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

Seventeenth Meeting
Montreal, 26-28 July 1995

PROJECT PROPOSALS: VENEZUELA

This document includes the following project proposals:

- Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Coresmalt Valencia C.A. — UNDP
- Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Madosa S.A. — UNDP
- Conversion of CFC-12 Compressor Production Facilities at Vecomesa S.A. to Manufacture HFC-134a Compressors — UNDP
- Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at Pinova S.A. — UNDP
- Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Grupo Frigilux C.A. — UNDP

PROJECT COVER SHEET

COUNTRY:	**VENEZUELA**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at CORESMALT VALENCIA C.A.
SECTOR COVERED:	Domestic Refrigeration (Mfg)
ODS USE IN SECTOR:	236.69 tons ODS
PROJECT IMPACT (ODP):	65.52 ODP tons
TOTAL PROJECT COST:	US$ 861,520
INCREMENTAL CAPITAL COST:	US$ 427,000
INCREMENTAL OPERATING COST:	US$ 434,520
PROPOSED MLF GRANT:	US$ 861,520
UNIT ABATEMENT COST:	7.69 US$/Kg
COST EFFECTIVENESS:	13.15 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	FONDOIN
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	December 1994/May 1995

PROJECT SUMMARY:

CORESMALT VALENCIA C.A. is a 100% Venezuelan-owned company manufacturing domestic refrigerators and freezers primarily for sale in Venezuela. Coresmalt currently uses CFC 11 as a blowing agent in the production of rigid polyurethane insulation foam for the refrigerator cabinets and doors, and CFC 12 is used as the refrigerant. Based on 1993 figures, this project will eliminate 65.52 ODP tons/yr of CFCs 11 and 12 by conversion to the use of HCFC 141b as the foam blowing agent and HFC 134a as the refrigerant respectively. Funds requested will be used to change the existing production lines, and for technology transfer, technical assistance, re-design, testing, pre-production trials, and training. Incremental operational costs resulting from the conversion to the new technology (6 months only) are also included.

Prepared by: Stuart Kelly, in collaboration with the Foundation for Protection of the Ozone Layer and the Environment (FONDOIN).

Reviewed by: Dr L.J.M. Kuijpers/Dr M.J.P. Janssen (Refrigeration) and Dr H. Creyf (Foam). Their comments are attached.

PROJECT OF THE GOVERNMENT OF VENEZUELA

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFCs used by CORESMALT C.A. in the manufacture of domestic refrigerators and freezers. CFC 11 is used as the blowing agent for producing the PU thermal insulating foams for the refrigerator cabinets and doors, and this will be eliminated by conversion to HCFC 141B. CFC 12, used as the refrigerant, will be replaced by HFC 134a.

2. SECTOR BACKGROUND.

The Venezuela Country Programme (CP) for the Phase-out of Ozone Depleting Substances (ODS) under the Montreal Protocol is presently in the course of preparation. It is anticipated that the CP will be presented to the 17th meeting of the Executive Committee of the Multilateral Fund for the Montreal Protocol in July 1995.

Due to the economic situation in Venezuela, 1994 data is not representative of either typical domestic refrigerator production volume, or ODS consumption. This project is, therefore, based on 1993 calender year data.

In preparing this project proposal, the following data for the 12 months January - December 1993 inclusive, was established as the best estimate of CFC consumption for the manufacture of domestic refrigerators and freezers in Venezuela. ODS elimination project proposals are being presented to the Montreal Protocol Multilateral Fund for the FOUR enterprises indicated in bold type, who account for 96.7% of domestic refrigerator and freezer production in Venezuela.

Enterprise	Production Volume	CFC 11 Consumption (Tons)	CFC 12 Consumption (Tons)
Coresmalt Valencia	95,646	50.51	20.57
Frigilux	41,605	27.73	4.85
Madosa	126,437	84.64	17.71
Muebles Eterna	3,153	-	0.38
Famusa Domestic	6,500	4.68	0.78
Others	2,500	1.80	0.30
Totals	275,841	169.36	44.59

The preceding Table relates to the DOMESTIC REFRIGERATION sector only. It should be noted that Frigilux C.A. is also engaged in the manufacture of unitary commercial refrigeration equipment. The production volumes and ODS consumption related to this activity are included in the project proposal for ODS elimination at Frigilux.

96.0% of the domestic refrigerators and freezers manufactured in Venzuela are sold in the local market. It is estimated that around 70,000 domestic refrigerators/freezers were also imported for sale in Venezuela in 1993, sourced from a variety of countries including Mexico, Colombia, USA, and Korea.

4.0% of local production, around 11,000 refrigerators are exported to other Latin American countries, principally Colombia and Ecuador.

This consumption of 213.95 ODP tons in the manufacture of domestic refrigerators and freezers represents approximately 7% of the total ODS consumption in the refrigeration and air-conditioning sector in Venezuela which was estimated at 3,200 tons in 1993.

There is additional consumption of CFC 12 for servicing domestic refrigerators. A project has already been approved by the MLF for a "Pilot Programme for Recovery/Recycling of CFC 12 in the Domestic Refrigeration Sector". This project has recently been implemented. These new project proposals do not, therefore, address the consumption of ODS in the servicing of domestic refrigerators and freezers in Venezuela.

The 236.69 tons "ODS USE IN SECTOR" in the Project Summary Sheet, therefore, refers only to identified ODS consumption in the MANUFACTURE of domestic refrigerators and freezers in Venezuela, plus the additional consumption of Frigilux C.A. in their unitary commercial refrigeration equipment manufacturing operations, and the ODS consumption of Vecomesa in manufacturing compressors.

Famusa Domestic was only identified as a manufacturer of domestic refrigerators as this project proposal was being completed, and it was not, therefore, possible to obtain the necessary data in time to prepare a project proposal for Famusa. It is proposed that an ODS elimination project proposal for this small enterprise be prepared for submission to the autumn 1995 meeting of the MLF EXCOM.

The industry uses locally manufactured hermetic compressors, refrigerants, and PU foam chemicals but also imports raw materials and parts. Compressors are also sourced from Embraco and Sicom (Brazil), Daewoo (Korea), and L'Unite Hermetique (France).

Uninhibited growth in the manufacture of domestic refrigerators and freezers would lead to an estimated consumption in the year 2000 of approximately 280 tons per year of CFCs 11 and CFC 12.

The Foundation for the Protection of the Ozone Layer and the Environment (FONDOIN), with the assistance of UNDP, has designed a strategy for the elimination of CFC 11 and CFC 12 in the domestic refrigeration manufacturing sector beginning in 1995. Approval of this project by the MLF in July 1995 should result in the phase-out of 96.5% of CFC consumption in the manufacture of domestic refrigerators and freezers in Venezuela in 1996.

3. ENTERPRISE BACKGROUND

CORESMALT VALENCIA C.A. is the second largest manufacturer of domestic refrigerators and freezers in Venezuela and they account for approximately 35% of the total local production of such products. Coresmalt is a 100 per cent Venezuelan owned enterprise.

More details on CORESMALT VALENCIA C.A. are given below:

CFC USE IN 1993:	50.51 tons CFC 11 20.57 tons CFC 12
FULL NAME:	CORESMALT VALENCIA C.A.
PLANT LOCATION:	Av. Henry Ford-Zona Industrial Sur, Apartado Postal 458, Valencia.
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Venezuela)
No. OF MODELS:	12
PRODUCTION IN 1993:	95,646 units
No. OF PRODUCTION LINES:	4
COMPRESSOR SUPPLIERS:	Vecomesa, Venezuela (60%) L'Unite Hermetique, France (5%) Embraco, Brazil (35%)
CONTACT PERSONS:	Roberto Martinez - Vice President Javier Sorazu - Plant Manager Pablo Salas - Engineering Manager
TEL / FAX:	Tel: (58 41) 334277 Fax: (58 41) 343598

Coresmalt Valencia C.A. was founded in 1975 and is one of five companies within Grupo Insanova S.A., a large white goods production and marketing organisation. Coresmalt manufactures refrigerators, freezers, and drinking water coolers which are marketed under the "Comet" brand-name. The Insanova Group also manufactures a range of package air-conditioners using HCFC 22.

The current product range at Coresmalt comprises 10 refrigerators, an upright freezer, and a drinking water cooler.

The original refrigerator designs and technology were obtained under a license agreement with the Whirlpool Corporation. This agreement expired in 1975 and subsequently new refrigerator models were developed "in-house". Currently Coresmalt has no technology transfer or licensing agreements with any internationally recognised domestic refrigerator manufacturers.

99.8% of production is sold within Venezuela, the small balance of exports go to Colombia. These exports are the 20/24 cubic feet, "side by side" double door, no-frost, models which are not manufactured in Colombia.

Coresmalt presently employs 360 persons all of whom are engaged in refrigeration related activities.

This project encompasses all ODS consumption used in refrigerator and freezer manufacturing operations at Coresmalt Valencia C.A. that is eligible for MLF funding.

The following tables provide a summary of refrigerator and freezer production by Coresmalt Valencia C.A. during the 12 month period January to December 1993 inclusive.

Model No.	Capacity Cu ft	Description	Productio n Volume	R 12 Charge Kgs	R12 Consumption Kgs
RF 9	3.2	SD Ref	439	0.100	43.9
RF 28	10.0	SD Ref	2,865	0.128	366.7
RF 32	11.0	SD Ref	45,119	0.190.	8,572.6
RF 36	13.0	SD Ref	738	0.190	140.2
RF 37	13.0	DD Ref	11,941	0.190	2,268.8
RF 43	15.0	DD Ref	2,065	0.260	
RF 33	11.0	SD Ref NF	1,036	0.162	536.9
RF 42	15.0	DD Ref NF	16,674	0.300	167.8
RF 56	20.0	SBS Ref NF	7,397	0.256	5,002.2
RF 67	24.0	SBS Ref NF	1,170	0.380	1,893.6
RF 26	11.0	SD Frz NF	2,405	0.377	444.6
EDB	-	Botellon	3,797	0.060	906.7
					227.8
Totals or Weighted Average			95,646	0.215	20,571.8

Model No.	PU Foam per Unit Kgs	Cabinet & Door Liner per Unit Kgs HIPS	R12 Compressor HP & Price US$	R134a Compressor HP & Price US$
RF 9	1.574	(metal)	1/10 28.04	1/10 32.04
RF 28	3.074	7.165	1/8 35.29	1/8 39.48
RF 32	3.319	7.165	1/6 36.47	1/6 40.70
RF 36	3.561	7.832	1/6 36.47	1/6 40.70
RF 37	3.739	7.832	1/6 36.47	1/6 40.70
RF 43	5.110	9.379	1/5 41.17	1/5 45.35
RF 33	3.319	7.165	1/6 36.47	1/6 40.70
RF 42	5.110	9.379	1/4 43.52	1/4 47.75
RF 56	6.799	(metal)	1/3 48.82	1/3 53.17
RF 67	8.529	(metal)	1/3 48.82	1/3 53.17
RF 26	3.397	7.165	1/5 41.17	1/5 45.35
EDB	-	-	1/10 28.04	1/10 32.04
Weighted Average	3.912	6.728	38.62	42.84

Key: SD = Single Door DD = Double Door Ref = Refrigerator
Frz = Freezer NF = No Frost SBS = Side by Side

4. PROJECT DESCRIPTION

Coresmalt Valencia presently uses CFC 11 for the production of rigid insulating foams needed for the refrigerator and freezer cabinets and doors, and uses CFC 12 as refrigerant. The total consumption in the 12 months January - December 1993, and the ODP tons that will be eliminated by this project are shown in the following table:

Enterprise	CFC 11 (tons)	ODP tons eliminated (see Note*)	CFC 12 (tons)	Total ODP tons eliminated
Coresmalt	50.51	44.95	20.57	65.52

Note: *The second column of figures for CFC 11 takes the ODP of HCFC 141b into account (ODP = 0.11).

It should be noted that Coresmalt has FOUR independent production lines in two quite separate factory buildings. The differring nature and volumes of the product range does not permit rationalisation.

4.1. REPLACEMENT OF CFC 11 WITH HCFC 141b.

Coresmalt C.A. will replace the CFC 11 used as a blowing agent in the production of the insulation foam with HCFC 141b as an interim step to an ODS-free system.

The enterprise currently has TWO PU foam dispensing systems. The main system dating from 1975 is based on a Mobay HKA 1000H high pressure machine for cabinet and door foaming. HCFC 141b can be used in this Mobay high pressure equipment with some modest retrofitting, including the replacement of seals and hoses with HCFC 141b compatible materials. Extensive trialling and training will, however, be necessary.

The second low pressure machine is used to foam some models of refrigerator cabinets on a separate production line. It is proposed that this machine be replaced with a high pressure foam dispensing system of equivalent capacity.

Both the existing high pressure foam dispensing machine, and the replacement high pressure machine, can also be used with most of the established, or developing, zero-ODP systems, although machine and equipment modifications will be necessary to safely handle flammable blowing agents such as cyclo-pentane.

The conversion to HCFC 141b will incur costs related to technology transfer, trialling and training at Coresmalt. These activities will include training of staff in worker-safety related to HCFC 141b.

Details of the existing foam injection equipment are provided in section 5.1.3.

Incremental Operational Costs associated with the technology change from CFC 11 to HCFC 141b are requested for a period of six months.

4.2. REPLACEMENT OF CFC 12 WITH HFC 134a.

HFC 134a is universally accepted as a zero-ODP replacement for CFC 12 in the manufacture of domestic refrigerators and the technology is mature. This is the CFC replacement technology selected by Coresmalt.

The conversion to HFC 134a requires the use of HFC 134a specific compressors and the associated new synthetic lubricants, re-design of the refrigeration systems to cater for the difference in thermodynamic performance of HFC 134a versus CFC 12, prototyping, testing and optimization of each refrigerator model, and pilot scale manufacture and testing before full scale conversion of production to HFC 134a for each model. The conversion will result in changes in manufacturing procedures for which production line supervisor and operator training will be required.

The different properties of HFC 134a, the need to avoid cross-contamination with CFC 12, and the phased nature of the conversion of refrigerator production from CFC 12 to HFC 134a, means that new system evacuation, refrigerant charging, and leak detection equipment will be required.

Details of the existing equipment on which the technology change will impact are provided in section 5.2.3.

Incremental Operational Costs associated with the technology change from CFC 12 to HFC 134a are requested for a period of six months.

5. TECHNOLOGY

5.1. REPLACEMENT OF CFC 11.

5.1.1. OVERVIEW

Currently, the three principal technology options for the replacement of CFC 11 in thermoset insulation foams are:

CFC 11 > partial water/HCFC 141b > ?
CFC 11 > partial water/HCFC 22,142b > HFC 134a, HFC 152a
CFC 11 > n-, iso-, or cyclo-, pentane

In addition, perfluoroalkanes, hydrofluoroalkanes such as HFCs 245, 356, etc., fluorinated ethers, 2-chloropropane, and vacuum panels have been suggested for specific applications, but the technologies are not mature. Furthermore, some of these products are either only available in limited quantities, or toxicological testing is not complete and, therefore, safety in use cannot be evaluated.

The first option, the "liquid" solution, employs technology that is closely related to the existing CFC 11 technology and generally means that existing foam dispensing equipment can be used. The final step to a zero-ODP technology in this process is not yet decided. One potential solution may be the use of liquid HFCs such as HFC 245 or HFC 356, but full water blown foam with improved cell structure remains another option.

The second one, the "gas" solution, utilizes physical blowing agents which are liquefied gases. This technology always requires new foam dispensing equipment and extensive adjustments. The final step to a zero-ODP technology in this process would be the use of a gaseous HFC such as HFC 134a.

The third option, pentane technology, is commercially proven and is now extensively used in many rigid PU insulation foam applications in Europe. It is currently the most cost effective of the non-ODS technologies for CFC replacement. However, pentanes are flammable and this means a careful review of manufacturing operations with respect to the safe handling of a flammable foam blowing agent.

Pentane technology may not be a practical or cost effective option in the existing workplace environments at many smaller scale enterprises due to the plant safety modifications required.

Several companies currently offer pentane technology packages, including equipment. Its use certainly requires implementation assistance and UNDP further requires an independent safety review prior to, and after, installation.

5.1.2. SELECTION

Based on economic and environmental considerations, cyclo-pentane appears to be the best choice for domestic refrigerator and freezer applications. It combines an attractive price with zero-ODP, and near-zero GWP properties, as well as acceptable foam insulation qualities. Coresmalt considered cyclo-pentane technology, and a cyclo-pentane based project is viable within the cost effectiveness threshold of US$ 13.76 after allowance for safety related costs. However, whilst recognising both the environmental and economic benefits of cyclo-pentane versus HCFC 141b, Coresmalt selected HCFC 141b as a first stage, interim, replacement for CFC 11.

Considerations that influenced the Coresmalt decision in favour of HCFC 141b technology, include the following:

- HCFC 141b is presently the technology selected by their principal competitor (Madosa).

- HCFC 141b technology can be introduced quickly, utilising the existing equipment, with minimal investment cost and plant downtime.

- whilst cyclo-pentane technology could be introduced by the provision of the necessary safety equipment, cyclo-pentane storage and blending facilities, and retrofit of the existing foam dispensing machines, for Coresmalt this would involve a major, and unacceptable, disruption of plant operations and loss of production.

- Coresmalt look to the USA for guidance on CFC replacement technology and Coresmalt believe that a zero-ODP solution other than pentane based technology will be commercially developed by the US refrigerator manufacturers. With the difficult economic climate in Venezuela at the present time, Coresmalt wish to take the interim step into HCFC 141b, and review the zero-ODP options in 2 -3 years time.

The selection of HCFC 141b technology as the immediate replacement for CFC 11 by Coresmalt is a realistic and sensible choice under the prevailing circumstances. Relatively modest funding is requested to achieve this and the technology choice is supported by the FONDOIN. Coresmalt understand that HCFC 141b is an interim solution which will require a change to an appropriate zero-ODP technology at some future date. Funding is requested to facilitate these changes but Coresmalt also understand and accept that all future costs associated with that subsequent technology change is for its own account.

5.1.3. IMPACT ON THE PRODUCTION PROCESS

HCFC 141b is a non-flammable liquid (no flash point), but moderately flammable in the gaseous state. The flammability limits are 7.6 - 17.1% by volume in air. The usually recommended PEL (Permissable Exposure Limit) is 500 ppm on an eight-hour time-weighted average. In the intended application, the use of HCFC 141b should not pose a significant risk, but UNDP will, as part of its safety audit programme, perform a monitoring check at commissioning to ensure the adherence to safe worker exposure levels. Ventilation will be installed if the results indicate the need.

The refrigerator and freezer models produced by Coresmalt use HIPS cabinet and door liners. A modified HIPS liner material which is resistant to HCFC 141b will be required.

Foam density adjustments will be necessary to obtain equivalent insulation values.

Coresmalt currently has two PU foam dispensing systems. The main system dating from 1975 is based on a Mobay HKA 1000H high pressure machine with a maximum throughput of 180 Kgs/minute. This has seven mixing heads for cabinet foaming and a separate, independently operable mixing head for door foaming. All doors are foamed using this machine. HCFC 141b technology can be introduced utilising this Mobay high pressure equipment with some modest retrofitting, including the replacement of seals and hoses. Provision for this is included in the project budget. Production trials and testing will be required prior to the introduction of full scale refrigerator production with HFC 141b using this equipment.

A second low pressure machine is used to foam some models of refrigerator cabinets. This is an Admiral 1000-2P/F machine dating from 1981 with a single mixing head and a maximum throughput of 45 Kgs/minute. To facilitate the final change to non-ODS technoloy it is proposed that this machine be replaced with a high pressure foam dispensing system of equivalent capacity and this is also included in the project budget. Production trials and testing will be required.

5.2. REPLACEMENT OF CFC 12.

5.2.1. OVERVIEW

HFC 134a is universally accepted as a replacement for CFC 12 in the manufacture of domestic refrigerators. HFC 134a is widely available and the technology is mature. Replacement of CFC 12 with HFC 134a requires relatively modest changes to existing production facilities.

Whilst hydrocarbon refrigerant (iso-butane) is being increasingly used in the manufacture of domestic refrigerators in several Developed Countries, the transfer of this technology to Developing Countries is not always cost effective. It also raises questions about safety issues and remains conditional on the support of a technology partner experienced in the production of comparable refrigerators and freezers on a commercial scale. It is further dependent on the technology partner providing assurances in writing on safety issues, and, of course, the availability of adequate supplies of both compressors and hydrocarbon refrigerant of the required quality.

HFC 152a might be considered another candidate for CFC 12 replacement in domestic refrigerators. However, HFC 152a is also flammable, the technology has not been developed commercially, and there are some questions around it's stability in refrigerator systems. Furthermore, compressors for use with HFC 152a are not commercially available.

5.2.2. SELECTION

Based on the results of discussions with compressor suppliers and participation in technical workshops on non-CFC technology etc., the CFC 12 replacement technology selected by Coresmalt is HFC 134a.

The new HFC 134a technology will be developed "in-house" with assistance from compressor and refrigerant suppliers. Coresmalt does not currently have any formal technology transfer agreements and additional technical assistance will be required in implementing the HFC 134a technology. This will be obtained from Vecomesa and Embraco, Coresmalt's main compressor suppliers, as well as the refrigerant supplier, and the relevant UNDP consultants. Provision for this is made within the project budget which will ensure successful project completion.

5.2.3. IMPACT ON THE PRODUCTION PROCESS

HFC 134a, like CFC 12, is non-flammable. HFC 134a has also been the subject of extensive toxicological testing and is considered safe in use in industrial applications provided the suppliers recommended occupational exposure levels are not exceeded. At the present time this means ensuring that exposure levels do not exceed 1000 parts per million on an 8-hour time-weighted average basis. This is the same as the Occupational Exposure Limit (OEL)/Threshold Limit Value (TLV) for CFC 12 and thus no changes from current practices are required.

There will be an approximately 10% reduction in the mass charge of HFC 134a compared with CFC 12 for a refrigerator system of the same capacity. This is taken into account in the calculation of the incremental operational costs.

It is well understood that the chemical stability of HFC 134a/synthetic lubricant systems in domestic refrigerators, and hence the long term performance of the appliance, is sensitive to moisture content and certain chlorinated impurities. This requires that CFC 12 and HFC 134a handling equipment be carefully segregated, and it also calls for better evacuation of the system prior to refrigerant charging.

