Capital Cost) = Net profit + Depriciation + 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 Nigeria)

	1993	1995	1996	1997	1999	2005	2007	2010
TOTAL NUMBER OF VENTURES								
- Recovery only	50	150	150	150	150	150	150	150
- Recycling only	10	10	10	10	10	10	10	10
A. BENEFITS								
1. Savings in import of CFC refrigerants								
- Quantity (in MT ; equal to recycled quantity)	24	78	77	72	65	35	23	8
- CIF price (in N per MT)	40000	40000	40000	40000	40000	40000	40000	40000
- Value saved (in N ; quantity * CIF price)	942398	3126031	3076776	2898311	2592821	1408240	909157	300445
2. Employment related benefits								
- Increase in consumption	269694	1044464	1029766	962382	826129	438085	274309	87929
- Increase in saving	132624	513623	506396	473259	406256	215432	134894	43240
- Total increase	402317	1558087	1536162	1435641	1232385	653517	409203	131169
3. Government expenditure related benefits								
- Increase in consumption	2934071	641016	439240	439240	439240	439240	439240	439240
- Increase in saving	1442853	315225	216000	216000	216000	216000	216000	216000
- Total increase	4376924	956241	655240	655240	655240	655240	655240	655240
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 *	151944	636847	632237	594648	536625	259442	124938	-41507
- Series 2 Ventures	0	86711	91577	93613	86722	70694	43978	8402
- Series 3 Ventures	0	81845	86711	91577	89883	82604	57410	19958
- TOTAL INCREASE IN TAXES	151944	805402	810525	779838	713230	412740	226326	-13146
TOTAL BENEFITS (A)	5873583	6445762	6078703	5769031	5193677	3129738	2199926	1073708

	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)	1468530	992250	0	0	0	0	0	0
- Consumables	285472	911553	896774	846565	765556	418303	272067	90551
- Plastic bags (@ 1.2Kg per bag; US$ 8.25 per bag; 25% wastage)	550679	2807699	2774979	2563917	2065764	1052519	623745	188316
2. Capital investment (excluding (1) above)	328155	224295	0	0	0	0	0	0
3. Government expenditures								
a. Training cost incurred in foreign currency	540000	0	0	0	0	0	0	0
b. Training cost incurred in local currency	146853	99225	0	0	0	0	0	0
c. Publicity expenses	1946853	99225	0	0	0	0	0	0
d. Administrative Expenses	792000	432000	432000	432000	432000	432000	432000	432000
e. Subsidy on equipments	279720	189000	0	0	0	0	0	0
4. Increase in wage costs (total wages and salaries weighted by 0.2)	16578	64203	63299	59157	50782	26929	16862	5405
5. Increase in operating costs (excluding raw material, consumables and labour)								
- Series 1 Ventures #	569807	1313028	1296146	1234941	1130119	724015	552916	344267
- Series 2 Ventures	0	13400	13400	13259	12430	9691	8359	6585
- Series 3 Ventures	0	13400	13400	13400	12831	10284	9028	7161
- TOTAL OPERATING COST	569807	1339829	1322946	1261600	1155380	743990	570303	358014
6. Decrease in government duties on import of CFCs								
- Rate of duty (%)	50	50	50	50	50	50	50	50
- Quantity of CFC import reduced (in MT)	24	78	77	72	65	35	23	8
- Value of reduced duties	471199	1563016	1538388	1449156	1296411	704120	454578	150222
TOTAL COSTS (B)	8187846	9154294	7460387	7044396	6197893	3809861	2801554	1656509
NET NATIONAL ECONOMIC BENEFIT								
- ANNUAL	-2314263	-2708532	-1381685	-1275365	-1004216	-680123	-601629	-582801
- PRESENT VALUE (@ 2.0% discounting) N	-17443482							
US $	-969082							

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. IW.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.

APPENDIX - 6.4 A

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 Hazardous Substances (Ordinance on Substances; Rs 814.013).