Because system cleanliness and moisture content is paramount to the successful manufacture of HFC 134a refrigerators, Coresmalt will need to critically re-assess production procedures and re-train its production personnel as appropriate. Provision for this is made within the project proposal budget.

The conversion from CFC 12 to HFC 134a will take place on a model by model basis, so that Coresmalt will be producing both CFC 12 and HFC 134a refrigerators during the implementation phase of this project. This is feasible given the configuration of the company's production facilities. This means that there is a requirement for new system evacuation equipment and refrigerant charging equipment.

Leak detection of the refrigeration system is an integral part of the manufacturing process and the use of HFC 134a requires that new leak detection equipment be employed.

The relevant existing equipment at Coresmalt Valencia on which the technology change to HFC 134a will impact is as follows:

- 2 x Galileo V210F automatic R12 charging machines
- 1 x PCU automatic R12 charging machine
- 1 x Airseco model AVC.1P8TLB-23 R12 charging machine
- 1 x Danfoss 118x5000 R12 charging machine
- 2 x Robinair "Dial a Charge" R12 charging units
- 34 x Kinney KC 15 dual stage vacuum pumps, 25.6 M3/hr
- 16 x Kinney KC 5 dual stage vacuum pumps, 8.8 M3/hr
- 1 x Stokes 21-2H10 vacuum pump
- 1 x Stokes 612-30 vacuum pump
- 4 x GE H10B hand-held electronic R12 leak detectors
- 1 x TIF 5050 hand-held electronic R12 leak detector

The refrigerant charging equipment and vacuum pumps listed above serve the following production lines:

The Robinair "Dial a Charge" units are used for development.

<u>Main Production Line (Models 28, 32, 36, 37, 43, 42)</u>

2 x Galileo V210 charging machines, 1 in use, 1 on standby.
33 Kinney KC 15 vacuum pumps, 30 in use, 3 on standby.

<u>Production Line 2. (Models 26, 33, 9)</u>

Airseco charging machine.
6 x Kinney KC 5 vacuum pumps, all in use.

<u>Production Line 3. (Models 56, 67)</u>

PCU Charging machine.
10 x Kinney KC 5 vacuum pumps (in use).
1 x Stokes 612-30 vacuum pump (normally on standby).

<u>Production Line 4 (Model EDB)</u>

Danfoss 118x5000 charging machine.
1 x Kinney KC 15 vaccum pump (in use).
1 x Stokes 21-2H10 vacuum pump (in use).

The project proposal includes provision for ONE new R134a charging machine of equivalent capacity for each production line. Replacement vacuum pumps are requested on the following basis:

Main Production Line	4 new vacuum pumps
Production Line 2.	2 new vacuum pumps
Production Line 3.	2 new vacuum pumps
Production Line 4.	2 new vacuum pumps

Provision is made for retrofit of the remaining vacuum pumps where considered feasible, or the funding provided for retrofitting will be used by Coresmalt towards the purchase of new vacuum pumps, at their own discretion.

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

RETROFIT OF EXISTING HIGH PRESSURE FOAM MACHINE	10,000
NEW HIGH PRESSURE FOAM MACHINE (45 Kgs/min)	100,000
TRAINING, TEST TRIALS & TECHNOLOGY TRANSFER	20,000
CONTINGENCIES (10%)	13,000
Subtotal (US$)	143,000

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (Main Line)	60,000
REFRIGERANT CHARGING EQUIPMENT (Line 2.)	30,000
REFRIGERANT CHARGING EQUIPMENT (Lines 3. & 4.)	45,000
REFRIGERANT CHARGING EQUIPMENT (Development)	2,500
NEW VACUUM PUMPS (10 off)	30,000
RETROFITTING VACUUM PUMPS (42 off)	21,000
LEAK DETECTION EQUIPMENT (5 off)	5,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION & RELIABILITY TEST TRIALS (12 models)	45,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	25,500
Subtotal (US$)	284,000
TOTAL INCREMENTAL CAPITAL COST (US$)	427,000

6.2 INCREMENTAL OPERATING COSTS

The calculation of the incremental operating costs is based on a six month period using 50% of the actual production for January to December 1993 inclusive. Annex A. provides detailed explanations on how the incremental operational costs were obtained, the costs are summarized below:

PHASE-OUT OF CFC 11	
Costs for Materials (see Annex A. Part 1.):	162,359
PHASE-OUT OF CFC 12	
Costs for Materials (see Annex A. Part 2.):	272,161
TOTAL INCREMENTAL OPERATING COST (US$)	434,520

6.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational) (US$)	861,520
% Article 5.1 Country Ownership	100%
FUNDING REQUESTED FROM MLF (US$)	861,520

6.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	427,000
b. Capital Recovery Factor (10% p.a.)	0.16275
c. Incremental Operating Costs	434,520
d. ODS Reduction (ODP Kgs Jan - Dec 1993)	65,520
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	7.69

THE PROJECT UNIT ABATEMENT COST IS 7.69 US$/Kg

6.5 COST EFFECTIVENESS (US$/Kg)

TOTAL PROJECT COST	=	861,520 US$
LESS PROJECT SAFETY RELATED COSTS	=	n/a
TOTAL ODS ELIMINATED	=	65,520 ODP Kgs
PROJECT COST EFFECTIVENESS	=	13.15 US$/Kg

THE PROJECT COST EFFECTIVENESS IS 13.15 US$/Kg

This is below the threshold value of 13.76 US$/Kg established by the Executive Committee of the MLF at its 16th meeting in March 1995 for projects in the Domestic Refrigeration sector.

7. FINANCING PLAN

Coresmalt C.A. requests reimbursement from the MLF of the sum of US$ 861,520, representing the incremental Capital and Operational costs of this ODS elimination project, correctly taking into account the 100% Article 5.1 country ownership of the enterprise.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP will oversee the successful implementation of this project, and will provide technical assistance during project execution.

8.2 SCHEDULE

TASK	TIME TO COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
MLF Approval	X					
Procurement Preparation	XX	X				
Vendor Selection		XX				
2. Installation						
Arrival of Equipment		XX				
Customs Clearance		X				
Machine Installation		X	X			
3. Start-Up						
Machine Start-up			X			
Trials & Training			XXX	XXX	XX	
Mass Production Change					X	XX
Certification						X

9. PROJECT IMPACT

Based on data for the 12 months, January - December 1993, this project will eliminate the use of 65.52 ODP tons per year.

10. ANNEXES

Annex A. - Incremental Operational Cost Calculations.
Annex B. - Project Technical Reviews.

ANNEX A. INCREMENTAL OPERATIONAL COST CALCULATIONS

1. <u>Incremental Costs resulting from replacing the CFC 11 Blowing Agent in the Refrigerator Insulation Foam with HCFC 141b (US$)</u>

CORESMALT VALENCIA C.A.	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.355	0.368	0.013
b. MDI	0.510	0.510	-
c. Kg Blowing Agent	0.135	0.122	(0.013)
Prices in US$/Kg			
d. Polyol	2.61	2.74	0.13
e. MDI	2.15	2.15	-
f. Blowing Agent	2.00	4.00	2.00
g. Liner (Type: HIPS)	1.72	1.90	0.18
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.927	1.008	0.081
i. = b. x e. MDI	1.097	1.097	-
j. = c. x f. Blowing Agent	0.270	0.488	0.218
k. = h+i+j Total Cost per Kg of Foam	2.294	2.593	0.299
Materials Used per Refrigerator			
l. Kg of Foam per Refrigerator (avg)	3.912	4.303	0.391
m. Kg of Liner material per refrigerator (avg)	6.728	6.728	-
Cost per Refrigerator			
n. = l. x k. for Foam	8.974	11.158	2.184
o. = m. x g. for Liner	11.572	12.783	1.211
p. = n. + o. Total per Refrigerator	20.546	23.941	3.395
q. = No. of Refrigerators (see Note 1.)	47,823		
TOTAL INCREMENTAL OPERATIONAL COST (US$)	162,359		

(see Notes 1., and 2. below)

2. Incremental Costs resulting from replacing the CFC 12 Refrigerant with HFC 134a (US$)

CORESMALT VALENCIA C.A.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.60	8.50	
b. Kg of Refrigerant per Refrigerator (avg.)	0.215	0.194	
c. No. of Refrigerators Produced (see Note 1.)	47,823	47,823	
1d. Cost for Refrigerant = a x b x c	26,733	78,860	52,127
2. Compressors			
a. Cost per Compressor (see Note 2.)	36.77	41.08	
b. No. of Compressors (see Note 1.)	47,823	47,823	
2c. Cost for Compressors = a x b	1,758,452	1,964,569	206,117
3. Condensers			
a. Cost per Condenser	N/C	N/C	
b. No. of Condensers	47,823	47,823	
3c. Cost for Condensers = a x b	-	-	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.593	0.723	
b. No. of Filter/Dryers (see Note 1.)	47,823	47,823	
4c. Cost for Filter/Dryers = a x b	28,359	34,576	6,217
5. Capillary Tubes			
a. Cost per Capillary Tube (average)	0.721	0.882	
b. No. of Capillary Tubes (see Note 1.)	47,823	47,823	
5c. Cost for Capillary Tubes = a x b	34,480	42,180	7,700
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)	272,161		

Notes relating to the calculation of Incremental Operational Costs

Note 1. Figures in the above tables are based on the actual production volume for the 12 month period January to December 1993 obtained from Coresmalt Valencia C.A. at the time of project preparation. As Incremental Operational costs are claimed for 6 months only, 50% of this 12 months production volume has been used in the calculation.

Note 2. Refrigerant, chemical, and compressor prices used in the above tables are weighted average prices for the principal domestic and commercial refrigerator manufacturers in Venezuela.

Note 3. The calculated incremental costs for the HFC 134a refrigerant are based on a 10% reduction in the mass charge compared with CFC 12.

TECHNICAL REVIEW.

1.Country:

Venezuela.

2.Project Title:

Elimination of CFCs 11 and 12 at four Domestic Refrigeration Manufacturers, and conversion of one Compressor Manufacturer.

3.(Sub)Sector:

(Domestic) Refrigeration.
This review covers only the foam part.

4.CP-Relationship:

The Venezuelan CP for phase-out of ODS is actually in preparation. It is believed that the CP will be presented at the 16th Meeting of the Executive Committee of the MLF in March 1995.
Beginning 1995, the "Foundation for the Protection of the Ozone Layer and the Environment" (FONDOIN), assisted by UNDP has assigned a strategy for CFC elimination in the domestic refrigeration sector.

5.Technology:

5.1.CORESMALT
Coresmalt will replace CFC11 with HCFC 141b.As an interim step to an ODS free technology; this can be accepted.
It can be agreed to replace the low pressure Admiral machine with a high pressure one, with equivalent capacity.

5.2 MADOSA.
Madosa wants to substitute CFC 11 with HCFC 141b as an interim step to a total ODS free technology.
Since three HP machines are available, no replacement is proposed in the project.

The two other firms, MUEBLES ETERNA and VECOMESA either do not use CFCs in the production of the insulation panels, or do not deal with refrigeration boxes.
They are hence not discussed in this review.

6. Environmental Impact:

The ODP of HCFC 141b is 0.11 versus 1.0 for CFC 11. The GWP of HCFC 141b is 10% of the GWP of CFC 11. The smog potential of HCFC 141b is 1.0 versus 0.1 for CFC 11 (as a reference: pentane 500)

7. Project Costs:

7.1. CORESMALT.
All elements mentioned in the incremental capital costs can be accepted. The USD 20,000 for training is also justified, since trials must be performed at two machines.
The incremental operation costs calculation is correct and can be accepted.
The cost for elimination of 1 kg of ODS is then USD (132,000+162,359)/44,950, or USD 6.55.

7.2 MADOSA.
The incremental capital costs, as well the incremental operational costs are correct, and can be accepted.
The cost for elimination of 1 kg of ODS becomes:
USD (33,000 + 299,464)/75,330 or USD 4.41.

8. Implementation:

The proposed implementation can be accepted as such.

9. Recommendation:

It is proposed to accept the foam part of the three projects discussed.

H Creyf

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date: 20 February 1995.

Country of origin: VENEZUELA

Project title: Elimination of CFCs 11 and 12 at FOUR Domestic Refrigerator Manufacturers (Coresmelt Valencia C.A., Grupo Frigilux C.A., Madosa S.A., Muebles Eterna C.A.), and conversion of ONE compressor manufacturer (Vecomesa S.A.)

Sector/sub-sector Domestic refrigeration

Relationship to country program UNDP (CP in preparation)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

- All manufacturers in this project have chosen for a conversion of their production to the HFC-134a technology.
- In domestic refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.
- Three companies in this project (Coresmalt, Frigilux and Eterna) do not have a formal technology transfer agreement. However, all these companies plan to develop the HFC-134a technology with assistance from compressor and refrigerant suppliers. Furthermore provisions for external assistance are present. Due to these facts, a successful project implementation can be expected at these companies. The fourth refrigerator manufacturer (Madosa) does have an ongoing technology transfer agreement with General Electric, USA and the compressor manufacturer Vecomesa has a technology licence agreement with Tecumseh, USA. Both agreements include support for the HFC-134a conversion process, so also for the latter two manufacturers a successful project implementation can be anticipated.
- During the review process two technology aspects in this project were discussed in depth with the UNDP consultant and the relevant companies:
    1. The Madosa company will obtain new HFC-134a compressors without lubricant. This is in contrast to the currently applied production procedure and therefore requires investments in oil storage, charging and dehydration equipment. On-line oil charging of compressors does have certain advantages in quality control but is not strictly necessary (namely, a large number of companies do apply compressors which are oil charged by the compressor manufacturer). However, on-line oil charging is a requirement put forward by the technology supplier (G.E.) and forms an essential part of the technology to be transferred. Costs of the related equipment are therefore considered essential for the conversion process.
    2. The compressor manufacturer Vecomesa will switch from a Tecumseh "AE" design for CFC-12 to a, higher efficient, "AZ" design for HFC-134a for the larger part of their production. This change in design does lead to additional investments in production equipment (e.g. presses, welding and brazing machines etc.). In fact the change from "AE" to "AZ" technology does include a technology upgrade to higher efficient products. However, it is demonstrated by the company that there is no alternative for this selection as no "AE" designs for HFC-134a are available by Tecumseh, in the capacity range considered. Therefore, these additional costs have to be considered as eligible incremental costs.
- Technologies other than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of the state of development, safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

Environmental impact

HFC-134a has an ODP of zero and a GWP of 0.27. For domestic refrigeration a GWP of this magnitude is negligible.

Project costs

- The equipment requested by all manufacturers is essential for the conversion process (see statements above). Costs of equipment, training and testing are reasonable.
- Incremental operational costs are reasonable and correctly applied (for six months).
- If the UAC values are calculated for the refrigerant conversion part of the projects separately, then the following values are obtained:

Coresmelt Valencia	15 USD/kg/y
Frigilux	19 USD/kg/y
Madosa	6 USD/kg/y (only 25 % local ownership)
Muebles Eterna	78 USD/kg/y

  Besides the value for Eterna, these values are reasonable compared to other, similar, projects. The high UAC value for Muebles Eterna is caused by the small size of the company. For Vecomesa an artificial UAC value of 2.9 USD/kg/y (41.35 % country ownership) is calculated based on the current compressor production and an average charge of the appliances to be produced with these compressors of 0.1 kg. The resulting UAC value is relatively low compared to other, similar, projects.
- The foreign ownership of the different companies is correctly taken into account.

Implementation timeframe

Reasonable.

Relevance and adequacy of information provided

Sufficient information was obtained from the project proposal together with comments from the UNDP consultant and the companies.

Recommendations

Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands
15-February-1995

Kuijpers L.J.M.,
University Eindhoven, The Netherlands

PROJECT COVER SHEET

COUNTRY:	**VENEZUELA**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at MADOSA S.A.
SECTOR COVERED:	Domestic Refrigeration (Mfg)
ODS USE IN SECTOR:	236.69 tons ODS
PROJECT IMPACT (ODP):	93.04 ODP tons
TOTAL PROJECT COST:	US$ 1,216,496
INCREMENTAL CAPITAL COST:	US$ 583,000
INCREMENTAL OPERATING COST:	US$ 633,496
PROPOSED MLF GRANT:	US$ 304,124
UNIT ABATEMENT COST:	1.96 US$/Kg
COST EFFECTIVENESS:	13.08 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	FONDOIN
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	December 1994/May 1995

PROJECT SUMMARY:

MADOSA S.A.is a 25% Venezuelan-owned company manufacturing domestic refrigerators and freezers primarily for sale in Venezuela. Madosa currently uses CFC 11 as a blowing agent in the production of rigid polyurethane insulation foam for the refrigerator cabinets and doors, and CFC 12 is used as the refrigerant. Based on 1993 figures, this project will eliminate 93.04 ODP tons/yr of CFCs 11 and 12 by conversion to the use of HCFC 141b as the foam blowing agent and HFC 134a as the refrigerant respectively. Funds requested will be used to change the existing production lines, and for technology transfer, technical assistance, re-design, testing, pre-production trials, and training. Incremental operational costs resulting from the conversion to the new technology (6 months only) are also included.

Prepared by: Stuart Kelly, in collaboration with the Foundation for Protection of the Ozone Layer and the Environment (FONDOIN).

Reviewed by: Dr L.J.M. Kuijpers/Dr M.J.P. Janssen (Refrigeration) and Dr H. Creyf (Foam). Their comments are attached.

PROJECT OF THE GOVERNMENT OF VENEZUELA

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFCs used by MADOSA S.A. in the manufacture of domestic refrigerators and freezers. CFC 11 is used as the blowing agent for producing the PU thermal insulating foams for the refrigerator cabinets and doors, and this will be eliminated by conversion to HCFC 141B. CFC 12, used as the refrigerant, will be replaced by HFC 134a.

2. SECTOR BACKGROUND.

The Venezuela Country Programme (CP) for the Phase-out of Ozone Depleting Substances (ODS) under the Montreal Protocol is presently in the course of preparation. It is anticipated that the CP will be presented to the 17th meeting of the Executive Committee of the Multilateral Fund for the Montreal Protocol in July 1995.

Due to the economic situation in Venezuela, 1994 data is not representative of either typical domestic refrigerator production volume, or ODS consumption. This project is, therefore, based on 1993 calender year data.

In preparing this project proposal, the following data for the 12 months January - December 1993 inclusive, was established as the best estimate of CFC consumption for the manufacture of domestic refrigerators and freezers in Venezuela. ODS elimination project proposals are being presented to the Montreal Protocol Multilateral Fund for the FOUR enterprises indicated in bold type, who account for 96.7% of domestic refrigerator and freezer production in Venezuela.

Enterprise	Production Volume	CFC 11 Consumption (Tons)	CFC 12 Consumption (Tons)
Coresmalt Valencia	95,646	50.51	20.57
Frigilux	41,605	27.73	4.85
Madosa	126,437	84.64	17.71
Muebles Eterna	3,153	-	0.38
Famusa Domestic	6,500	4.68	0.78
Others	2,500	1.80	0.30
Totals	275,841	169.36	44.59

The preceding Table relates to the DOMESTIC REFRIGERATION sector only. It should be noted that Frigilux C.A. is also engaged in the manufacture of unitary commercial refrigeration equipment. The production volumes and ODS consumption related to this activity are included in the project proposal for ODS elimination at Frigilux.

96.0% of the domestic refrigerators and freezers manufactured in Venzuela are sold in the local market. It is estimated that around 70,000 domestic refrigerators/freezers were also imported for sale in Venezuela in 1993, sourced from a variety of countries including Mexico, Colombia, USA, and Korea.

4.0% of local production, around 11,000 refrigerators are exported to other Latin American countries, principally Colombia and Ecuador.

This consumption of 213.95 ODP tons in the manufacture of domestic refrigerators and freezers represents approximately 7% of the total ODS consumption in the refrigeration and air-conditioning sector in Venezuela which was estimated at 3,200 tons in 1993.

There is additional consumption of CFC 12 for servicing domestic refrigerators. A project has already been approved by the MLF for a "Pilot Programme for Recovery/Recycling of CFC 12 in the Domestic Refrigeration Sector". This project has recently been implemented. These new project proposals do not, therefore, address the consumption of ODS in the servicing of domestic refrigerators and freezers in Venezuela.

The 236.69 tons "ODS USE IN SECTOR" in the Project Summary Sheet, therefore, refers only to identified ODS consumption in the MANUFACTURE of domestic refrigerators and freezers in Venezuela, plus the additional consumption of Frigilux C.A. in their unitary commercial refrigeration equipment manufacturing operations, and the ODS consumption of Vecomesa in manufacturing compressors.

Famusa Domestic was only identified as a manufacturer of domestic refrigerators as this project proposal was being completed, and it was not, therefore, possible to obtain the necessary data in time to prepare a project proposal for Famusa. It is proposed that an ODS elimination project proposal for this small enterprise be prepared for submission to the autumn 1995 meeting of the MLF EXCOM.

The industry uses locally manufactured hermetic compressors, refrigerants, and PU foam chemicals but also imports raw materials and parts. Compressors are also sourced from Embraco and Sicom (Brazil), Daewoo (Korea), and L'Unite Hermetique (France).

Uninhibited growth in the manufacture of domestic refrigerators and freezers would lead to an estimated consumption in the year 2000 of approximately 280 tons per year of CFCs 11 and CFC 12.

The Foundation for the Protection of the Ozone Layer and the Environment (FONDOIN), with the assistance of UNDP, has designed a strategy for the elimination of CFC 11 and CFC 12 in the domestic refrigeration manufacturing sector beginning in 1995. Approval of this project by the MLF in July 1995 should result in the phase-out of 96.5% of CFC consumption in the manufacture of domestic refrigerators and freezers in Venezuela in 1996.

3. ENTERPRISE BACKGROUND

MADOSA S.A. is the largest manufacturer of domestic refrigerators and freezers in Venezuela and they account for approximately 46% of the total local production of such products. Madosa is a 25% Venezuelan owned enterprise, with Enron, USA, (42%) and General Electric Co., USA, (33%), making up the balance.

CFC USE IN 1993:	84.64 tons CFC 11 17.71 tons CFC 12
FULL NAME:	Manufacturera de Aparatos Domesticos S.A. (MADOSA)
PLANT LOCATION:	Interseccion La Raiza con Carretera Nacional, Santa Teresa del Tuy, Edo Miranda, Venezuela.
% ARTICLE 5 COUNTRY OWNERSHIP:	25% (Venezuela)
No. OF MODELS:	6
PRODUCTION IN 1993:	126,437 units
No. OF PRODUCTION LINES:	2
COMPRESSOR SUPPLIERS:	Vecomesa, Venezuela (100%)
CONTACT PERSONS:	Tomas Wachter - Marketing Director Luis Pernas - Plant Manager George Sawnson - Operations Manager Antonio Pitelli - Prod. Eng. Manager
TEL / FAX:	Tel: (58 2) 9041525 Fax: (58 2) 9041550

Madosa S.A. was founded in 1961 and is engaged in the manufacture, distribution, and service of an extensive range of domestic appliances, including domestic refrigerators and freezers. The products are marketed under the General Electric (GE), Admiral, and Condesa brand-names. Madosa also manufacture a range of package air-conditioners using HCFC 22.

The current product range comprises 5 refrigerators, and an upright freezer.

Madosa was originally established as an enterprise manufacturing domestic cooking stoves. Madosa today is the result of several enterprise mergers including Siadca (an Admiral subsidiary) and General Electric Venezuela. The original refrigerator designs thus came from both Admiral and GE. The Enron capital share in Madosa stems from the early days of Madosa operations making cooking stoves. Enron is involved in the oil and gas industry and has no direct connection with the domestic appliance industry.

There is an ongoing GE Appliances - Madosa technical agreement which will cover all aspects of the CFC elimination programme at Madosa including design, evaluation, quality, and manufacturing. This allows for up to 30 man days per year of consultation. (See attached Annex 3.A)

95.0% of production is sold within Venezuela, the balance of exports go to Colombia (3.5%) and Ecuador (1.5%). These exports are primarily the 21.5 cubic feet, "side by side" double door, no-frost, model which is not manufactured in Colombia and Ecuador.

Madosa employs a total of 1,800 persons, some 700 of whom are engaged in the refrigeration related activities.

This project encompasses all ODS consumption used in refrigerator and freezer manufacturing operations at Madosa S.A. that is eligible for MLF funding.

The following tables provide a summary of refrigerator and freezer production by Madosa S.A. during the 12 month period January to December 1993 inclusive.

Model No.	Capacity Cu ft	Description	Production Volume	R 12 Charge Kgs	R12 Consumption Kgs
12 STD	12.0	SD Ref	65,131	0.129	8,401.9
14 STD	14.0	SD Ref	12,572	0.142	1,785.2
13 VF	13.0	SD Frz NF	6,176	0.142	877.0
15 DT	15.0	DD Ref NF	21,679	0.129	2,796.6
T 14	14.0	DD Ref	4,589	0.282	1,294.1
22 DX	21.5	SBS Ref NF	16,290	0.157	2,557.5
Totals or Weighted Average			126,437	0.140	17,712.3

Model No.	PU Foam per Unit Kgs	Cabinet & Door Liner per Unit Kgs HIPS	R12 Compressor HP & Price US$	R134a Compressor HP & Price US$
12 STD	4.509	7.252	1/6 33.55	1/6 37.78
14 STD	6.850	10.075	1/6 33.55	1/6 37.78
13 VF	6.850	8.700	1/4 40.05	1/4 44.28
15 DT	7.447	11.360	1/4 40.05	1/4 44.28
T 14	5.881	10.050	1/4 40.05	1/4 44.28
22 DX	7.318	16.370	1/3 44.92	1/3 49.27
Weighted Average	5.771	9.584	36.68	40.93

Key: SD = Single Door DD = Double Door Ref = Refrigerator
Frz = Freezer NF = No Frost SBS = Side by Side

4. PROJECT DESCRIPTION

Madosa presently uses CFC 11 for the production of rigid insulating foams needed for the refrigerator and freezer cabinets and doors, and uses CFC 12 as refrigerant. The total consumption in the 12 months January - December 1993, and the ODP tons that will be eliminated by this project are shown in the following table:

Enterprise	CFC 11 (tons)	ODP tons eliminated (see Note*)	CFC 12 (tons)	Total ODP tons eliminated
Madosa	84.64	75.33	17.71	93.04

Note: *The second column of figures for CFC 11 takes the ODP of HCFC 141b into account (ODP = 0.11).

4.1. REPLACEMENT OF CFC 11 WITH HCFC 141b.

Madosa S.A. will replace the CFC 11 used as a blowing agent in the production of the insulation foam with HCFC 141b as an interim step to an ODS-free system.

The enterprise currently has THREE high pressure PU foam dispensing machines, which are separately used for refrigerator cabinet and door foaming operations. Trials using the existing high pressure foam injection machines have already demonstrated that HCFC 141b can be successfully introduced with relatively minor modifications involving the change of some seals and hoses etc.

The same dispensing machines can also be used with most of the established, or developing, zero-ODP systems, although machine and equipment modifications will be necessary to safely handle flammable blowing agents such as cyclo-pentane.

The conversion to HCFC 141b will incur some costs related to technology transfer, trialling and training at Madosa. These activities will include training of staff in worker-safety related to HCFC 141b.

Details of the existing foam injection equipment are provided in section 5.1.3.

Incremental Operational Costs associated with the technology change from CFC 11 to HCFC 141b are requested for a period of six months.

4.2. REPLACEMENT OF CFC 12 WITH HFC 134a.

HFC 134a is universally accepted as a zero-ODP replacement for CFC 12 in the manufacture of domestic refrigerators and the technology is mature. This is the CFC replacement technology selected by Madosa.

The conversion to HFC 134a requires the use of HFC 134a specific compressors and the associated new synthetic lubricants, re-design of the refrigeration systems to cater for the difference in thermodynamic performance of HFC 134a versus CFC 12, prototyping, testing and optimization of each refrigerator model, and pilot scale manufacture and testing before full scale conversion of production to HFC 134a for each model. The conversion will result in changes in manufacturing procedures for which production line supervisor and operator training will be required.

The different properties of HFC 134a, the need to avoid cross-contamination with CFC 12, and the phased nature of the conversion of refrigerator production from CFC 12 to HFC 134a, means that new system evacuation, refrigerant charging, and leak detection equipment will be required.

Details of the existing equipment on which the technology change will impact are provided in section 5.2.3.

Incremental Operational Costs associated with the technology change from CFC 12 to HFC 134a are requested for a period of six months.

5. TECHNOLOGY

5.1. REPLACEMENT OF CFC 11.

5.1.1. OVERVIEW

Currently, the three principal technology options for the replacement of CFC 11 in thermoset insulation foams are:

CFC 11 > partial water/HCFC 141b > ?
CFC 11 > partial water/HCFC 22,142b > HFC 134a, HFC 152a
CFC 11 > n-, iso-, or cyclo-, pentane

In addition, perfluoroalkanes, hydrofluoroalkanes such as HFCs 245, 356, etc., fluorinated ethers, 2-chloropropane, and vacuum panels have been suggested for specific applications, but the technologies are not mature. Furthermore, some of these products are either only available in limited quantities, or toxicological testing is not complete and, therefore, safety in use cannot be evaluated.

The first option, <u>the "liquid" solution</u>, employs technology that is closely related to the existing CFC 11 technology and generally means that existing foam dispensing equipment can be used. The final step to a zero-ODP technology in this process is not yet decided. One potential solution may be the use of liquid HFCs such as HFC 245 or HFC 356, but full water blown foam with improved cell structure remains another option.

The second one, <u>the "gas" solution</u>, utilizes physical blowing agents which are liquefied gases. This technology always requires new foam dispensing equipment and extensive adjustments. The final step to a zero-ODP technology in this process would be the use of a gaseous HFC such as HFC 134a.

The third option, <u>pentane technology</u>, is commercially proven and is now extensively used in many rigid PU insulation foam applications in Europe. It is currently the most cost effective of the non-ODS technologies for CFC replacement. However, pentanes are flammable and this means a careful review of manufacturing operations with respect to the safe handling of a flammable foam blowing agent. Pentane technology may not be a practical or cost effective option in the existing workplace environments at many smaller scale enterprises due to the plant safety modifications required.

Several companies currently offer pentane technology packages, including equipment. Its use certainly requires implementation assistance and UNDP further requires an independent safety review prior to, and after, installation.

<u>5.1.2. SELECTION</u>

Based on economic and environmental considerations, cyclo-pentane appears to be the best choice for domestic refrigerator and freezer applications. It combines an attractive price with zero-ODP, and near-zero GWP properties, as well as acceptable foam insulation qualities. Madosa considered cyclo-pentane technology, and a cyclo-pentane based project is viable within the cost effectiveness threshold of US$ 13.76 after allowance for safety related costs. However, whilst recognising both the environmental and economic benefits of cyclo-pentane versus HCFC 141b, Madosa selected HCFC 141b as a first stage, interim, replacement for CFC 11.

Considerations influencing the Madosa decision in favour of HCFC 141b technology include:

- HCFC 141b is presently the technology selected by their US shareholder and technology partner, General Electric, from whom they will receive technical assistance with CFC 11 replacement.

- completed trials at Madosa prove that HCFC 141b technology can be introduced quickly, utilising the existing equipment, with minimal investment cost and plant downtime.

- whilst cyclo-pentane technology could be introduced by the provision of the necessary safety equipment, cyclo-pentane storage and blending facilities, and retrofit of the existing foam dispensing machines, for Madosa this would involve a major, and unacceptable, disruption of plant operations and loss of production. Considering the 25% Article 5.1 country ownership of Madosa, the cyclo-pentane technology would require an <u>additional</u> capital investment by Madosa of US$ 204,750 over the cost of the HCFC 141b option. Investment of nearly US$ 500,000 by Madosa is required to eliminate the CFC 12 consumption. The present economic climate in Veneuzela precludes the possibility of the additional capital investment for cyclo-pentane.

- As a GE associated company, Madosa wish to adopt the same final, zero-ODP technology as GE. It is by no means certain that this will be pentane technology.

- cyclo-pentane technology would only be an attractive option for Madosa if the appropriate equipment for cyclo-pentane could be supplied, installed, and commissioned in parallel to the existing equipment, in order to minimise production downtime, <u>and</u> if <u>totally</u> financed by the MLF. With only 25% Article 5.1 country ownership this option is outside the funding rules of the MLF.

The selection of HCFC 141b technology as the immediate replacement for CFC 11 by Madosa is a realistic and sensible choice under the prevailing circumstances. Very modest funding is requested to achieve this and the technology choice is supported by the FONDOIN. Madosa understand that HCFC 141b is an interim solution which will require a change to an appropriate zero-ODP technology at some future date. Madosa also understand and accept that the costs associated with that subsequent technology change is for its own account.

5.1.3. IMPACT ON THE PRODUCTION PROCESS

In-house trials have already demonstrated that HCFC 141b technology can be introduced utilising the existing high pressure foam dispensing equipment. Additional fine tuning trials and testing will be required when full scale production with HFC 141b is introduced.

HCFC 141b is a non-flammable liquid (no flash point), but moderately flammable in the gaseous state. The flammability limits are 7.6 - 17.1% by volume in air. The usually recommended PEL (Permissable Exposure Limit) is 500 ppm on an eight-hour time-weighted average. In the intended application, the use of HCFC 141b should not pose a significant risk, but UNDP will, as part of its safety audit programme, perform a monitoring check at commissioning to ensure the adherence to safe worker exposure levels. Ventilation will be installed if the results indicate the need.

The refrigerator and freezer models produced by Madosa use HIPS cabinet and door liners. A modified HIPS liner material which is resistant to HCFC 141b will be required.

Foam density adjustments will be necessary to obtain equivalent insulation values.

Madosa currently has three PU foam dispensing systems all of which are based on Elastogram Puromat high pressure machines. There are two cabinet foaming stations supplied from the same blending facility, and a door foaming station with it's own blending facility.

Production Line A.

Elastogram Puromat PU-50 high pressure foam dispensing machine with a throughput of 24-168 Kgs/min. Serial No. 4672. Vintage 1978.

Production Line B.

Elastogram Puromat PU-80 high pressure foam dispensing machine with a throughput of 24-168 Kgs/min. Serial No. 10896. Vintage 1988.

Door Foaming Station

Elastogram Puromat PU-30 high pressure foam dispensing machine with a throughput of 3-24 Kgs/min. Serial No. 11037. Vintage 1988.

HCFC 141b can be used in this high pressure equipment without any major modifications but extensive trialling and training will be necessary.

5.2. REPLACEMENT OF CFC 12.

5.2.1. OVERVIEW

HFC 134a is universally accepted as a replacement for CFC 12 in the manufacture of domestic refrigerators. HFC 134a is widely available and the technology is mature. Replacement of CFC 12 with HFC 134a requires relatively modest changes to existing production facilities.

Whilst hydrocarbon refrigerant (iso-butane) is being increasingly used in the manufacture of domestic refrigerators in several Developed Countries, the transfer of this technology to Developing Countries is not always cost effective. It also raises questions about safety issues and remains conditional on the support of a technology partner experienced in the production of comparable refrigerators and freezers on a commercial scale. It is further dependent on the technology partner providing assurances in writing on safety issues, and, of course, the availability of adequate supplies of both compressors and hydrocarbon refrigerant of the required quality.

HFC 152a might be considered as another candidate for CFC 12 replacement in domestic refrigerators. However, HFC 152a is also flammable, the technology has not been developed commercially, and there are some questions around it's stability in refrigerator systems. Furthermore, compressors for use with HFC 152a are not commercially available.

5.2.2. SELECTION

Based on the advice of its technology partner, the selected CFC 12 replacement technology is HFC 134a. General Electric has also instructed Madosa to source "dry", lube-free, compressors for use with HFC 134a to ensure total control of refrigerator system moisture levels. This is a major change from current practice and requires that Madosa install the necessary lubricant storage, drying, testing, and charging equipment. The justification for this change is clearly described in the attached Annex C.

5.2.3. IMPACT ON THE PRODUCTION PROCESS

HFC 134a, like CFC 12, is non-flammable. HFC 134a has also been the subject of extensive toxicological testing and is considered safe in use in industrial applications provided the suppliers recommended occupational exposure levels are not exceeded. At the present time this means ensuring that exposure levels do not exceed 1000 parts per million on an 8-hour time-weighted average basis. This is the same as the Occupational Exposure Limit (OEL)/Threshold Limit Value (TLV) for CFC 12 and thus no changes from current practices are required.

There will be an approximately 10% reduction in the mass charge of HFC 134a compared with CFC 12 for a refrigerator system of the same capacity. This is taken into account in the calculation of the incremental operational costs.

It is well understood that the chemical stability of HFC 134a/synthetic lubricant systems in domestic refrigerators, and hence the long term performance of the appliance, is sensitive to moisture content and certain chlorinated impurities. This requires that CFC 12 and HFC 134a handling equipment be carefully segregated, and it also calls for better evacuation of the system prior to refrigerant charging.

Because system cleanliness and moisture content is paramount to the successful manufacture of HFC 134a refrigerators, Madosa will need to critically re-assess production procedures and re-train its production personnel as appropriate. Provision for this is made within the project proposal budget.

The conversion from CFC 12 to HFC 134a will take place on a model by model basis, so that Madosa will be producing both CFC 12 and HFC 134a refrigerators during the implementation phase of this project. This is feasible given the configuration of the company's production facilities. This means that there is a requirement for new system evacuation equipment and refrigerant charging equipment.

Leak detection of the refrigeration system is an integral part of the manufacturing process and the use of HFC 134a requires that new leak detection equipment be employed.

The relevant existing equipment at Madosa on which the technology change to HFC 134a will impact is as follows:

- 2 x PCU 40501 automatic R12 charging machines
- 3 x Danfoss 118 x 5000 R 12 charging machines
- 30 x Kinney KC 8 dual stage vacuum pumps, 14.2 M3/hr
- 30 x Hyvac 14 dual stage vacuum pumps, 8.4 M3/hr
- 6 x Leybold HLD 3000 electronic R12 leak detectors

The refrigerant charging equipment, vacuum pumps, and leak detection equipment listed above serve the following production lines:

Finished Products Quality Control Facility

2 x Leybold HLD 3000 electronic R 12 leak detectors for final QC leak testing.

Production Line A. (Models 12STD, 13VF, 14STD, T14)

1 x PCU 40501 charging machine.
25 x Hyvac 14 vacuum pumps, carousel mounted.
1 x Danfoss 118 x 5000 charging machine c/w Kinney KC 8 vacuum pump on emergency standby duty for the PCU charging machine.
1 x Danfoss 118 x 5000 charging machine c/w Kinney KC 8 vacuum pump for Line A. repair station.
4 x Kinney KC 8 vacuum pumps for Line A. repair station
2 x Leybold HLD 3000 electronic R12 leak detectors for low and high pressure system leak testing.

Production Line B. (Models 15DT & 22DX)

1 x PCU 4051 charging machine.
25 x Kinney KC 8 vacuum pumps, carousel mounted.
1 x Danfoss 118 x 5000 charging machine c/w Kinney KC 8 vacuum pump for Line B. repair station.
3 x Kinney KC 8 vacuum pumps for Line B. repair station.
2 x Leybold HLD 3000 electronic R 12 leak detectors for low and high pressure system leak testing.

The project proposal includes provision for ONE new R134a/Lube charging machine of equivalent capacity for each production line, and ONE new R134a charging machine for each repair station. Replacement vacuum pumps are requested on the following basis:

Production Line A.	4 new vacuum pumps
Production Line B.	4 new vacuum pumps

Provision is made within the project budget for retrofit of the remaining 52 vacuum pumps where considered feasible, or the funding provided for retrofitting will be used by Madosa towards the purchase of new vacuum pumps, at the enterprises own discretion.

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

ADDITIONAL VENTILATION AT THE THREE FOAMING STATIONS	10,000
TRAINING, TEST TRIALS & TECHNOLOGY TRANSFER	20,000
CONTINGENCIES (10%)	3,000
Subtotal (US$)	33,000

CAPITAL COST FOR CFC 12 PHASE-OUT

R134a/LUBE CHARGING MACHINES (2 off)	180,000
REPAIR STATION R134a CHARGING EQUIPMENT (2 off)	24,000
LUBE STORAGE & DEHYDRATION SYSTEM (1 off)	120,000
R134a REFRIGERANT BOOSTER PUMP	24,000
NEW VACUUM PUMPS (8 off)	24,000
RETROFITTING VACUUM PUMPS (52 off)	26,000
LEAK DETECTION EQUIPMENT (6 off)	42,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION & RELIABILITY TEST TRIALS (6 models)	40,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	50,000
Subtotal (US$)	550,000
TOTAL INCREMENTAL CAPITAL COST (US$)	583,000

6.2 INCREMENTAL OPERATING COSTS

The calculation of the incremental operating costs is based on a six month period using 50% of the actual production for January to December 1993 inclusive. Annex A. provides detailed explanations on how the incremental operational costs were obtained, the costs are summarized below:

PHASE-OUT OF CFC 11

Costs for Materials (see Annex A. Part 1.):	299,464

PHASE-OUT OF CFC 12

Costs for Materials (see Annex A. Part 2.):	334,032
TOTAL INCREMENTAL OPERATING COST (US$)	633,496

6.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational) (US$)	1,216,496
% Article 5.1 Country Ownership	25%
FUNDING REQUESTED FROM MLF (US$)	304,124

6.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs (25% of US$ 583,000)	145,750
b. Capital Recovery Factor (10% p.a.)	0.16275
c. Incremental Operating Costs (25% of US$ 633,496)	158,374
d. ODS Reduction (ODP Kgs Jan - Dec 1993)	93,040
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	1.96

THE PROJECT UNIT ABATEMENT COST IS 1.96 US$/Kg

6.5 COST EFFECTIVENESS (US$/Kg)

TOTAL PROJECT COST	=	1,216,496 US$
LESS PROJECT SAFETY RELATED COSTS	=	n/a
TOTAL ODS ELIMINATED	=	93,040 DP Kgs
PROJECT COST EFFECTIVENESS	=	13.08 US$/Kg

THE PROJECT COST EFFECTIVENESS IS 13.08 US$/Kg

This is below the threshold value of 13.76 US$/Kg established by the Executive Committee of the MLF at its 16th meeting in March 1995 for projects in the Domestic Refrigeration sector.

7. FINANCING PLAN

Madosa S.A. requests reimbursement from the MLF of the sum of US$ 304,124, representing the incremental Capital and Operational costs of this ODS elimination project, correctly taking into account the 25% Article 5.1 country ownership of the enterprise.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP will oversee the successful implementation of this project, and will provide technical assistance during project execution.

8.2 SCHEDULE

TASK	TIME TO COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
MLF Approval	X					
Procurement Preparation	XX	X				
Vendor Selection		XX				
2. Installation						
Arrival of Equipment		XX				
Customs Clearance		X				
Machine Installation		X	X			
3. Start-Up						
Machine Start-up			X			
Trials & Training			XXX	XXX	XX	
Mass Production Change					X	XX
Certification						X

9. PROJECT IMPACT

Based on data for the 12 months, January - December 1993, this project will eliminate the use of 93.04 ODP tons per year.

10. ANNEXES

Annex A. - Incremental Operational Cost Calculations.
Annex B. - Madosa Letter relating to Compressor Lubricant Charging
Annex C. - Project Technical Reviews.

ANNEX A. INCREMENTAL OPERATIONAL COST CALCULATIONS

1. Incremental Costs resulting from replacing the CFC 11 Blowing Agent in the Refrigerator Insulation Foam with HCFC 141b (US$)

MADOSA S.A.	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.375	0.387	0.012
b. MDI	0.509	0.509	-
c. Kg Blowing Agent	0.116	0.104	(0.012)
Prices in US$/Kg			
d. Polyol	2.61	2.74	0.13
e. MDI	2.15	2.15	-
f. Blowing Agent	2.00	4.00	2.00
g. Liner (Type: HIPS)	1.72	1.90	0.18
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.979	1.060	0.081
i. = b. x e. MDI	1.094	1.094	-
j. = c. x f. Blowing Agent	0.232	0.416	0.184
k. = h+i+j Total Cost per Kg of Foam	2.305	2.570	0.265
Materials Used per Refrigerator			
l. Kg of Foam per Refrigerator (avg)	5.771	6.348	0.577
m. Kg of Liner material per refrigerator (avg)	9.584	9.584	-
Cost per Refrigerator			
n. = l. x k. for Foam	13.302	16.314	3.012
o. = m. x g. for Liner	16.485	18.210	1.725
p. = n. + o. Total per Refrigerator	29.787	34.524	4.737
q. = No. of Refrigerators (see Note 1.)	63,218		
TOTAL INCREMENTAL OPERATIONAL COST (US$)	299,464		

(see Notes 1., and 2. below)

2. Incremental Costs resulting from replacing the CFC 12 Refrigerant with HFC 134a (US$)

MADOSA S.A.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.60	8.50	
b. Kg of Refrigerant per Refrigerator (avg.)	0.140	0.126	
c. No. of Refrigerators Produced (see Note 1.)	63,218	63,218	
1d. Cost for Refrigerant = a x b x c	23,011	67,707	44,696
2. Compressors			
a. Cost per Compressor (see Note 2.)	36.77	39.60	
b. No. of Compressors (see Note 1.)	63,218	63,218	
2c. Cost for Compressors = a x b	2,324,526	2,503,433	178,907
3. Condensers			
a. Cost per Condenser	N/C	N/C	
b. No. of Condensers	63,218	63,218	
3c. Cost for Condensers = a x b	-	-	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.550	0.680	
b. No. of Filter/Dryers (see Note 1.)	63,218	63,218	
4c. Cost for Filter/Dryers = a x b	34,770	42,988	8,218
5. Capillary Tubes			
a. Cost per Capillary Tube (average)	0.543	0.675	
b. No. of Capillary Tubes (see Note 1.)	63,218	63,218	
5c. Cost for Capillary Tubes = a x b	34,327	42,672	8,345
6. Compressor Lubricant			
a. Price per Litre of Lubricant	-	4.64	
b. Litres of Lubricant per Compressor (avg)	-	0.32	
c. No. of Compressors (see Note 1.)	63,218	63,218	
6d. Cost for Lubricant = a x b x c	-	93,866	93,866
TOTAL INCREMENTAL OPERATIONAL COST (US$)	334,032		

Notes relating to the calculation of the Incremental Operational Costs

Note 1. **Figures in the above tables are based on the actual production volume for the 12 month period January to December 1993 obtained from Madosa S.A. at the time of project preparation. As Incremental Operational costs are claimed for 6 months only, 50% of this 12 months production volume has been used in the calculation.**

Note 2. **Refrigerant, chemical, and compressor prices used in the above tables are weighted average prices for the principal domestic and commercial refrigerator manufacturers in Venezuela. Note, however, that the HFC 134a compressor price for Madosa reflects the fact that it will be supplied without lube.**

Note 3. **The calculated incremental costs for the HFC 134a refrigerant are based on a 10% reduction in the mass charge compared with CFC 12.**

TECHNICAL REVIEW.

1.Country:

Venezuela.

2.Project Title:

Elimination of CFCs 11 and 12 at four Domestic Refrigeration Manufacturers, and conversion of one Compressor Manufacturer.

3.(Sub)Sector:

(Domestic) Refrigeration.
This review covers only the foam part.

4.CP-Relationship:

The Venezuelan CP for phase-out of ODS is actually in preparation. It is believed that the CP will be presented at the 16th Meeting of the Executive Committee of the MLF in March 1995.
Beginning 1995, the "Foundation for the Protection of the Ozone Layer and the Environment" (FONDOIN), assisted by UNDP has assigned a strategy for CFC elimination in the domestic refrigeration sector.

5.Technology:

5.1.CORESMALT
Coresmalt will replace CFC11 with HCFC 141b.As an interim step to an ODS free technology; this can be accepted.
It can be agreed to replace the low pressure Admiral machine with a high pressure one, with equivalent capacity.

5.2 MADOSA.
Madosa wants to substitute CFC 11 with HCFC 141b as an interim step to a total ODS free technology.
Since three HP machines are available, no replacement is proposed in the project.

The two other firms, MUEBLES ETERNA and VECOMESA either do not use CFCs in the production of the insulation panels, or do not deal with refrigeration boxes.
They are hence not discussed in this review.

6.Environmental Impact:

The ODP of HCFC 141b is 0.11 versus 1.0 for CFC 11.The GWP of HCFC 141b is 10% of the GWP of CFC 11. The smog potential of HCFC 141b is 1.0 versus 0.1 for CFC 11 (as a reference: pentane 500)

7.Project Costs:

7.1.CORESMALT.
All elements mentioned in the incremental capital costs can be accepted. The USD 20,000 for training is also justified, since trials must be performed at two machines.
The incremental operation costs calculation is correct and can be accepted.
The cost for elimination of 1 kg of ODS is then USD (132,000+162,359)/44,950, or USD 6.55.

7.2 MADOSA.
The incremental capital costs, as well the incremental operational costs are correct, and can be accepted.
The cost for elimination of 1 kg of ODS becomes:
USD (33,000 + 299,464)/75,330 or USD 4.41.

8.Implementation:

The proposed implementation can be accepted as such.

9.Recommendation:

It is proposed to accept the foam part of the three projects discussed.

H Creyf

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date: 20 February 1995.

Country of origin: VENEZUELA

Project title: Elimination of CFCs 11 and 12 at FOUR Domestic Refrigerator Manufacturers (Coresmelt Valencia C.A., Grupo Frigilux C.A., Madosa S.A., Muebles Eterna C.A.), and conversion of ONE compressor manufacturer (Vecomesa S.A.)

Sector/sub-sector Domestic refrigeration

Relationship to country program UNDP (CP in preparation)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

- All manufacturers in this project have chosen for a conversion of their production to the HFC-134a technology.
- In domestic refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.
- Three companies in this project (Coresmalt, Frigilux and Eterna) do not have a formal technology transfer agreement. However, all these companies plan to develop the HFC-134a technology with assistance from compressor and refrigerant suppliers. Furthermore provisions for external assistance are present. Due to these facts, a successful project implementation can be expected at these companies. The fourth refrigerator manufacturer (Madosa) does have an ongoing technology transfer agreement with General Electric, USA and the compressor manufacturer Vecomesa has a technology licence agreement with Tecumseh, USA. Both agreements include support for the HFC-134a conversion process, so also for the latter two manufacturers a successful project implementation can be anticipated.
- During the review process two technology aspects in this project were discussed in depth with the UNDP consultant and the relevant companies:
    1. The Madosa company will obtain new HFC-134a compressors without lubricant. This is in contrast to the currently applied production procedure and therefore requires investments in oil storage, charging and dehydration equipment. On-line oil charging of compressors does have certain advantages in quality control but is not strictly necessary (namely, a large number of companies do apply compressors which are oil charged by the compressor manufacturer). However, on-line oil charging is a requirement put forward by the technology supplier (G.E.) and forms an essential part of the technology to be transferred. Costs of the related equipment are therefore considered essential for the conversion process.
    2. The compressor manufacturer Vecomesa will switch from a Tecumseh "AE" design for CFC-12 to a, higher efficient, "AZ" design for HFC-134a for the larger part of their production. This change in design does lead to additional investments in production equipment (e.g. presses, welding and brazing machines etc.). In fact the change from "AE" to "AZ" technology does include a technology upgrade to higher efficient products. However, it is demonstrated by the company that there is no alternative for this selection as no "AE" designs for HFC-134a are available by Tecumseh, in the capacity range considered. Therefore, these additional costs have to be considered as eligible incremental costs.
- Technologies other than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of the state of development, safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

Environmental impact

HFC-134a has an ODP of zero and a GWP of 0.27. For domestic refrigeration a GWP of this magnitude is negligible.

Project costs

- The equipment requested by all manufacturers is essential for the conversion process (see statements above). Costs of equipment, training and testing are reasonable.
- Incremental operational costs are reasonable and correctly applied (for six months).
- If the UAC values are calculated for the refrigerant conversion part of the projects separately, then the following values are obtained:

Coresmelt Valencia	15 USD/kg/y
Frigilux	19 USD/kg/y
Madosa	6 USD/kg/y (only 25 % local ownership)
Muebles Eterna	78 USD/kg/y

  Besides the value for Eterna, these values are reasonable compared to other, similar, projects. The high UAC value for Muebles Eterna is caused by the small size of the company. For Vecomesa an artificial UAC value of 2.9 USD/kg/y (41.35 % country ownership) is calculated based on the current compressor production and an average charge of the appliances to be produced with these compressors of 0.1 kg. The resulting UAC value is relatively low compared to other, similar, projects.
- The foreign ownership of the different companies is correctly taken into account.

Implementation timeframe

Reasonable.

Relevance and adequacy of information provided

Sufficient information was obtained from the project proposal together with comments from the UNDP consultant and the companies.

Recommendations

Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands
15-February-1995

Kuijpers L.J.M.,
University Eindhoven, The Netherlands

PROJECT COVER SHEET

COUNTRY:	**VENEZUELA**
PROJECT TITLE:	Conversion of CFC 12 Compressor Production Facilities at VECOMESA S.A. to Manufacture HFC 134a Compressors.
SECTOR COVERED:	Domestic Refrigeration (Mfg)
ODS USE IN SECTOR:	236.69 tons ODS
PROJECT IMPACT (ODP):	0.72 ODP tons (Direct Impact Only)
TOTAL PROJECT COST:	US$ 1,316,000
INCREMENTAL CAPITAL COST:	US$ 1,316,000
INCREMENTAL OPERATING COST:	US$ (Not requested)
PROPOSED MLF GRANT:	US$ 544,166
UNIT ABATEMENT COST:	123.00 US$/Kg (Direct Impact Only)
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	FONDOIN
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	December 1994/May 1995

PROJECT SUMMARY:

Venezolana de Compresores y Motores S.A. (VECOMESA) is a 41.35% Venezuelan-owned company manufacturing fractional HP, hermetic, CFC 12 compressors. Vecomesa currently supplies around 76% of the compressor requirements of the domestic refrigeration manufacturing sector in Venezuela. They also sell replacement compressors to the service sector, plus sales to commercial refrigeration equipment manufacturers. The compressor technology is supplied by Tecumseh, USA. Vecomesa will convert to the manufacture of the Tecumseh "AZ" design HFC 134a compressor. Changes to the cleaning technology at Vecomesa will eliminate 0.72 ODP tons/year of 1,1,1-trichloroethane. Funds requested will be used to change the existing production lines, and for technical assistance, testing, and training. The resulting incremental operational costs are <u>not</u> included.

Prepared by: Stuart Kelly, in collaboration with the Foundation for Protection of the Ozone Layer and the Environment (FONDOIN).

Reviewed by: Dr L.J.M. Kuijpers/Dr M.J.P. Janssen. Their comments are attached.

PROJECT OF THE GOVERNMENT OF VENEZUELA

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE.

The objective of this project is to convert the existing CFC 12 compressor production facilities at Venezolana de Compresores y Motores S.A. (VECOMESA) to manufacture HFC 134a compressors. This will facilitate CFC 12 elimination in the manufacture of domestic refrigerators in Venezuela. (Ref projects for Coresmalt Valencia, Grupo Frigilux, Madosa, and Muebles Eterna).

2. SECTOR BACKGROUND.

The Venezuela Country Programme (CP) for the Phase-out of Ozone Depleting Substances (ODS) under the Montreal Protocol is presently in the course of preparation. It is anticipated that the CP will be presented to the 17th meeting of the Executive Committee of the Multilateral Fund for the Montreal Protocol in July 1995.

Due to the economic situation in Venezuela, 1994 data is not representative of either typical domestic refrigerator production volume, or ODS consumption. This project is, therefore, based on 1993 calender year data.

In preparing this project proposal, the following data for the 12 months January - December 1993 inclusive, was established as the best estimate of CFC consumption for the manufacture of domestic refrigerators and freezers in Venezuela. ODS elimination project proposals are being presented to the Montreal Protocol Multilateral Fund for the FOUR enterprises indicated in bold type, who account for 96.7% of domestic refrigerator and freezer production in Venezuela.

Enterprise	Production Volume	CFC 11 Consumption (Tons)	CFC 12 Consumption (Tons)
Coresmalt Valencia	95,646	50.51	20.57
Frigilux	41,605	27.73	4.85
Madosa	126,437	84.64	17.71
Muebles Eterna	3,153	-	0.38
Famusa Domestic	6,500	4.68	0.78
Others	2,500	1.80	0.30
Totals	275,841	169.36	44.59

The preceding Table relates to the DOMESTIC REFRIGERATION sector only. It should be noted that Frigilux C.A. is also engaged in the manufacture of unitary commercial refrigeration equipment. The production volumes and ODS consumption related to this activity are included in the project proposal for ODS elimination at Frigilux.

96.0% of the domestic refrigerators and freezers manufactured in Venzuela are sold in the local market. It is estimated that around 70,000 domestic refrigerators/freezers were also imported for sale in Venezuela in 1993, sourced from a variety of countries including Mexico, Colombia, USA, and Korea.

4.0% of local production, around 11,000 refrigerators are exported to other Latin American countries, principally Colombia and Ecuador.

This consumption of 213.95 ODP tons in the <u>manufacture</u> of domestic refrigerators and freezers represents approximately 7% of the total ODS consumption in the refrigeration and air-conditioning sector in Venezuela which was estimated at 3,200 tons in 1993.

There is additional consumption of CFC 12 for servicing domestic refrigerators. A project has already been approved by the MLF for a "Pilot Programme for Recovery/Recycling of CFC 12 in the Domestic Refrigeration Sector". This project has recently been implemented. These new project proposals do not, therefore, address the consumption of ODS in the servicing of domestic refrigerators and freezers in Venezuela.

The 236.69 tons "ODS USE IN SECTOR" in the Project Summary Sheet, therefore, refers only to identified ODS consumption in the MANUFACTURE of domestic refrigerators and freezers in Venezuela, plus the additional consumption of Frigilux C.A. in their unitary commercial refrigeration equipment manufacturing operations, and the ODS consumption of Vecomesa in manufacturing compressors.

Famusa Domestic was only identified as a manufacturer of domestic refrigerators as this project proposal was being completed, and it was not, therefore, possible to obtain the necessary data in time to prepare a project proposal for Famusa. It is proposed that an ODS elimination project proposal for this small enterprise be prepared for submission to the autumn 1995 meeting of the MLF EXCOM.

The industry uses locally manufactured hermetic compressors, refrigerants, and PU foam chemicals but also imports raw materials and parts. Compressors are also sourced from Embraco and Sicom (Brazil), Daewoo (Korea), and L'Unite Hermetique (France).

Uninhibited growth in the manufacture of domestic refrigerators and freezers would lead to an estimated consumption in the year 2000 of approximately 280 tons per year of CFCs 11 and CFC 12.

The Foundation for the Protection of the Ozone Layer and the Environment (FONDOIN), with the assistance of UNDP, has designed a strategy for the elimination of CFC 11 and CFC 12 in the domestic refrigeration manufacturing sector beginning in 1995. Approval of this project by the MLF in July 1995 should result in the phase-out of 96.5% of CFC consumption in the manufacture of domestic refrigerators and freezers in Venezuela in 1996.

3. ENTERPRISE BACKGROUND

VECOMESA S.A. is the only manufacturer of fractional HP, hermetic, refrigeration compressors in Venezuela.

Vecomesa supplies approximately 76% of the requirements of the domestic refrigeration manufacturing sector, as well as supplying the unitary commercial refrigeration equipment manufacturing sector, and the service sector with replacement compressors. Total annual compressor sales are around 300,000 units and production capacity is 350,000 units p.a. The sales split is approximately:

Domestic Refrigeration Manufacturing Sector	-	200,000
Commercial Refrigeration Manufacturing Sector	-	10,000
Service Sector (Replacement Compressors)	-	90,000

Vecomesa is a 41.35 per cent Venezuelan owned enterprise, the remaining 58.65% capital share is held by US companies (see below).

ODS USE IN 1994:	6.50 tons 1,1,1-trichloroethane
FULL NAME:	Venezolana de Compresores y Motores, S.A. (VECOMESA)
PLANT LOCATION:	Calle Boliva, Urb Las Flores, Santa Teresa del Tuy, Estado Miranda, (Apartado 50724 Sabana Grande, Caracas 1050A).
% ARTICLE 5 COUNTRY OWNERSHIP:	41.35% (Venezuela)
No. OF MODELS:	8
PRODUCTION IN 1994:	296,882 compressors
No. OF PRODUCTION LINES:	1
CONTACT PERSONS:	Jorge A. Puebla - General Manager Rodrigo A. Rengifo Q. - Plant Manager
TEL / FAX:	Tel: (58 39) 310311/311797 Fax: (58 39) 311780

Vecomesa S.A. was founded in 1966 but did not commence compressor manufacturing operations until 1974. In addition to the manufacture of refrigeration compressors, Vecomesa also manufactures some 80,000 washing machine motors per annum under license from General Electric Co. Vecomesa employs a total of 342 persons.

Vecomesa was created to supply compressors to Venezuelan refrigerator manufacturing companies and the domestic refrigerator manufacturers are shareholders in Vecomesa. The capital shares are as follows:

Madosa (25% of 36.40%)	9.100%
Eminca (Grupo Frigilux)	17.650%
Fondo de Inversiones de Venezuela	12.500%
Muebles Eterna	1.240%
Insanova (Corresmalt)	0.824%
Siadca	0.040%
TOTAL	41.354%
General Electic Co., USA	31.346%
GE (33% of Madosa's 36.40%)	12.018%
Enron (42% of Madosa's 36.40%)	15.288%
TOTAL	58.652%

Vecomesa manufactures a range of Tecumseh "AE" model CFC 12 compressors under a technology licensing agreement with Tecumseh Products Co., Michigan, USA. Under this ongoing Tecumseh-Vecomesa technology license agreement, assistance is supplied either from Michigan, USA, or from SICOM, Tecumseh's wholly owned subsidiary in Brazil. Compressor parts are supplied to Vecomesa from Sicom, and Vecomesa imports around 50% of its materials. Vecomesa pays Tecumseh 2.5% of net technological sales (net sales minus total purchases from Tecumseh/Sicom) for the supply of technology.

All compressor production is sold within Venezuela.

The following table provides a summary of compressor production by Vecomesa S.A. in 1994.

Compressor Model	Compressor HP	Production Volume
AE 1336	1/8	14,075
AE 1343	1/6	140,766
AE 1360	1/5	5,526
AE 2380	1/4	68,745
AE 2410	1/4	6,693
AE 2413	1/3	31,274
AE 4430	1/4	14,515
AE 4440	1/3	15,288
		296,882

This project encompasses all ODS consumption used in compressor manufacturing operations at Vecomesa S.A. that is eligible for MLF funding.

4. PROJECT DESCRIPTION

Vecomesa S.A. presently uses 1,1,1-trichloroethane for the cleaning of small components during compressor manufacture. The total consumption in the 12 months January - December 1994, and the ODP tons that will be eliminated by this project are shown in the following table:

Enterprise	1,1,1-trichloroethane (tons)	Total ODP tons eliminated
Vecomesa S.A.	6.50	0.72

The consumption of 1,1,1-trichloroethane will be eliminated through the conversion to aqueous-based cleaning technology for compressor parts using a new ultrasonic immersion cleaner for which capital funding is requested. However, the real purpose of this project proposal, and the request for MLF project funding, is to assist Vecomesa in changing to the manufacture of zero-ODP technology compressors in order to eliminate ODS consumption in the domestic refrigeration manufacturing sector in Venezuela. The cost effectiveness of the Vecomesa project should not, therefore, be judged solely on the quantity of 1,1,1-trichloroethane eliminated.

4.1. CONVERSION OF COMPRESSOR MANUFACTURE

Key to the success of CFC 12 elimination in the manufacture of domestic refrigerators and freezers in Venezuela is the local availability of HFC 134a compressors. Madosa, the largest producer of refrigerators, and Muebles Eterna source all their compressors from Vecomesa S.A. Coresmalt, Frigilux, and Famusa Domestic also source a substantial part of their compressor requirements from Vecomesa.

Significant changes to Vecomesa's present CFC 12 compressor manufacturing operations are required in order to produce HFC 134a compressors which will be clean, dry, and free from all trace contaminants likely to have an adverse effect on HFC 134a/synthetic ester lubricant chemistry in a domestic refrigerator system.

The changes that are necessary include new equipment associated with compressor shell fabrication, welding, cleaning, drying, lube dehydration and charging, and pressure testing. Also necessary are new items of test equipment for calorimetry studies, dielectric strength measurements, residual moisture determination, and additional compressor lifetime test equipment.

A detailed description of the new equipment required by Vecomesa to be able to sucessfully manufacture HFC 134a compressors is provided in Section 5.

Incremental Operating Costs are not requested by Vecomesa, in line with the policy adopted for earlier compressor projects approved by the MLF.

5. TECHNOLOGY CHANGES & IMPACT ON THE PRODUCTION PROCESS

Vecomesa S.A. will convert their existing Tecumseh "AE" model R12 compressor manufacturing facilities to the production of HFC 134a compressors. This is to meet the needs of their customers who will change to the manufacture of HFC 134a technology based domestic and commercial refrigerators and freezers. MLF project funding is also requested for these enterprises and HFC 134a compressors will be required during the transitional phase of the various projects in 1995/96 before full scale production of HFC 134a refrigerators in late 1996.

The new HFC 134a compressor technology will also be supplied by Tecumseh under the existing technology licensing agreement.

This involves a change to production of Tecumseh's "AZ" model for the 1/8, 1/6, and 1/5 HP capacity compressors. These are "high efficiency" design compressors with the added advantage of being able to be used with either HFC 134a or CFC 12 refrigerants. For 1/4 and 1/3 HP compressors, Vecomesa will use the same external design, but the pump, motor winding, insulation, etc. are modified for use with HFC 134a. The "AZ" model compressor is a significantly different design to the existing "AE" model, and there are, therefore, consequent changes required to the manufacturing process for which Vecomesa are seeking funding from the MLF.

More details of the changes and the justification for them are contained in the attached Annex 5.E.

Compressor pump kits and motors will be supplied by Sicom in the first stages of the project enabling Vecomesa to assemble HFC 134a compressors.

System cleanliness and dryness are essential for the successful manufacture of HFC 134a domestic refrigerators and freezers and changes to the compressor manufacturing process must be made to meet these requirements.

Vecomesa's largest customer, Madosa, will purchase "dry" compressors for HFC 134a duty and they will charge both lube and refrigerant during the refrigerator manufacturing process. Other customers, including Coresmalt, Frigilux, and Muebles Eterna, will purchase compressors containing lube. These differing requirements also impact on the changes necessary to Vecomesa's manufacturing operations in converting to the production of HFC 134a compressors.

As a part of the licensing agreement, Vecomesa must comply with the relevant Tecumseh Standards throughout the various stages of compressor manufacturing operations.

"Pressing & Welding", "Assembly", and "Finishing", processes for the "AZ" compressor, and the areas where changes are required, are depicted diagramatically in the attached Annexes 5.A, 5.B, and 5.C.

Vecomesa has a two stage investment programme associated with the conversion to production of HFC 134a compressors, including improvements in the production and assembly processes for both compressors and motors, as well as production line layout changes to ensure a "clean and dry" finished product. No specific production capacity increases are included, but while some small incidental increase in production capacity might be anticipated, it is not possible to quantify. The investments in 1996 relate to manufacture of the 15 frame size "high efficiency" hermetic motor. The following represents a summary of the total Vecomesa investment progamme for 1995 and 1996 (excluding contingencies):

1995		US$
Compressors	- Improvements to Production Process	235,000
Hermetic Motors	- Improvements to Production Process	185,000
Compressors	- Manufacture of "AZ" R134a Models	1,236,000

1996		US$
Hermetic Motors	- "High Efficiency" Motor Production	1,623,500

MLF funding is requested only for the incremental capital costs essential to the conversion to HFC 134a compressor manufacture and associated training. The costs of improvements to production and assembly processes, and the conversion to manufacture of the "high efficiency" motor are borne by Vecomesa.

The "AZ" R134a compressor project costs of US$ 1,236,000, are made up of the following:

	US$
<u>Production Machinery & Equipment</u>	
MIG Welding Machines (2), for new compresor shells:	92,000
Assembly Line Conveyor, air and power supplies:	40,000
Dehydration Oven and Vacuum Pump:	50,000
Spot Welding Machine, for welding internal supports:	60,000
Hydraulic Press for "AZ" shell production:	70,000
Ester Lube Dehydration and Charging equipment:	60,000
Ultrasonic Immersion Cleaner for small parts:	150,000
Brazing Machine for fixing suction/discharge tubes:	110,000
Sub total:	632,000
<u>Process & Quality Control Equipment</u>	
Retrofit of 8-stage degreasing, cleaning, chemical treatment unit:	58,000
Quality Control Equipment:	30,000
Aluminum Injection Mold (for "AZ" rotors):	15,000
Leak Test equipment for Shell, and Tube/Shell, Seam Welds:	20,000
Electrical Test & Nitrogen Charging System:	116,000
Sub total	239,000
<u>Other Related Equipment & Changes</u>	
Tools and Fixtures for Compressor Shells and Small Parts manufacturing:	112,000
Tools and Fixtures for "AZ" Compressor assembly:	100,000
Retrofit of Assembly Area Ventilation and Air-conditioning system (to control atmospheric humidity):	56,000
Sub total	268,000
<u>Trials & Testing</u>	
Calorimeter Test Equipment (for "AZ" compressor evaluation tests):	40,000
Residual Humidity Test Equipment (for test of completed compressor):	15,000
Di-electric Strength Test Equipment:	10,000
Additional Compressor Lifetime Test facilities:	12,000
Sub total	77,000
<u>Training</u>	
2 Engineers/2 Supervisors to Sicom, Brazil for one month on the job training:	20,000

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS

HYDRAULIC PRESS (1 off)	70,000
INJECTION MOLD FOR ALUMINIUM ROTORS	15,000
WELDING MACHINES (3 off)	152,000
BRAZING MACHINE (1 off)	110,000
ULTRASONIC IMMERSION CLEANER	150,000
TOOLS & FIXTURES FOR COMPRESSOR SHELL & SMALL PARTS MANUFACTURING	112,000
TOOLS & FIXTURES FOR COMPRESSOR ASSEMBLY	100,000
RETROFIT OF 8-STAGE DEGREASING, CLEANING, & CHEMICAL TREATMENT SYSTEM	58,000
DEHYDRATION OVEN & VACUUM PUMP (1 off)	50,000
LUBE DEHYDRATION & CHARGING SYSTEM (1 off)	60,000
COMPRESSOR LEAK TEST EQUIPMENT	20,000
NITROGEN CHARGING EQUIPMENT	116,000
QUALITY CONTROL EQUIPMENT	30,000
RETROFIT OF ASSEMBLY ROOM A/C SYSTEM	56,000
CALORIMETER TEST EQUIPMENT	40,000
RESIDUAL HUMIDITY TEST EQUIPMENT	15,000
DI-ELECTRIC STRENGTH TEST EQUIPMENT	10,000
ADDITIONAL COMPRESSOR LIFETIME TEST EQUIPMENT	12,000
TRAINING	20,000
CONTINGENCIES (10%)	120,000
TOTAL INCREMENTAL CAPITAL COST (US$)	1,316,000

6.2 INCREMENTAL OPERATING COSTS & BENEFITS

Incremental operating costs associated with the change from CFC 12 to HFC 134a compressor manufacture are not requested in line with the policy agreed in earlier MLF compressor conversion projects. There are no incremenatl operating benefits.

6.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital Only) (US$)	1,316,000
% Article 5.1 Country Ownership	41.35%
FUNDING REQUESTED FROM MLF (US$)	544,166

6.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs (41.35%)	544,166
b. Capital Recovery Factor (10% p.a.)	0.16275
c. Incremental Operating Costs (not requested)	-
d. ODS Reduction (ODP Kgs Jan - Dec 1994)	720
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	123.00

THE PROJECT UNIT ABATEMENT COST IS 123.00 US$/Kg

Notes:

The Unit Abatement Cost reflects only the direct project impact in eliminating 6,500 Kgs p.a. consumption of 1,1,1,-trichloroethane at Vecomesa for the cleaning of compressor components. The funding requested for Vecomesa should be considered in the context of eliminating ODS consumption in the domestic refrigeration manufacturing sector.

More details on Vecomesa's investment programme are attached as Annex C.

7. FINANCING PLAN

Venezuelana de Compresores y Motores (VECOMESA) S.A. requests reimbursement from the MLF of the sum of US$ 544,166 representing the Incremental Capital Costs of this ODS elimination project, correctly taking into account the 41.35% Article 5.1 country ownership of the enterprise.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP will oversee the successful implementation of this project, and will provide technical assistance during project execution.

8.2 SCHEDULE

TASK	TIME TO COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
MLF Approval	X					
Procurement Preparation	XX	X				
Vendor Selection		XX				
2. Installation						
Arrival of Equipment			XX			
Customs Clearance				X		
Machine Installation				XX		
3. Start-Up						
Machine Start-up				X		
Trials & Training					XX	
Mass Production Change					X	XX
Certification						X

9. PROJECT IMPACT

Based on data for the 12 months, January - December 1993, this project will eliminate the use of 0.72 ODP tons per year.

10. ANNEXES

Annex A. - Incremental Operational Cost Calculations.
Annex B. - Project Technical Reviews.
Annex C. - Details of Vecomesa's Investment Programme.

Country of origin: VENEZUELA

Project title: Elimination of CFCs 11 and 12 at FOUR Domestic Refrigerator Manufacturers (Coresmelt Valencia C.A., Grupo Frigilux C.A., Madosa S.A., Muebles Eterna C.A.), and conversion of ONE compressor manufacturer (Vecomesa S.A.)

Sector/sub-sector Domestic refrigeration

Relationship to country program UNDP (CP in preparation)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

- All manufacturers in this project have chosen for a conversion of their production to the HFC-134a technology.
- In domestic refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.
- Three companies in this project (Coresmalt, Frigilux and Eterna) do not have a formal technology transfer agreement. However, all these companies plan to develop the HFC-134a technology with assistance from compressor and refrigerant suppliers. Furthermore provisions for external assistance are present. Due to these facts, a successful project implementation can be expected at these companies. The fourth refrigerator manufacturer (Madosa) does have an ongoing technology transfer agreement with General Electric, USA and the compressor manufacturer Vecomesa has a technology licence agreement with Tecumseh, USA. Both agreements include support for the HFC-134a conversion process, so also for the latter two manufacturers a successful project implementation can be anticipated.
- During the review process two technology aspects in this project were discussed in depth with the UNDP consultant and the relevant companies:
    1. The Madosa company will obtain new HFC-134a compressors without lubricant. This is in contrast to the currently applied production procedure and therefore requires investments in oil storage, charging and dehydration equipment. On-line oil charging of compressors does have certain advantages in quality control but is not strictly necessary (namely, a large number of companies do apply compressors which are oil charged by the compressor manufacturer). However, on-line oil charging is a requirement put forward by the technology supplier (G.E.) and forms an essential part of the technology to be transferred. Costs of the related equipment are therefore considered essential for the conversion process.
    2. The compressor manufacturer Vecomesa will switch from a Tecumseh "AE" design for CFC-12 to a, higher efficient, "AZ" design for HFC-134a for the larger part of their production. This change in design does lead to additional investments in production equipment (e.g. presses, welding and brazing machines etc.). In fact the change from "AE" to "AZ" technology does include a technology upgrade to higher efficient products. However, it is demonstrated by the company that there is no alternative for this selection as no "AE" designs for HFC-134a are available by Tecumseh, in the capacity range considered. Therefore, these additional costs have to be considered as eligible incremental costs.
- Technologies other than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of the state of development, safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

Environmental impact
HFC-134a has an ODP of zero and a GWP of 0.27. For domestic refrigeration a GWP of this magnitude is negligible.

Project costs
- The equipment requested by all manufacturers is essential for the conversion process (see statements above). Costs of equipment, training and testing are reasonable.
- Incremental operational costs are reasonable and correctly applied (for six months).
- If the UAC values are calculated for the refrigerant conversion part of the projects separately, then the following values are obtained:

Coresmelt Valencia	15 USD/kg/y
Frigilux	19 USD/kg/y
Madosa	6 USD/kg/y (only 25 % local ownership)
Muebles Eterna	78 USD/kg/y

  Besides the value for Eterna, these values are reasonable compared to other, similar, projects. The high UAC value for Muebles Eterna is caused by the small size of the company. For Vecomesa an artificial UAC value of 2.9 USD/kg/y (41.35 % country ownership) is calculated based on the current compressor production and an average charge of the appliances to be produced with these compressors of 0.1 kg. The resulting UAC value is relatively low compared to other, similar, projects.
- The foreign ownership of the different companies is correctly taken into account.

Implementation timeframe
Reasonable.

Relevance and adequacy of information provided
Sufficient information was obtained from the project proposal together with comments from the UNDP consultant and the companies.

Recommendations
Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands
15-February-1995

Kuijpers L.J.M.,
University Eindhoven, The Netherlands

PROJECT COVER SHEET

COUNTRY:	**VENEZUELA**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at PINOVA S.A.
SECTOR COVERED:	Commercial Refrigeration (Mfg)
ODS USE IN SECTOR:	113.95 tons ODS
PROJECT IMPACT (ODP):	27.32 ODP tons
TOTAL PROJECT COST:	US$ 592,117
INCREMENTAL CAPITAL COST:	US$ 565,600
INCREMENTAL OPERATING COST:	US$ 26,517
PROPOSED MLF GRANT:	US$ 565,600
UNIT ABATEMENT COST:	3.37 US$/Kg
COST EFFECTIVENESS:	12.25 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	FONDOIN
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	December 1994/May 1995

PROJECT SUMMARY:

PINOVA S.A. is a 100% Venezuelan-owned company manufacturing and installing non-unitary commercial refrigeration equipment, and PU insulation panels. Currently CFC 11 is used as the blowing agent in the production of the rigid polyurethane insulation foam for the refrigerated show cases and walk-in chillers, and for the PU foam insulation panels. CFC 12 is used as the refrigerant. Based on 1993/94 figures, this project will eliminate 27.32 ODP tons/yr of CFCs 11 and 12 by conversion to cyclo-pentane as the foam blowing agent and HFC 134a as the refrigerant respectively. Funds requested will be used to change the existing production lines, and for technology transfer, technical assistance, re-design, testing, pre-production trials, and training. Incremental operational costs resulting from the conversion to the new technology (6 months) are calculated for illustrative purposes, they are NOT requested by the enterprise.

Prepared by:	S.W. Kelly/F.F.J. Voorwalt, in collaboration with the Foundation for Protection of the Ozone Layer and the Environment (FONDOIN).
Reviewed by:	Dr L.J.M. Kuijpers/Dr M.J.P. Janssen (Refrigeration) and Dr H. Creyf (Foam). Their comments are attached.

PROJECT OF THE GOVERNMENT OF VENEZUELA

ELIMINATION OF CFCs IN THE MANUFACTURE OF COMMERCIAL REFRIGERATION EQUIPMENT

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFCs used by PINOVA S.A. in the manufacture of commercial refrigeration equipment and PU foam insulation panels. CFC 11 is used as the blowing agent for producing the PU thermal insulating foams for the refrigerator cabinets and insulation panels, and this will be eliminated by conversion to cyclo-pentane. CFC 12, used as the refrigerant, will be replaced by HFC 134a.

2. SECTOR BACKGROUND.

The Venezuela Country Programme (CP) for the Phase-out of Ozone Depleting Substances (ODS) under the Montreal Protocol is presently in the course of preparation. It is anticipated that the CP will be presented to the 17th meeting of the Executive Committee of the Multilateral Fund for the Montreal Protocol in July 1995.

Total ODS consumption in the refrigeration and air-conditioning sector in Venezuela in 1993 is estimated at approximately 3,200 tons, and this accounts for around 80% of total ODS consumption.

Due to the economic situation in Venezuela, 1994 data is not representative of either typical commercial refrigeration equipment production volume, or ODS consumption. This project is, therefore, based on 1993 calender year data for Pinova. (An accompanying project for Industrias Nutal C.A. uses 1994 data because the enterprise re-structured it's product range during 1993).

In preparing this project proposal, and in the absence of a CP, the data in the following table was established as the best estimate representing CFC consumption for the manufacture and installation of both unitary and non-unitary commercial refrigeration equipment in Venezuela.

ODS elimination project proposals are being presented to the Montreal Protocol Multilateral Fund for the TWO enterprises indicated in bold type, Pinova S.A. and Industrias Nutal C.A..

It should be noted that the estimates are based on limited discussions with industry representatives, plus information from a World Bank study mission to Venezuela in May 1994.

The "Production Volume" figures reflect both unitary and non-unitary equipment ranging from small drinking water coolers to large display cases. In some cases non-CFC insulation material is used, also some companies do not install the units they manufacture so they have no CFC refrigerant consumption.

Enterprise	Production Volume	CFC 11 Consumption (Tons)	CFC 12 Consumption (Tons)
Industrias Nutal			
Unitary Equipment	3,152	3.14	3.15 *
Insulation Panels	1,436	1.90	-
Pinova			
Display Cases	4,262	9.94	3.00
Insulation Panels	32,582 M2	14.08	-
Grupo Frigilux **	19,846 **	10.01 **	6.23 **
Tecoven	4,000	6.00	2.00
Couttenye Refrig.	2,000	35.00(?)	1.50
Refrivenca	4,000	6.00	2.00
Frigra Nevelara Invitrel Articold Deincopa Friobox Refrigeracion Europa	10,000	7.50	2.50
Totals		93.57	20.38

* Some of the CFC 12 consumption at Industrias Nutal is for "frothing" in the PU foaming process.

** Grupo Frigilux C.A. is also engaged in the manufacture of domestic refrigerators and the enterprise is included as part of an overall domestic refrigeration sector ODS elimination project.

This consumption of 113.95 ODP tons represents approximately 3.5% of total ODS consumption in the refrigeration sector in Venezuela in 1993.

The industry uses locally manufactured hermetic compressors, refrigerants, and PU foam chemicals but also imports other raw materials and parts. In addition to the local compressor manufacturer, Vecomesa S.A., compressors are also sourced from Embraco and Sicom (Brazil), Daewoo (Korea), L'Unite Hermetique (France), Tecumseh and Copeland (USA).

The Foundation for the Protection of the Ozone Layer and the Environment (FONDOIN), with the assistance of UNDP, has designed a strategy for reduction of CFC 11 and CFC 12 consumption in the commercial refrigeration manufacturing sector beginning in 1995. Approval of this project by the MLF in July 1995 will result in the phase-out of an estimated 31% of CFC consumption in the manufacture of commercial refrigeration equipment in Venezuela in 1996.

3. ENTERPRISE BACKGROUND

PINOVA S.A. manufactures an extensive range of non-unitary supermarket refrigerated display cases and walk-in chillers. They also make metal clad PU foam insulation panels. Pinova installs around 20% of the equipment which they manufacture, the rest is sold for installation by the end-user, or other independent commercial refrigeration engineers. Pinova has an estimated 95% share of the market for supermarket refrigerated display cases. Pinova S.A. is a 100% Venezuelan owned enterprise.

TOTAL CFC USE IN 1993:	24.02 tons CFC 11 3.75 tons CFC 12
FULL NAME:	PINOVA S.A.
ADDRESS:	Carretera Panamericana, Km 14, San Antonio de Los Altos, Edo Miranda, Venezuela.
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Venezuela)
No. OF MODELS:	58
PRODUCTION IN 1993:	4,262 units + 32,582 M2 of Panels
No. OF PRODUCTION LINES:	2
CONTACT PERSONS:	Camel Torbay - General Manager Malek Torbay - Director Enrique Pazo - Production Manager Edwin Mattar Torbay - Project Mgr
TEL / FAX:	Tel: (58 32) 72 38 22 Fax: (58 32) 72 46 12

Pinova market their display cases under the "NeveRama" brand name and the product range covers all of the temperature ranges found in supermarket refrigerated display cases. All production is sold within Venezuela.

The display case and "walk-in" chiller designs were developed "in-house" by Pinova. They install and commission around 20% of their annual production, calculating the refrigeration capacity required and sourcing proprietary equipment from Copeland and Tecumseh. Pinova has no technology transfer or licensing agreements with any internationally recognised commercial refrigeration equipment manufacturers.

Pinova presently employs 243 persons all of whom are engaged in display case and insulation panel related activities, including 8 refrigeration engineers who install, commission, repair, and service the equipment.

This project encompasses all ODS blowing agent consumption used in the manufacture of supermarket refrigerated display cases, "walk-in" chillers, and PU foam insulation panels at Pinova S.A. It also includes provision to reduce ODS refrigerant consumption through the supply of equipment to enable non-ODS refrigerants to be charged, although it is recognised that the choice of refrigerant cannot always be directly influenced by Pinova.

The following tables provide a summary of bottle cooler and freezer production by Pinova S.A. during the 12 month period January to December 1993 inclusive.

Model No.	Description	Production Volume	PU Foam per unit Kgs	Total PU Foam Consumption Kgs
EXC-7	1.9M G Ref SC	309	11.25	3,476.25
EXC-9	2.5M G Ref SC	425	15.13	6,430.25
EXC-11	3.1M G Ref SC	299	18.75	5,606.25
EXC-13	3.7M G Ref SC	212	22.50	4,770.00
EXC-ESQ	1.25M G Ref SC	11	3.75	41.25
FV-6	1.8M G Ref SC	170	6.75	1,147.50
FV-8	2.4M G Ref SC	83	9.25	767.75
FV-10	3.0M G Ref SC	9	11.50	103.50
CHA-7	1.9M G Ref SC	15	11.25	168.75
CHA-9	2.5M G Ref SC	59	15.13	892.67
CHA-11	3.1M G Ref SC	56	18.75	1,050.00
CHA-13	3.7M G Ref SC	50	22.50	1,125.00
GAL-7	1.9M G Ref SC	11	6.50	71.50
GAL-9	2.5M G Ref SC	25	8.75	218.75
GAL-11	3.1M G Ref SC	13	11.00	143.00
GAL-13	3.7M G Ref SC	19	13.00	247.00
BAK-7	1.9M G Ref SC	31	6.75	209.25
BAK-9	2.5M G Ref SC	19	9.25	175.75
BAK-11	3.1M G Ref SC	14	11.50	161.00
VN-4	1.26M Vitrina G	323	9.75	3,149.25
VN-6	1.83M Vitrina G	245	14.75	3,613.75
VN-8	2.41M Vitrina G	124	18.75	2,325.00
VN-12	3.60M Vitrina G	8	26.25	210.00
VNC-4	1.26M Vitrina G/M	23	10.00	230.00
VNC-6	1.83M Vitrina G/M	24	15.00	360.00
RVN-2	1.28 M3 Ref	11	13.25	145.75
RVN-3	1.88 M3 Ref	6	19.88	119.28
RVN-4	2.56 M3 Ref	8	25.50	204.00
CVN-1	0.80 M3 Frz	28	15.00	420.00
CVN-2	1.28 M3 Frz	18	13.25	238.50
CVN-3	1.88 M3 Frz	6	19.88	119.28
CVN-4	2.56 M3 Frz	8	25.50	204.00
Totals or Weighted Average		2,662		38,144.23

Model No.	Description	Production Volume	PU Foam per unit Kgs	Total PU Foam Consumption Kgs
RCV 1x1	1.28 M3 Ref/Frz	745	13.25	9,871.25
RCV 1x2	1.88 M3 Ref/Frz	5	19.88	99.40
RCV 2x1	1.88 M3 Ref/Frz	11	19.88	218.68
RCV 2x2	2.56 M3 Ref/Frz	2	25.50	51.00
RCV 3x1	2.56 M3 Ref/Frz	4	25.50	102.00
FN-4	1.25M Ref GSC	99	3.75	371.25
FN-6	1.85M Ref GSC	86	5.50	473.00
FN-8	2.45M Ref GSC	16	7.25	116.00
5L-9	2.5M Dairy SC	6	22.75	136.50
5L-13	3.7M Dairy SC	30	31.25	937.50
ASC-9	2.5M SS Ref Deli SC	16	14.50	232.00
ASC-13	3.7M SS Ref Deli SC	74	20.00	1,480.00
ASC-3-9	2.5M Multideck Deli SC	1	25.00	25.00
ASC-3-13	3.7M Multideck Deli SC	6	36.00	216.00
ASP-9	2.5M Fish SC	1	14.50	14.50
VA2-9	2.5M Multideck Veg SC	20	18.66	373.20
VA2-13	3.7M Multideck Veg SC	16	26.75	428.00
VA-9	2.5M Veg/Fruit SC	26	25.50	663.00
VA-13	3.7M Veg/Fruit SC	104	35.00	3,640.00
CA-9	2.5M SS Frz Deli SC	29	10.00	290.00
CA-13	3.7M SS Frz deli SC	15	15.50	232.50
RH-1	0.96M Reach-in G Ref	71	15.38	1,091.98
RH-2	1.73M Reach-in G Ref	84	23.50	1,974.00
RH-3	2.50M Reach-in G Ref	68	31.75	2,159.00
RH-4	3.27M Reach-in G Ref	25	40.00	1,000.00
RH-5	4.05M Reach-in G Ref	40	48.50	1,940.00
Totals or Weighted Average		1,600		28,135.76

Key: Ref = Refrigerator Frz = Freezer SC = Show Case
SS = Self Service G = Glass door/front
GSC = Glass Show Case G/M = Glass & Metal Doors

Total Production	Total PU Foam (Kgs)	Average PU Foam/Unit
4,262	66,280	15.55

Based on the PU foam formulation used by Pinova which contains 15% by weight of CFC 11 as blowing agent, CFC 11 consumption is then 9.94 tons.

In 1994, Pinova produced 32,582 M2 of metal clad PU foam insulation panels. With a weight of 2.88 Kgs of foam per M2, this activity consumed 14.08 tons of CFC 11.

Pinova installed around 20% of the 4,262 display cases that they produced in 1993 and the CFC 12 consumption involved was 3.00 tons. The rest of the production was sold for installation by the end user or other independent commercial refrigeration engineers. In addition, Pinova also consumed 0.75 tons of CFC 12 for service and maintenance of existing equipment.

4. PROJECT DESCRIPTION

Pinova presently uses CFC 11 as the blowing agent for the rigid PU insulating foam used in the display cases, "walk-in" chillers, and insulation panels. CFC 12 is used as refrigerant, both for initial charge and servicing. Pinova can influence the choice of refrigerant for new non-unitary equipment and the ODS consumption of 3.00 tons of CFC 12 for this purpose is included in the project. It is estimated that 0.3 tons of the 0.75 tons of CFC 12 consumed for servicing can be eliminated by the provision of eight small "Recovery & Recycle" machines and this is, therefore, also included in the project.

The total consumption in the 12 months January - December 1993, and the ODP tons that will be eliminated by this project are shown in the following table:

CFC 11 consumed (tons)	ODP tons eliminated * see Note	CFC 12 consumed (tons)	ODP tons eliminated	Total ODP tons eliminated
24.02	24.02	3.75	3.30	27.32

Note: *Based on replacement of the CFC 11 with cyclo-pentane.

4.1. REPLACEMENT OF CFC 11 WITH cyclo-PENTANE

Pinova has selected the zero-ODP cyclo-pentane to replace CFC 11 as the blowing agent for the PU insulation foam in both its commercial refrigerators and insulation panels.

This will require replacement of the existing low pressure PU foam dispensing machines, as well as new equipment related to the safe storage and handling of cyclo-pentane and the preparation of polyol/cyclo-pentane blends.

The conversion to cyclo-pentane will also incur costs related to technology transfer, production trials, training, and safety audits at Pinova. These activities will include training of staff in worker-safety issues related to cyclo-pentane.

Details of the existing foam injection equipment are provided in section 5.1.3.

Incremental Operational Costs associated with the technology change from CFC 11 to cyclo-pentane are calculated for a period of six months for illustrative purposes, <u>but they are not requested from the MLF and they will be absorbed by the enterprise.</u>

4.2. REPLACEMENT OF CFC 12 WITH HFC 134a.

HFC 134a is widely accepted as a zero-ODP replacement for CFC 12 in the domestic and commercial refrigeration sectors and the technology is mature. This is the CFC replacement technology selected by Pinova.

The conversion to HFC 134a requires the use of HFC 134a specific compressors and the associated new synthetic lubricants, plus re-design of the refrigeration systems to cater for the difference in thermodynamic performance of HFC 134a versus CFC 12.

4.2.1. NON-UNITARY EQUIPMENT INSTALLATION & COMMISSIONING

All of Pinova's refrigeration equipment is non-unitary and it uses semi-hermetic compressors. All systems are charged on site, approximately 20% by Pinova, the rest by the end user or his designated contractor. However, by re-design of the evaporators and the recommendation to use only HFC 134a, Pinova can dictate the selection of refrigerant to its customers. Appropriately sized HFC 134a compressors will be either sourced, or recommended, from Tecumseh or Copeland according to the refrigeration capacity of the installation.

Information on lubricants and materials compatibility will likewise be provided by the compressor supplier and there will be no requirement for prototyping, etc. There will, however, be a training requirement for the refrigeration engineers before working on the installation and service of HFC 134a systems.

The different properties of HFC 134a, the need to avoid cross-contamination with CFC 12, and the phased nature of the conversion of refrigerator production from CFC 12 to HFC 134a, means that new system evacuation, refrigerant charging, and leak detection equipment will be required.

Pinova has a team of EIGHT refrigeration engineers who install, commission, repair, and service the company's refrigeration equipment. These engineers are equipped with the basics of manifold gauge charging sets, vacuum pumps, and hand held electronic leak detectors.

In order to be able to offer its clients HFC 134a technology and eliminate the annual consumption of 3.0 tons of CFC 12 for the installation and commissioning of equipment which is under Pinova's control, Pinova requires new manifold gauge charging sets, vacuum pumps, and electronic leak detectors suitable for HFC 134a.

4.2.2. RETROFITTING EXISTING CFC 12 EQUIPMENT TO USE HFC 134a

Pinova has some 24,000 refrigerated display cases and 8,000 walk-in chillers in service in Venezuela. There will be a need to retrofit some of these installations to R134a duty in order to prolong their useful economic lifetime.

The refrigeration engineers existing R12 evacuation, charging and leak detection equipment, together with the new equipment proposed in 4.2.1 will enable Pinova to offer a retrofit service to their customers (and others).

However, the R12 removed during retrofit needs to be recovered and recycled for future use in servicing equipment where retrofit is not a cost effective or practical option. With refrigerant charges in the range of 2 - 14.5 Kgs, EIGHT recovery and recycling machines of the appropriate capacity are required in order to offer retrofit combined with CFC 12 recovery and recycling. It is not possible at this time to quantify the amount of CFC 12 consumption which can be eliminated by retrofitting.

4.2.3. RECOVERY AND RECYCLE OF CFC 12 DURING SERVICING

The same EIGHT refrigeration engineers carry out maintenance and service operations for Pinova's customers. All service and repair operations are "on-site" and ODS consumption for these activities is 750 Kgs of R12 per annum. It is estimated that the provision of suitable recovery and recycling equipment is also capable of eliminating around 300 Kgs of this annual R12 consumption.

5. TECHNOLOGY

5.1. REPLACEMENT OF CFC 11.

5.1.1. OVERVIEW

Currently, the three principal technology options for the replacement of CFC 11 in thermoset insulation foams are:

CFC 11 > partial water/HCFC 141b > ?
CFC 11 > partial water/HCFC 22,142b > HFC 134a, HFC 152a
CFC 11 > n-, iso-, or cyclo-, pentane

In addition, hydrofluoroalkanes such as HFCs 245, 356, etc., fluorinated ethers, and vacuum panels have been suggested for specific applications, but the technologies are not mature. Furthermore, some of these products are either only available in limited quantities, or toxicological testing is not complete and, therefore, safety in use cannot be evaluated.

The first option, <u>the "liquid" solution</u>, employs technology that is closely related to the existing CFC 11 technology and generally means that existing foam dispensing equipment can be used. The final step to a zero-ODP technology in this process is not yet decided. One potential solution may be the use of liquid HFCs such as HFC 245 or HFC 356, but full water blown foam with improved cell structure remains another option.

The second one, <u>the "gas" solution</u>, utilizes physical blowing agents which are liquefied gases. This technology always requires new foam dispensing equipment and extensive adjustments. The final step to a zero-ODP technology in this process would be the use of a gaseous HFC such as HFC 134a.

The third option, <u>pentane technology</u>, is commercially proven and is now extensively used in many rigid PU insulation foam applications in Europe. It is a zero-ODP technology which in many countries can be very cost effective. However, pentanes are flammable and this means a careful review of manufacturing operations with respect to the safe handling of a flammable foam blowing agent. Pentane technology may not be a practical or cost effective option in the existing workplace environments at many smaller scale enterprises due to the plant safety modifications required.

Several companies currently offer pentane technology packages, including equipment. Its use certainly requires implementation assistance and UNDP further requires an independent safety review prior to, and after, installation.

<u>5.1.2. SELECTION</u>

Based on economic, environmental, safety, performance and technical considerations, cyclo-pentane technology appears to be the best choice for the commercial refrigeration applications at Pinova. Pinova also prefer to change in a single step from CFC 11 to a zero-ODP solution, rather than via an interim technology like HCFC 141b. The selected technology is, therefore, cyclo-pentane but the change to this technology is dependent upon adequate financial assistance from the MLF.

The following considerations also influenced the Pinova decision in favour of cyclo-pentane technology:

- it is a proven zero-ODP technology that is now being applied commercially in many countries,
- with formulation, and other relatively minor changes, near equivalent insulation values and structural properties to the

existing CFC 11 blown foam can be achieved,
- it is an acceptable "long-term" CFC 11 replacement,
- it meets the zero-ODP requirements of some of Pinova's multinational clients.

The selection of cyclo-pentane technology by Pinova is a realistic and sensible choice under the prevailing circumstances. It is, however, dependent on the necessary funding from the MLF, although the enterprise will absorb the incremental operational costs as their contribution towards the total project costs. The technology choice is supported by the FONDOIN.

5.1.3. IMPACT ON THE PRODUCTION PROCESS

The use of cyclo-pentane technology will require substantial changes in the chemicals storage, processing, and refrigerator and panel manufacturing facilities because of the highly flammable nature of the substance. The adherence to the strictest safety Standards available, such as EN, NFPA, or other internationally recognised Standards, is required for UNDP implemented projects. These Standards classify explosive zones ("EX areas") generally in THREE categories:

Zone 0 Where a constant amount of highly flammable/explosive liquids or gases can be expected. The inside of cyclo-pentane pipework, and cyclo-pentane storage tanks would be classified as "Zone 0". All equipment, materials, fittings, etc. in a Zone 0 area must be "explosion proof (EX)" and earthed.

Zone 1 Where, from time to time, highly flammable liquids or gases can be expected. Areas where foaming operations are carried out including molds, jigs, or other such fittings would be classified as "Zone 1". All equipment, materials, fittings, etc. in a Zone 1 area must be EX-e, EX-d or ia, and earthed.

A Zone 1 area may be re-classified to a Zone 2 area by the provision of sufficient extract ventilation.

Zone 2 Where, only by accident or scheduled maintenance, highly flammble/explosive gases can be expected. Areas such as the cyclo-pentane storage, polyol/cyclo-pentane blend stations, foam dispensing machines, would generally be classified as "Zone 2". All equipment, materials, fittings, etc. in a Zone 2 area must be EX-n, or with IP54 sealing. Earthing to avoid static build-up and discharge is required.

Other requirements relating to the use of cyclo-pentane are:

- there shall be implementation assistance by a UNDP approved process consultant experienced in cyclo-pentane technology, who must provide assurances on safety issues to the enterprise,
- Process Safety Audits, by a UNDP appointed independent contractor are required, prior to, during, and after project implementation.
- the installation of cyclo-pentane gas detectors in all EX areas which shall be connected to a central control panel c/w automatic recorder and printer. The control panel shall in turn activate secondary extract ventilation, and/or cyclo-pentane shut-down valves when pre-set levels of the Lower Explosion Limit (LEL) for cyclo-pentane is measured,
- the installation of containment around cyclo-pentane storage tanks, and enclosure of other areas, as deemed necessary,
- the provision of cyclo-pentane/polyol blending equipment, as a pre-mix cannot be purchased,
- Antistatic clothing and shoes shall be worn in Zone 0 and Zone 1 areas,
- the provision of a portable gas detector to monitor cyclo-pentane concentrations throughout the plant according to an approved monitoring plan,
- the preparation of an approved preventative maintenance system, and the preparation of, and practice implementation of, an emergency response plan,
- the training of production and maintenance personnel in the safe handling of cyclo-pentane,

The use of cyclo-pentane technology will be facilitated by the provision of new high pressure foam production equipment prepared for cyclo-pentane duty.

Formulation changes, together with an increase in the thickness of the insulation foam, will need to be considered in order to obtain equivalent insulation values.

Some of the refrigerator models produced by Pinova use GRP reinforced cabinet liners. The compatibility of this material with cyclo-pentane blown PU foam will need to be checked and changes may be necessary.

Pinova currently has FOUR low pressure Decker PU foam dispensing machines, each with a single mixing head. Polyol and CFC 11 are purchased as a pre-mix. The dispensing machine details are:

Decker Model D-40 low pressure foam dispensing machine with a maximum throughput of 20 Kgs/min. Serial No. 518. Vintage 1978.

Decker Model D-40-6 low pressure foam dispensing machine with a maximum throughput of 25 Kgs/min. Serial No.398. Vintage 1979.

Decker Model D-40-6 low pressure foam dispensing machine with a maximum throughput of 25 Kgs/min. Serial No. 417. Vintage 1988.

Decker Model D-150-6P low pressure foam dispensing machine with a maximum throughput of 70 Kgs/min. Serial No. 469. Vintage 1981.

Pinova manufacture their display cases and insulation panels on two floors of a four storey building. The two D-40-6 machines are used for display cases, while the D-150-6P is located on rails and is used only for long panels using 38-40 Kg/M3 density PU foam. The D-40 is used for short panels, and for panels where lower density 30 Kg/M3 PU foam is required.

Rationalisation of the number of foam dispensing machines and the PU foam densities were carefully examined. It is proposed that the FOUR existing low pressure machine will be replaced with TWO high pressure foam dispensing machines of 45 Kgs/min capcity with all the required accessories for cyclo-pentane duty, including pre-mixers etc. When the cyclo-pentane technology is introduced, a single foam density will be utilised in all applications.

5.2. REPLACEMENT OF CFC 12.

5.2.1. OVERVIEW

HFC 134a is universally accepted as a CFC 12 replacement in the manufacture of unitary and non-unitary commercial refrigeration equipment. HFC 134a is widely available and the technology is mature. Replacement of CFC 12 with HFC 134a in non-unitary equipment is less critical than in small unitary appliances. Modest equipment replacement for installation and servicing is required and technology can be acessed from the compressor suppliers.

Whilst hydrocarbon refrigerant (iso-butane) is being increasingly used in the manufacture of domestic refrigerators in several Developed Countries, it has not yet found application in the commercial refrigeration sector due to the safety issues concerned with the larger refrigerant charges.

5.2.2. SELECTION

The technology selected by Pinova is HFC 134a. The refrigeration technology used by Pinova is basic technology augmented by the information supplied by Copeland and Tecumseh relating to their respective compressors. Pinova has no formal technology transfer agreements with internationally recognised commercial refrigeration equipment manufacturers or compressor suppliers.

5.2.3. IMPACT ON THE PRODUCTION PROCESS

HFC 134a, like CFC 12, is non-flammable. HFC 134a has also been the subject of extensive toxicological testing and is considered safe in use in industrial applications provided the suppliers recommended occupational exposure levels are not exceeded. At the present time this means ensuring that exposure levels do not exceed 1000 parts per million on an 8-hour time-weighted average basis. This is the same as the Occupational Exposure Limit (OEL)/Threshold Limit Value (TLV) for CFC 12 and thus no changes from current practices are required.

There will be an approximately 10% reduction in the mass charge of HFC 134a compared with CFC 12 for a refrigerator system of the same capacity.

It is well understood that the chemical stability of the HFC 134a and synthetic lubricant systems, and hence the long term performance of the refrigeration unit, is sensitive to moisture content and certain chlorinated impurities. This requires that CFC 12 and HFC 134a handling equipment be carefully segregated, and it also calls for better evacuation of the system prior to refrigerant charging. Training of Pinova's refrigeration engineers in these requirements relating to HFC 134a technology will be required.

Leak detection of the refrigeration system is an integral part of the refrigeration equipment comissioning and servicing and the use of HFC 134a requires that new leak detection equipment be employed.

To enable Pinova to install and service HFC 134a based non-unitary systems, and to offer retrofit of existing systems from CFC 12 to HFC 134a, new vacuum pumps, manifold gauge charging sets, hand-held electronic leak detectors, and CFC 12 recovery and recycle equipment will be required.

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

cyclo-PENTANE STORAGE TANK inc installation	35,000
2 X 45 Kgs/min HIGH PRESSURE FOAM DISPENSING MACHINES, & POLYOL/cyclo-PENTANE PRE-MIX UNITS	330,000
cyclo-PENTANE GAS DETECTION SYSTEM	30,000
FREIGHT & INSTALLATION	15,000
EXTRACT VENTILATION SYSTEM	10,000
GROUNDING	5,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE/TRAINING	20,000
SAFETY AUDITS	10,000
PRODUCTION TRIALS (2 Machines)	10,000
CONTINGENCIES (10%)	46,000
Subtotal (US$)	511,000

CAPITAL COST FOR CFC 12 PHASE-OUT

R134a MANIFOLD GAUGE SETS & HOSES (8 off)	1,600
NEW VACUUM PUMPS (8 off)	10,000
R134a LEAK DETECTION EQUIPMENT (8 off)	4,000
R12 RECOVERY & RECYCLE MACHINES (8 off)	24,000
TRAINING	5,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE (Retrofit)	5,000
CONTINGENCIES (10%)	5,000
Subtotal (US$)	54,600
TOTAL INCREMENTAL CAPITAL COST (US$)	565,600

6.2 INCREMENTAL OPERATING COSTS

The calculation of the incremental operating costs is based on a six month period using 50% of the actual production for January to December 1993 inclusive. Annex A. provides detailed explanations on how the incremental operational costs were obtained. This is for illustrative purposes only, the incremental operating costs are NOT requested by the enterprise. The costs are summarized below:

PHASE-OUT OF CFC 11

Costs for Materials (see Annex A. Part 1.):	26,517
TOTAL INCREMENTAL OPERATING COST (US$)	26,517

6.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational) (US$)	592,117	
% Article 5.1 Country Ownership	100%	
FUNDING REQUESTED FROM MLF (US$)	565,600	*

6.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	565,600	
b. Capital Recovery Factor (10% p.a.)	0.16275	
c. Incremental Operating Costs	n/a	*
d. ODS Reduction (ODP Kgs Jan - Dec 1993)	27,320	
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	3.37	

THE PROJECT UNIT ABATEMENT COST IS 3.37 US$/Kg

(* The funding requested from the MLF does not include the project incremental operating costs which will be absorbed by the enterprise.)

6.5 PROJECT SAFETY RELATED COSTS (US$)

cyclo-Pentane Storage Tank	=	35,000
High Pressure Foam Dispensing Machines/ Polyol/cyclo-Pentane pre-mixers	=	120,000
cyclo-Pentane Gas Detection System	=	30,000
Extract Ventilation	=	10,000
Grounding	=	5,000
Safety Audits	=	10,000
Contingencies	=	21,500
TOTAL SAFETY RELATED COSTS	=	231,000

6.6 COST EFFECTIVENESS (US$/Kg)

(a) TOTAL PROJECT COST - INC. OPERATING COSTS	=	565,600	US$
(b) LESS PROJECT SAFETY RELATED COSTS	=	231,000	US$
(c) TOTAL ODS ELIMINATED	=	27,320	ODP Kgs
(d) PROJECT COST EFFECTIVENESS (a - b)/c	=	12.25	US$/Kg

THE PROJECT COST EFFECTIVENESS IS 12.25 US$/Kg

This is below the threshold value of 15.21 US$/Kg established by the Executive Committee of the MLF at its 16th meeting in March 1995.

7. FINANCING PLAN

Pinova S.A. requests reimbursement from the MLF of the sum of US$ 565,600, representing the incremental Capital Costs of this ODS elimination project, correctly taking into account the Article 5.1 country ownership of the enterprise. Incremental Operational Costs are not requested.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP will oversee the successful implementation of this project, and will provide technical assistance during project execution.

8.2 SCHEDULE

TASK	TIME TO COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
MLF Approval	X					
Procurement Preparation	XX	X				
Vendor Selection		XX				
2. Installation						
Arrival of Equipment			X	X		
Customs Clearance				XX		
Machine Installation				X	X	
3. Start-Up						
Machine Start-up					X	
Trials & Training				XX	XX	
Mass Production Change					X	XX
Safety Audits				X	X	X
Certification						X

9. PROJECT IMPACT

Based on data for the 12 months, January - December 1993, this project will eliminate the use of 27.32 ODP tons per year.

10. ANNEXES

Annex A. - Incremental Operational Cost Calculations.
Annex B. - Project Technical Reviews.

Notes relating to the calculation of the Incremental Operational Costs

Note 1.
Figures in the following table are based on the actual production volumes for the 12 month period January to December 1993 obtained from Pinova S.A. at the time of project preparation. The Incremental Operational Costs for CFC 11 replacement are calculated for 6 months for illustrative purposes only, using 50% of this 12 months production volume. Pinova will absorb these costs as its contribution to the total project costs. There are no incremental operating costs for the CFC 12 replacement attributable to Pinova.

Note 2.
Chemical prices used in the table are current weighted average prices for the principal domestic and commercial refrigerator manufacturers in Venezuela. The price for cyclo-pentane is estimated.

ANNEX A. INCREMENTAL OPERATIONAL COST CALCULATIONS

1. Incremental Costs resulting from replacing the CFC 11 Blowing Agent in the Refrigerator Insulation Foam with cyclo-pentane (US$)

PINOVA S.A.	CFC 11	C-P	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.350	0.366	0.016
b. MDI	0.500	0.582	0.082
c. Kg Blowing Agent	0.150	0.045	(0.105)
d. Water	-	0.007	0.007
Prices in US$/Kg			
e. Polyol	2.61	2.87	0.26
f. MDI	2.15	2.15	-
g. Blowing Agent	2.00	1.80	(0.20)
Cost per Kg of Foam Produced			
h. = a. x e. Polyol	0.914	1.050	0.136
i. = b. x f. MDI	1.075	1.251	0.176
j. = c. x g. Blowing Agent	0.300	0.081	(0.219)
k. = h+i+j Total Cost per Kg of Foam	2.289	2.382	0.093
Materials Used per Display Case			
l. Kg of Foam per Display Case (avg)	15.550	17.105	1.555
m. Kg of Foam per M2 of Insulation Panel	2.880	3.168	0.288
Cost per Display Case/Insulation Panel (US$)			
n. = l. x k. for Display Case Foam	35.594	40.744	5.150
o. = m. x k. per M2 of Insulation Panel Foam	6.592	7.546	0.954
s. = No. of Display Cases (see Note 1.) Incremental Operating Cost (Display Cases) US$	2,131 2,131 x 5.150 = 10,975		
t. = M2 of Insulation Panels (see Note 1.) Incremental Operating Cost (Panels) US$	16,291 16,291 x 0.954 = 15,542		
TOTAL INCREMENTAL OPERATIONAL COST (US$)	26,517		

TECHNICAL REVIEW.

1. Country:

Venezuela.

2. Project Title:

Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at PINOVA S.A.

3. (Sub)Sector:

Commercial Refrigeration.
This review covers only the foam part.

4. CP-Relationship:

The Venezuelan CP for phase-out of ODS is actually in preparation. It is believed that the CP will be presented at the 16th Meeting of the Executive Committee of the MLF in March 1995.
Beginning 1995, the "Foundation for the Protection of the Ozone Layer and the Environment" (FONDOIN), assisted by UNDP has assigned a strategy for CFC elimination in the domestic refrigeration sector.

5. Technology:

PINOVA wishes to change the use the cyclopentane technology to replace its actual CFC 11 in the manufacture of insulating PUF. The reasons given in the project can be accepted, provided of course that the safety aspect is well looked after, as well in the hardware, in the management procedures, as in the mentality of the workers.
High pressure equipment will be necessary in order to ensure correct mixing of the chemicals.

6. Environmental Impact:

Cyclopentane has no ODP and GWP, but it has a smog potential of 500 (versus 0.1 for CFC 11). It will hence be important to compare cyclopentane emissions with the actual or future Venezuelan emission legislation.

(27)

7.Project Costs:

Project costs can be accepted as presented.About half of the capital costs are safety related.

The company does not claim incremental operating costs.

The cost for eliminating 1 kg of ODS for the foam part is USD 511,000/ 24,020 or USD 21.27.

8.Implementation:

Management and time schedule can be accepted.

9.Recommendation:

It is recommended to accept the project as it is presented.

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date: 061195.

Creyf

Country of origin: VENEZUELA

Project title: Elimination of CFCs 11 and 12 at TWO Manufacturers of Commercial Refrigeration Equipment (Industrias Nutal C.A. and Pinova S.A.)

Sector/sub-sector Commercial refrigeration

Relationship to country program UNDP (CP in preparation)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

- Both manufacturers in this project have chosen for a conversion of their production to the HFC-134a technology.
- In commercial refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.
- The two companies in this project do not have a formal technology transfer agreement. However, both companies plan to develop the HFC-134a technology with assistance from compressor and refrigerant suppliers. This holds for both the unitary equipment produced by Nutal and for the installation of non-unitary equipment by both companies. Furthermore provisions for external assistance are present. Due to these facts, a successful project implementation can be expected at both companies.
- Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of safety issues related to the use of flammable refrigerants in commercial equipment and because of the lack of commercially available compressors. From the zero ODP technologies HFC-134a is a cost effective solution.

Environmental impact

HFC-134a has an ODP of zero and a GWP of 0.27.

Project costs

Industrias Nutal:

- The equipment requested is essential for the conversion process of the unitary equipment. Costs of equipment, redesign, training, testing and technical assistance are reasonable.
- The refrigeration equipment requested for installing new equipment, for servicing existing equipment (including retrofits) and for recovery/recycling is essential for a successful reduction of CFC-12 usage in the non-unitary sector. The costs claimed are reasonable.
- Incremental operational costs are reasonable and correctly applied (for six months).
- If the UAC value is calculated for the refrigerant conversion part of the project, a value of 2.9 USD/kg/year is obtained which is reasonable for commercial refrigeration projects.
- The estimated value for the CFC reduction is reasonable.

Pinova S.A.:

- The refrigeration equipment requested for installing new equipment and for servicing existing equipment (including retrofits) is essential for a successful reduction of CFC-12 usage in the non-unitary sector. The costs claimed are reasonable. The investment in 8 recovery/recycling stations is not very cost effective due to the low CFC-12 reduction involved (only 300 kg/year which is much lower than the estimated reduction for Industrias Nutal) but is still acceptable.
- No incremental operational costs are claimed (only for the foam part).

- If the UAC value is calculated for the refrigerant conversion part of the project, a value of 3.7 USD/kg/year is obtained which is a reasonable value for commercial refrigeration projects.
- The estimated value for the CFC reduction is reasonable.

Implementation timeframe Reasonable.

Relevance and adequacy of information provided Sufficient

Recommendations Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands
30-January-1995

Kuijpers L.J.M.,
University Eindhoven, The Netherlands

PROJECT COVER SHEET

COUNTRY:	**VENEZUELA**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at GRUPO FRIGILUX C.A.
SECTOR COVERED:	Domestic Refrigeration (Mfg)
ODS USE IN SECTOR:	236.69 tons ODS
PROJECT IMPACT (ODP):	48.82 ODP tons
TOTAL PROJECT COST:	US$ 1,221,599
INCREMENTAL CAPITAL COST:	US$ 1,008,000
INCREMENTAL OPERATING COST:	US$ 213,599
PROPOSED MLF GRANT:	US$ 1,008,000
UNIT ABATEMENT COST:	3.36 US$/Kg
COST EFFECTIVENESS:	13.55 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	FONDOIN
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	December 1994/May 1995

PROJECT SUMMARY:

GRUPO FRIGILUX C.A. is a 100% Venezuelan-owned company manufacturing domestic refrigerators and freezers as well as a range of unitary commercial refrigeration equipment primarily for sale in Venezuela. Frigilux currently uses CFC 11 as a blowing agent in the production of rigid polyurethane insulation foam for the refrigerator cabinets and doors, and CFC 12 is used as the refrigerant. Based on 1993 figures, this project will eliminate 48.82 ODP tons/yr of CFCs 11 and 12 by conversion to the use of cyclo-pentane as the foam blowing agent and HFC 134a as the refrigerant respectively. Funds requested will be used to change the existing production lines, and for technology transfer, technical assistance, re-design, testing, pre-production trials, and training. Incremental operational costs resulting from the conversion to the new technology (6 months) are calculated for illustrative purposes, they are NOT requested by the enterprise.

Prepared by: S.W. Kelly/F.F.J. Voorwalt, in collaboration with the Foundation for Protection of the Ozone Layer and the Environment (FONDOIN).

Reviewed by: Dr L.J.M. Kuijpers/Dr M.J.P. Janssen (Refrigeration) and Dr G. Baumann (Foam). Their comments are attached.

PROJECT OF THE GOVERNMENT OF VENEZUELA

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFCs used by GRUPO FRIGILUX C.A. in the manufacture of domestic refrigerators and freezers, as well as range of unitary commercial refrigeration equipment. CFC 11 is used as the blowing agent for producing the PU thermal insulating foams for the refrigerator cabinets and doors, and this will be eliminated by conversion to cyclo-pentane. CFC 12, used as the refrigerant, will be replaced by HFC 134a.

2. SECTOR BACKGROUND.

The Venezuela Country Programme (CP) for the Phase-out of Ozone Depleting Substances (ODS) under the Montreal Protocol is presently in the course of preparation. It is anticipated that the CP will be presented to the Executive Committee of the Multilateral Fund for the Montreal Protocol during 1995.

Due to the economic situation in Venezuela, 1994 data is not representative of either typical domestic refrigerator production volume, or ODS consumption. This project is, therefore, based on 1993 calender year data.

In preparing this project proposal, the following data for the 12 months January - December 1993 inclusive, was established as the best estimate of CFC consumption for the manufacture of domestic refrigerators and freezers in Venezuela. ODS elimination project proposals are being presented to the Montreal Protocol Multilateral Fund for the FOUR enterprises indicated in bold type, who account for 96.7% of domestic refrigerator and freezer production in Venezuela.

Enterprise	Production Volume	CFC 11 Consumption (Tons)	CFC 12 Consumption (Tons)
Coresmalt Valencia	95,646	50.51	20.57
Frigilux	41,605	27.73	4.85
Madosa	126,437	84.64	17.71
Muebles Eterna	3,153	-	0.38
Famusa Domestic	6,500	4.68	0.78
Others	2,500	1.80	0.30
Totals	275,841	169.36	44.59

The preceding Table relates to the DOMESTIC REFRIGERATION sector only. It should be noted that Frigilux C.A. is also engaged in the manufacture of unitary commercial refrigeration equipment. Whilst the production volumes and ODS consumption related to this latter activity are included in this project proposal for ODS elimination at Frigilux, the DOMESTIC REFRIGERATION SECTOR COST EFFECTIVENESS THRESHOLD of 13.76 US$/Kg is applied.

96.0% of the domestic refrigerators and freezers manufactured in Venzuela are sold in the local market. It is estimated that around 70,000 domestic refrigerators/freezers were also imported for sale in Venezuela in 1993, sourced from a variety of countries including Mexico, Colombia, USA, and Korea.

4.0% of local production, around 11,000 refrigerators are exported to other Latin American countries, principally Colombia and Ecuador.

This consumption of 213.95 ODP tons in the <u>manufacture</u> of domestic refrigerators and freezers represents approximately 7% of the total ODS consumption in the refrigeration and air-conditioning sector in Venezuela which was estimated at 3,200 tons in 1993.

There is additional consumption of CFC 12 for servicing domestic refrigerators. A project has already been approved by the MLF for a "Pilot Programme for Recovery/Recycling of CFC 12 in the Domestic Refrigeration Sector". This project has recently been implemented. These new project proposals do not, therefore, address the consumption of ODS in the servicing of domestic refrigerators and freezers in Venezuela.

The 236.69 tons "ODS USE IN SECTOR" in the Project Summary Sheet, therefore, refers only to identified ODS consumption in the MANUFACTURE of domestic refrigerators and freezers in Venezuela, plus the additional consumption of Frigilux C.A. in their unitary commercial refrigeration equipment manufacturing operations, and the ODS consumption of Vecomesa in manufacturing compressors.

Famusa Domestic was only identified as a manufacturer of domestic refrigerators as this project proposal was being completed, and it was not, therefore, possible to obtain the necessary data in time to prepare a project proposal for Famusa. It is proposed that an ODS elimination project proposal for this small enterprise be prepared for submission to the autumn 1995 meeting of the MLF EXCOM.

The industry uses locally manufactured hermetic compressors, refrigerants, and PU foam chemicals but also imports raw materials and parts. Compressors are also sourced from Embraco and Sicom (Brazil), Daewoo (Korea), and L'Unite Hermetique (France).

Uninhibited growth in the manufacture of domestic refrigerators and freezers would lead to an estimated consumption in the year 2000 of approximately 280 tons per year of CFCs 11 and CFC 12.

The Foundation for the Protection of the Ozone Layer and the Environment (FONDOIN), with the assistance of UNDP, has designed a strategy for the elimination of CFC 11 and CFC 12 in the domestic refrigeration manufacturing sector beginning in 1995. Approval of this project by the MLF in July 1995 should result in the phase-out of 96.5% of CFC consumption in the manufacture of domestic refrigerators and freezers in Venezuela in 1996.

3. ENTERPRISE BACKGROUND

GRUPO FRIGILUX C.A. is the third largest manufacturer of domestic refrigerators and freezers in Venezuela and they account for approximately 15% of the total local production of such products. Frigilux also manufacture a range of unitary commercial refrigeration equipment including refrigerators, freezers, display cases, and drinking water coolers. Frigilux is a 100 per cent Venezuelan owned enterprise.

More details on FRIGILUX C.A. are given below:

CFC USE IN 1993:	37.74 tons CFC 11 11.08 tons CFC 12
FULL NAME:	GRUPO FRIGILUX C.A.
PLANT LOCATION:	Av. 17 Los Haticos #125-97, Maracaibo, Zulia, Venezuela.
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Venezuela)
No. OF MODELS:	20
PRODUCTION IN 1993:	61,725 units
No. OF PRODUCTION LINES:	5
COMPRESSOR SUPPLIERS:	Embraco, Brazil (60%) Vecomesa, Venezuela (20%) Daewoo, Korea (20%)
CONTACT PERSONS:	John Vainrub - President Jaun Carlos Pagone - Project Manager Roberto Salas - General Manager
TEL / FAX:	Tel: (58 61) 651054 Fax: (58 61) 653189

Grupo Frigilux C.A. was founded in 1964 and is engaged in the manufacture, sales, and servicing of a wide range of domestic appliances as well as equipment for the food and beverage industry. In two quite separate manufacturing facilities Frigilux manfactures domestic refrigerators in one factory, and the range of commercial refrigeration equipment in the other. The domestic refrigerators are marketed under the "Frigilux" brand-name, while the commercial refrigeration equipment is sold under both "Frigilux" and "Cyberlux" brand-names. Frigilux also manufacture a range of package air-conditioners using HCFC 22 at their domestic refrigerator plant.

The existing refrigerator designs and technology were developed "in-house" with assistance from compressor, component, and refrigerant suppliers. Frigilux has no formal technical assistance, technology transfer, or licensing, agreements with internationally recognised refrigerator manufacturers.

90.0% of production is sold within Venezuela, the balance of exports go to other Latin American countries and Africa.

Frigilux employs a total of 1,032 persons, 840 of whom are engaged in refrigeration related activities.

This project encompasses all ODS consumption used in refrigerator and freezer manufacturing operations at Grupo Frigilux C.A. that is eligible for MLF funding.

The following tables provide information on the product range and a summary of refrigerator and commercial refrigeration equipment production by Grupo Frigilux C.A. during the 12 month period January to December 1993 inclusive.

Model No.	Capacity Cu ft	Description	Productio n Volume	R 12 Charge Kgs	R12 Consumption Kgs
Domestic					
FXR12GP-1	12.0	SD Ref	35,521	0.113	4,013.87
FXR15GP-1	15.0	SD Ref	1,810	0.156	282.36
FXRGP15-2	15.0	DD Ref NF	2,392	0.156	373.15
NE-55	5.0	SD Ref	1,622	0.085	137.87
NE-3	2.5	SD Ref	534	0.085	45.39
			--------- -		
Sub total			41,879		
Commercia			--------- -		
l	9.0	Chest Frz		0.567	367.98
CD-9	15.0	Chest Frz		0.678	338.32
CD-15	25.0	Chest Frz	649	0.867	333.80
CD-25	12.0	Chest Frz	499	0.640	6.40
CL-12	10.0	Bot Cooler	385	0.302	1,305.55
AR-27	20.0	Bot Cooler	10	0.529	845.34
AR-49	28.0	Bot Cooler	4,323	0.907	1,188.17
AR-69	36.0	Bot Cooler	1,598	0.942	27.32
AR-89	22.0	Bot Cooler	1,310	0.302	76.41
BV-47	44.0	GD Ref	29	0.794	79.40
VT-4U	91.0	GD Ref	253	1.190	41.65
VT-8U	91.0	GD Ref	100	1.210	18.15
VC-8U	20.0	GD Ref	35	0.567	2.84
VR-1	4 gph	Water	15	0.132	967.69
VJ-66	8 gph	Cooler	5	0.189	624.46
FF-8		Water	7,331		
		Cooler	3,304		
Sub total			--------- -		
			19,846		
			--------- -		
Totals or Weighted Average			61,725	0.179	11,076.12

Model No.	PU Foam per Unit Kgs	Cabinet & Door Liner per Unit Kgs HIPS	R12 Compressor HP & Price US$	R134a Compressor HP & Price US$
Domestic				
	4.425	5.450	1/6 31.84	1/6 36.85
FXR12GP-1	5.775	6.900	1/4 37.14	1/4 40.38
FXR15GP-1	5.775	6.900	1/4 37.14	1/4 40.38
FXRGP15-2	1.840	3.690	1/8 30.79	1/8 35.72
NE-55	0.820	1.400	1/8 30.79	1/8 35.72
NE-3				
Commercial	5.880	1.378	1/4 37.14	1/4 40.38
CD-9	8.180	2.500	1/4 37.14	1/4 40.38
CD-15	11.520	3.200	1/3 40.35	1/3 43.23
CD-25	5.970	n/a	1/4 37.14	1/4 40.38
CL-12	5.372	1.400	1/4 37.14	1/4 40.38
AR-27	7.820	1.000	1/4 37.14	1/4 40.38
AR-49	10.580	2.100	1/3 40.35	1/3 43.23
AR-69	12.880	2.800	1/2 105.43	1/2 116.13
AR-89	7.820	1.400	1/4 37.14	1/4 40.38
BV-47	11.960	n/a	1/3 40.35	1/3 43.23
VT-4U	23.920	n/a	1/2 105.43	1/2 116.13
VT-8U	23.920	4.000	1/2 105.43	1/2 116.13
VC-8U	8.280	n/a	1/3 40.35	1/3 43.23
VR-1	n/a	n/a	1/6 31.84	1/6 36.85
VJ-66	n/a	n/a	1/4 37.14	1/4 40.38
FF-8				
Weighted Average	4.077	3.949	33.42	37.95

Key: SD = Single Door DD = Double Door Ref = Refrigerator
Frz = Freezer NF = No Frost GD = Glass Door

4. PROJECT DESCRIPTION

Frigilux presently uses CFC 11 for the production of rigid insulating foams needed for the refrigerator and freezer cabinets and doors, and CFC 12 is used as refrigerant. The total consumption in the 12 months January - December 1993, and the ODP tons that will be eliminated by this project based on replacement by the non-ODS cyclo-pentane and HFC 134a, are shown in the following table:

Enterprise	CFC 11 (tons)	ODP tons eliminated (see Note*)	CFC 12 (tons)	Total ODP tons eliminated
Frigilux	37.74	37.74	11.08	48.82

It should be noted that Frigilux have FIVE independent production lines in two quite separate factory buildings. The differring nature and volumes of the product range and production line configurations limits the possibilities for rationalisation.

4.1. REPLACEMENT OF CFC 11 WITH CYCLO-PENTANE

Frigilux has selected the zero-ODP cyclo-pentane to replace CFC 11 as the blowing agent for the PU insulation foam in their range of domestic and commercial refrigerators.

This will require replacement of the existing low pressure PU foam dispensing machines, as well as new equipment related to the safe storage and handling of cyclo-pentane and the preparation of polyol/cyclo-pentane blends.

The conversion to cyclo-pentane will also incur costs related to technology transfer, production trials, training, and safety audits at Frigilux. These activities will include training of staff in worker-safety issues related to cyclo-pentane.

Details of the existing foam injection equipment are provided in section 5.1.3.

Incremental Operational Costs associated with the technology change from CFC 11 to cyclo-pentane are calculated for a period of six months for illustrative purposes, but they are not requested from the MLF and they will be absorbed by the enterprise.

4.2. REPLACEMENT OF CFC 12 WITH HFC 134a.

HFC 134a is widely accepted as a zero-ODP replacement for CFC 12 in the manufacture of both domestic and unitary commercial refrigeration equipment and the technology is mature. This is the CFC replacement technology selected by Frigilux.

The conversion to HFC 134a requires the use of HFC 134a specific compressors and the associated new synthetic lubricants, re-design of the refrigeration systems to cater for the difference in thermodynamic performance of HFC 134a versus CFC 12, prototyping, testing and optimization of each refrigerator model, and pilot scale manufacture and testing before full scale conversion of production to HFC 134a for each model. The conversion will result in changes in manufacturing procedures for which production line supervisor and operator training will be required.

The different properties of HFC 134a, the need to avoid cross-contamination with CFC 12, and the phased nature of the conversion of refrigerator production from CFC 12 to HFC 134a, means that new system evacuation, refrigerant charging, and leak detection equipment will be required.

Details of the existing equipment on which the technology change will impact are provided in section 5.2.3.

Incremental Operational Costs associated with the technology change from CFC 12 to HFC 134a are calculated for a period of six months for illustrative purposes, but they are not requested from the MLF and they will be absorbed by the enterprise.

5. TECHNOLOGY

5.1. REPLACEMENT OF CFC 11.

5.1.1. OVERVIEW

Currently, the three principal technology options for the replacement of CFC 11 in thermoset insulation foams are:

CFC 11 > partial water/HCFC 141b > ?
CFC 11 > partial water/HCFC 22,142b > HFC 134a, HFC 152a
CFC 11 > n-, iso-, or cyclo-, pentane

In addition, hydrofluoroalkanes such as HFCs 245, 356, etc., fluorinated ethers, and vacuum panels have been suggested for specific applications, but the technologies are not mature. Furthermore, some of these products are either only available in limited quantities, or toxicological testing is not complete and, therefore, safety in use cannot be evaluated.

The first option, the "liquid" solution, employs technology that is closely related to the existing CFC 11 technology and generally means that existing foam dispensing equipment can be used. The final step to a zero-ODP technology in this process is not yet decided. One potential solution may be the use of liquid HFCs such as HFC 245 or HFC 356, but full water blown foam with improved cell structure remains another option.

The second one, the "gas" solution, utilizes physical blowing agents which are liquefied gases. This technology always requires new foam dispensing equipment and extensive adjustments. The final step to a zero-ODP technology in this process would be the use of a gaseous HFC such as HFC 134a.

The third option, pentane technology, is commercially proven and is now extensively used in many rigid PU insulation foam applications in Europe. It is a zero-ODP technology which in many countries can be very cost effective. However, pentanes are flammable and this means a careful review of manufacturing operations with respect to the safe handling of a flammable foam blowing agent. Pentane technology may not be a practical or cost effective option in the existing workplace environments at many smaller scale enterprises due to the plant safety modifications required.

Several companies currently offer pentane technology packages, including equipment. Its use certainly requires implementation assistance and UNDP further requires an independent safety review prior to, and after, installation.

5.1.2. SELECTION

Based on economic, environmental, safety, performance and technical considerations, cyclo-pentane technology appears to be the best choice for the mixed domestic and commercial refrigeration applications at Frigilux. Frigilux also prefer to change in a single step from CFC 11 to a zero-ODP solution, rather than via an interim technology like HCFC 141b. The selected technology is, therefore, cyclo-pentane but the change to this technology is dependent upon adequate financial assistance from the MLF.

The following considerations also influenced the Frigilux decision in favour of cyclo-pentane technology:

- it is a proven zero-ODP technology that is now being applied commercially in many countries,
- with formulation, and other relatively minor changes, near equivalent insulation values and structural properties to the existing CFC 11 blown foam can be achieved,
- it is an acceptable "long-term" CFC 11 replacement.

The selection of cyclo-pentane technology by Frigilux is a realistic and sensible choice under the prevailing circumstances. It is, however, dependent on the necessary funding from the MLF, although the enterprise will absorb the incremental operational costs as their contribution towards the total project costs. The technology choice is supported by the FONDOIN.

5.1.3. IMPACT ON THE PRODUCTION PROCESS

The use of cyclo-pentane technology will require substantial changes in the chemicals storage, processing, and refrigerator manufacturing facilities because of the highly flammable nature of the substance. The adherence to the strictest safety Standards available, such as EN, NFPA, or other internationally recognised Standards, is required for UNDP implemented projects.
These Standards classify explosive zones ("EX areas") generally in THREE categories:

Zone 0 Where a constant amount of highly flammable/explosive liquids or gases can be expected. The inside of cyclo-pentane pipework, and cyclo-pentane storage tanks would be classified as "Zone 0". All equipment, materials, fittings, etc. in a Zone 0 area must be "explosion proof (EX)" and earthed.

Zone 1 Where, from time to time, highly flammable liquids or gases can be expected. Areas where foaming operations are carried out including molds, jigs, or other such fittings would be classified as "Zone 1". All equipment, materials, fittings, etc. in a Zone 1 area must be EX-e, EX-d or ia, and earthed.

A Zone 1 area may be re-classified to a Zone 2 area by the provision of sufficient extract ventilation.

Zone 2 Where, only by accident or scheduled maintenance, highly flammble/explosive gases can be expected. Areas such as the cyclo-pentane storage, polyol/cyclo-pentane blend stations, foam dispensing machines, would generally be classified as "Zone 2". All equipment, materials, fittings, etc. in a Zone 2 area must be EX-n, or with IP54 sealing. Earthing to avoid static build-up and discharge is required.

Other requirements relating to the use of cyclo-pentane are:

- there shall be implementation assistance by a UNDP approved process consultant experienced in cyclo-pentane technology, who must provide assurances on safety issues to the enterprise,
- Process Safety Audits, by a UNDP appointed independent contractor are required, prior to, during, and after project implementation.
- the installation of cyclo-pentane gas detectors in all EX areas which shall be connected to a central control panel c/w automatic recorder and printer. The control panel shall in turn activate secondary extract ventilation, and/or cyclo-pentane shut-down valves when pre-set levels of the Lower Explosion Limit (LEL) for cyclo-pentane is measured,
- the installation of containment around cyclo-pentane storage tanks, and enclosure of other areas, as deemed necessary,
- the provision of cyclo-pentane/polyol blending equipment, as a pre-mix cannot be purchased,
- Antistatic clothing and shoes shall be worn in Zone 0 and Zone 1 areas,
- the provision of a portable gas detector to monitor cyclo-pentane concentrations throughout the plant according to an approved monitoring plan,
- the preparation of an approved preventative maintenance system, and the preparation of, and practice implementation of, an emergency response plan,
- the training of production and maintenance personnel in the safe handling of cyclo-pentane,

The use of cyclo-pentane technology will be facilitated by the provision of new high pressure foam production equipment prepared for cyclo-pentane duty.

Formulation changes, together with an increase in the thickness of the insulation foam, will need to be considered in order to obtain equivalent insulation values.

Many of the refrigerator models produced by Frigilux use HIPS cabinet and door liners. It is not anticipated that any change to the HIPS liner material will be required due to the change to cyclo-pentane.

Frigilux currently has four PU foam dispensing systems, two for the domestic refrigerator manfacturing operations, and two for the commercial refrigeration equipment production. All are low pressure machines with single mixing heads. Frigilux currently purchases a polyol/CFC 11 pre-mix.

Domestic Refrigerator Production Line.

Decker Model D-40 low pressure foam dispensing machine with a maximum throughput of 20 Kgs/min. Serial No. 584. Vintage 1981. This machine is used for foaming cabinets.

Cannon Model C80RF2 low pressure foam dispensing machine with a maximum throughput of 80 Kgs/min. Serial No. 120173. Vintage 1980. This machine is used for foaming doors.

Commercial Refrigeration Equipment Production Lines.

Decker Model D-70 low pressure foam dispensing machine with a maximum throughput of 32 Kgs/min. Serial No. 586. Vintage 1981.

Admiral Model M-15/2H low pressure foam dispensing machine with a maximum throughput of 15 Kgs/min. Vintage 1979.

It is proposed that the two machines used in domestic refrigerator production be replaced with two high pressure foam dispensing machines each with a capacity of 45 Kgs/min. For commercial refrigerator production it is proposed that the two machines be replaced with a single high pressure machine with a capacity of 45 Kgs/min equipped with two mixing heads. Two polyol/cyclo-pentane pre-mixing units will also be required to feed these three foam dispensing mahines.

5.2. REPLACEMENT OF CFC 12.

5.2.1. OVERVIEW

HFC 134a is widely accepted as a replacement for CFC 12 in the manufacture of both domestic refrigerators and freezers, as well as unitary commercial refrigerators. HFC 134a is widely available and the technology is mature. Replacement of CFC 12 with HFC 134a requires relatively modest changes to existing production facilities.

Whilst hydrocarbon refrigerant (iso-butane) is being increasingly used in the manufacture of domestic refrigerators in several Developed Countries, the transfer of this technology to Developing Countries is not always cost effective. It also raises questions about safety issues and remains conditional on the support of a technology partner experienced in the production of comparable refrigerators and freezers on a commercial scale. It is further dependent on the technology partner providing assurances in writing on safety issues, and, of course, the availability of adequate supplies of both compressors and hydrocarbon refrigerant of the required quality.

Safety issues relating to the larger refrigerant charges means that there is only very limited use of hydrocarbon refrigerants in the commercial refrigeration sector. Considering the product range at Frigilux, iso-butane technology is not recommended at the present time.

HFC 152a might be considered as another candidate for CFC 12 replacement in domestic refrigerators. However, HFC 152a is also flammable, the technology has not been developed commercially, and there are some questions around it's stability in refrigerator systems. Furthermore, compressors for use with HFC 152a are not commercially available.

5.2.2. SELECTION

Based on the results of discussions with compressor suppliers and participation in technical workshops on non-CFC technology etc., the CFC 12 replacement technology selected by Frigilux is HFC 134a.

The new HFC 134a technology, like the existing CFC 12 based technology, will be developed "in-house" by Frigilux with assistance from compressor, and refrigerant suppliers. The enterprise does not currently have any formal technology transfer agreements and additional technical assistance will be required in implementing the HFC 134a technology. This will be provided by Embraco, Frigilux's main compressor supplier, as well as the refrigerant supplier, and the relevant UNDP consultants. Provision for this is made within the project budget which will ensure successful project completion.

5.2.3. IMPACT ON THE PRODUCTION PROCESS

HFC 134a, like CFC 12, is non-flammable. HFC 134a has also been the subject of extensive toxicological testing and is considered safe in use in industrial applications provided the suppliers recommended occupational exposure levels are not exceeded. At the present time this means ensuring that exposure levels do not exceed 1000 parts per million on an 8-hour time-weighted average basis. This is the same as the Occupational Exposure Limit (OEL)/Threshold Limit Value (TLV) for CFC 12 and thus no changes from current practices are required.

There will be an approximately 10% reduction in the mass charge of HFC 134a compared with CFC 12 for a refrigerator system of the same capacity.

It is well understood that the chemical stability of HFC 134a/synthetic lubricant systems in domestic refrigerators, and hence the long term performance of the appliance, is sensitive to moisture content and certain chlorinated impurities. This requires that CFC 12 and HFC 134a handling equipment be carefully segregated, and it also calls for better evacuation of the system prior to refrigerant charging.

Because system cleanliness and moisture content is paramount to the successful manufacture of HFC 134a refrigerators, Frigilux will need to carefully re-assess production procedures and re-train production personnel as appropriate. Provision for this is made within the project proposal budget.

The conversion from CFC 12 to HFC 134a will take place on a model by model basis, so that Frigilux will be producing both CFC 12 and HFC 134a refrigerators during the implementation phase of this project. This is feasible given the configuration of the company's production facilities. This means that there is a requirement for new system evacuation equipment and refrigerant charging equipment.

Leak detection of the refrigeration system is an integral part of the manufacturing process and the use of HFC 134a requires that new leak detection equipment be employed.

The relevant existing equipment at Frigilux on which the technology change to HFC 134a will impact is as follows:

- 2 x SERV-I-QUIP R-2110-TC-6a auto R12 charging machines
- 3 x Danfoss based R12 charging units
- 8 x Kinney KC 5 dual stage vacuum pumps, 8.8 M3/hr
- 10 x Kinney KC 8 dual stage vacuum pumps, 14.2 M3/hr
- 6 x Leybold Inficon HLD 2000/3000 R12 leak detectors

The refrigerant charging equipment and vacuum pumps listed above serve the following production lines:

Domestic Refrigerator Production Line.

1 x SERV-I-QUIP automatic R12 charging machine.
2 x Leybold Inficon HLD 3000 R12 leak detectors for low and high pressure system testing.
8 x Kinney KC 8 vacuum pumps, 6 in service, 2 on standby.

Commercial Refrigeration Equipment Production Lines (4).

1 x SERV-I-QUIP automatic R12 charging machine.
3 x Danfoss based R12 charging units.
4 x Leybold Inficon HLD 2000 R12 leak detectors, one per line.
2 x Kinney KC 8 vacuum pumps, all in service.
8 x Kinney KC 5 vacuum pumps, 6 in service 2 on standby.

The project proposal includes provision for ONE new R134a charging machine of equivalent capacity for each production line. Replacement vacuum pumps are requested on the following basis:

Domestic Refrigerator Factory	2 new vacuum pumps
Commercial Refrigeration Factory	2 new vacuum pumps

Provision is made for retrofit of the remaining 14 vacuum pumps where considered feasible, or the funding provided for retrofitting will be used by Frigilux towards the purchase of new vacuum pumps, at their own discretion.

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

cyclo-PENTANE STORAGE TANKS inc installation (2)	70,000
HIGH PRESSURE FOAM DISPENSING MACHINES, 3 x 45 Kg/min COMPLETE WITH TWO POLYOL/cyclo-PENTANE BLENDERS	440,000
ADDITIONAL MIXING HEAD	25,000
CP GAS DETECTION SYSTEMS (2)	60,000
FREIGHT & INSTALLATION	20,000
EXTRACT VENTILATION SYSTEM (4 Lines)	10,000
GROUNDING	5,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE/TRAINING	20,000
SAFETY AUDITS	10,000
PRODUCTION TRIALS (3 Machines)	10,000
CONTINGENCIES (10%)	67,000
Subtotal (US$)	737,000

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (5 off)	115,000
NEW VACUUM PUMPS (4 off)	12,000
RETROFITTING VACUUM PUMPS (14 off)	7,000
LEAK DETECTION EQUIPMENT (6 off)	42,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION & RELIABILITY TEST TRIALS (20 models)	50,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	25,000
Subtotal (US$)	271,000
TOTAL INCREMENTAL CAPITAL COST (US$)	1,008,000

6.2 INCREMENTAL OPERATING COSTS

The calculation of the incremental operating costs is based on a six month period using 50% of the actual production for January to December 1993 inclusive. Annex A. provides detailed explanations on how the incremental operational costs were obtained. This is for illustrative purposes only, the incremental operating costs are NOT requested by the enterprise. The costs are summarized below:

PHASE-OUT OF CFC 11	
Costs for Materials (see Annex A. Part 1.):	41,695
PHASE-OUT OF CFC 12	
Costs for Materials (see Annex A. Part 2.):	171,904
TOTAL INCREMENTAL OPERATING COST (US$)	213,599

6.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational) (US$)	1,221,599
% Article 5.1 Country Ownership	100%
FUNDING REQUESTED FROM MLF (US$)	1,008,000 *

6.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	1,008,000	
b. Capital Recovery Factor (10% p.a.)	0.16275	
c. Incremental Operating Costs	n/a	*
d. ODS Reduction (ODP Kgs Jan - Dec 1993)	48,820	
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	3.36	

THE PROJECT UNIT ABATEMENT COST IS 3.36 US$/Kg

(* The funding requested from the MLF does not include the project incremental operating costs which will be absorbed by the enterprise.)

6.5 PROJECT SAFETY RELATED COSTS (US$)

Cyclo-pentane Storage Tank	=	70,000
High Pressure Foam Dispensing Machines/ Polyol/cyclo-pentane pre-mixers	=	160,000
Cyclo-pentane Gas Detection System	=	60,000
Extract Ventilation	=	10,000
Grounding	=	5,000
Safety Audits	=	10,000
Contingencies	=	31,500
TOTAL SAFETY RELATED COSTS	=	346,500

6.6 COST EFFECTIVENESS (US$/Kg)

(a) TOTAL PROJECT COST - INC. OPERATING COSTS	=	1,008,000	US$
(b) LESS PROJECT SAFETY RELATED COSTS	=	661,500	US$
(c) TOTAL ODS ELIMINATED	=	48,820	ODP Kgs
(d) PROJECT COST EFFECTIVENESS (a - b)/c	=	13.55	US$/Kg

THE PROJECT COST EFFECTIVENESS IS 13.55 US$/Kg

This is below the threshold value of 13.76 US$/Kg established by the Executive Committee of the MLF at its 16th meeting in March 1995 for projects in the Domestic Refrigeration Sector.

7. FINANCING PLAN

Grupo Frigilux C.A., requests reimbursement from the MLF of the sum of US$ 1,008,000, representing the incremental Capital Costs of this ODS elimination project, correctly taking into account the Article 5.1 country ownership of the enterprise. Incremental Operational Costs are not requested.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP will oversee the successful implementation of this project, and will provide technical assistance during project execution.

8.2 SCHEDULE

TASK	TIME TO COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
MLF Approval	X					
Procurement Preparation	XX					
Vendor Selection	X	X				
2. Installation						
Arrival of Equipment			XXX	X		
Customs Clearance			XX	XX		
Machine Installation			X	XXX		
3. Start-Up						
Machine Start-up				XX	X	
Trials & Training				XX	XXX	X
Mass Production Change					X	XX
Safety Audits				X	X	X
Certification						X

9. PROJECT IMPACT

Based on data for the 12 months, January - December 1993, this project will eliminate the use of 48.82 ODP tons per year.

10. ANNEXES

Annex A. - Incremental Operational Cost Calculations.
Annex B. - Project Technical Reviews.

ANNEX A. INCREMENTAL OPERATIONAL COST CALCULATIONS

1. Incremental Costs resulting from replacing the CFC 11 Blowing Agent in the Refrigerator Insulation Foam with cyclo-pentane (US$)

GRUPO FRIGILUX C.A.	CFC 11	C-P	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.350	0.366	0.016
b. MDI	0.500	0.582	0.082
c. Kg Blowing Agent	0.150	0.045	(0.105)
d. Water	-	0.007	0.007
Prices in US$/Kg			
e. Polyol	2.61	2.87	0.26
f. MDI	2.15	2.15	-
g. Blowing Agent	2.00	1.80	(0.20)
Cost per Kg of Foam Produced			
h. = a. x e. Polyol	0.914	1.050	0.136
i. = b. x f. MDI	1.075	1.251	0.176
j. = c. x g. Blowing Agent	0.300	0.081	(0.219)
k. = h+i+j Total Cost per Kg of Foam	2.289	2.382	0.093
Materials Used per Refrigerator			
l. Kg of Foam per Refrigerator (avg)	4.077	4.485	0.408
Cost per Refrigerator			
m. = l. x k. for Foam	9.332	10.683	1.351
n. = No. of Refrigerators (see Note 1.)	30,862		
TOTAL INCREMENTAL OPERATIONAL COST (US$)	41,695		

(see Notes 1., and 2. below)

2. Incremental Costs resulting from replacing the CFC 12 Refrigerant with HFC 134a (US$)

GRUPO FRIGILUX C.A.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.60	8.50	
b. Kg of Refrigerant per Refrigerator (avg.)	0.179	0.161	
c. No. of Refrigerators Produced (see Note 1.)	30,862	30,862	
1d. Cost for Refrigerant = a x b x c	14,363	42,235	27,872
2. Compressors			
a. Cost per Compressor (see Note 2.)	36.77	41.08	
b. No. of Compressors (see Note 1.)	30,862	30,862	
2c. Cost for Compressors = a x b	1,134,796	1,267,811	133,015
3. Condensers			
a. Cost per Condenser	N/C	N/C	
b. No. of Condensers	30,862	30,862	
3c. Cost for Condensers = a x b	-	-	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.608	0.758	
b. No. of Filter/Dryers (see Note 1.)	30,862	30,862	
4c. Cost for Filter/Dryers = a x b	18,764	23,393	4,629
5. Capillary Tubes			
a. Cost per Capillary Tube (average)	0.834	1.041	
b. No. of Capillary Tubes (see Note 1.)	30,862	30,862	
5c. Cost for Capillary Tubes = a x b	25,739	32,127	6,388
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)	171,904		

Notes relating to the calculation of the Incremental Operational Costs

Note 1. Figures in the above tables are based on the actual production volumes for the 12 month period January to December 1993 obtained from Frigilux C.A. at the time of project preparation. The Incremental Operational Costs are calculated for 6 months for illustrative purposes only, using 50% of this 12 months production volume. Frigilux will absorb these costs as its contribution to the total project costs.

Note 2. Refrigerant, chemical, and compressor prices used in the above tables are current weighted average prices for the principal domestic and commercial refrigerator manufacturers in Venezuela.

Note 3. The calculated incremental costs for the HFC 134a refrigerant are based on a 10% reduction in the mass charge compared with CFC 12.

TECHNICAL REVIEW.

1. Country:

Venezuela.

2. Project Title:

Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at GRUPO FRIGILUX C.A.

3. (Sub)Sector:

Domestic Refrigeration.
This review covers only the foam part.

4. CP-Relationship:

The Venezuelan CP for phase-out of ODS is actually in preparation. It is believed that the CP will be presented at the 16th Meeting of the Executive Committee of the MLF in March 1995.
Beginning 1995, the "Foundation for the Protection of the Ozone Layer and the Environment" (FONDOIN), assisted by UNDP has assigned a strategy for CFC elimination in the domestic refrigeration sector.

5. Technology:

FRIGILUX wishes to change the use the cyclopentane technology to replace its actual CFC 11 in the manufacture of insulating PUF. The reasons given in the project can be accepted, provided of course that the safety aspect is well looked after, as well in the hardware, in the management procedures, as in the mentality of the workers.
High pressure equipment will be necessary in order to ensure correct mixing of the chemicals.

6. Environmental Impact:

Cyclopentane has no ODP and GWP, but it has a smog potential of 500 (versus 0.1 for CFC 11). It will hence be important to compare cyclopentane emissions with the actual or future Venezuelan emission legislation.

Project costs can be accepted as presented.About half of the capital costs are safety related.
The company does not claim incremental operating costs.
The cost for eliminating 1 kg of ODS for the foam part is
USD 737,000/ 37,740 or USD 19.53

8.Implementation:
Management and time schedule can be accepted.

9.Recommendation:
It is recommended to accept the project as it is presented.

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date: 061195.

Frigilux

Country of origin: VENEZUELA

Project title: Elimination of CFCs 11 and 12 at FOUR Domestic Refrigerator Manufacturers (Coresmelt Valencia C.A., Grupo Frigilux C.A., Madosa S.A., Muebles Eterna C.A.), and conversion of ONE compressor manufacturer (Vecomesa S.A.)

Sector/sub-sector Domestic refrigeration

Relationship to country program UNDP (CP in preparation)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

- All manufacturers in this project have chosen for a conversion of their production to the HFC-134a technology.
- In domestic refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.
- Three companies in this project (Coresmalt, Frigilux and Eterna) do not have a formal technology transfer agreement. However, all these companies plan to develop the HFC-134a technology with assistance from compressor and refrigerant suppliers. Furthermore provisions for external assistance are present. Due to these facts, a successful project implementation can be expected at these companies. The fourth refrigerator manufacturer (Madosa) does have an ongoing technology transfer agreement with General Electric, USA and the compressor manufacturer Vecomesa has a technology licence agreement with Tecumseh, USA. Both agreements include support for the HFC-134a conversion process, so also for the latter two manufacturers a successful project implementation can be anticipated.
- During the review process two technology aspects in this project were discussed in depth with the UNDP consultant and the relevant companies:
    1. The Madosa company will obtain new HFC-134a compressors without lubricant. This is in contrast to the currently applied production procedure and therefore requires investments in oil storage, charging and dehydration equipment. On-line oil charging of compressors does have certain advantages in quality control but is not strictly necessary (namely, a large number of companies do apply compressors which are oil charged by the compressor manufacturer). However, on-line oil charging is a requirement put forward by the technology supplier (G.E.) and forms an essential part of the technology to be transferred. Costs of the related equipment are therefore considered essential for the conversion process.
    2. The compressor manufacturer Vecomesa will switch from a Tecumseh "AE" design for CFC-12 to a, higher efficient, "AZ" design for HFC-134a for the larger part of their production. This change in design does lead to additional investments in production equipment (e.g. presses, welding and brazing machines etc.). In fact the change from "AE" to "AZ" technology does include a technology upgrade to higher efficient products. However, it is demonstrated by the company that there is no alternative for this selection as no "AE" designs for HFC-134a are available by Tecumseh, in the capacity range considered. Therefore, these additional costs have to be considered as eligible incremental costs.
- Technologies other than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of the state of development, safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

Environmental impact

HFC-134a has an ODP of zero and a GWP of 0.27. For domestic refrigeration a GWP of this magnitude is negligible.

Project costs

- The equipment requested by all manufacturers is essential for the conversion process (see statements above). Costs of equipment, training and testing are reasonable.
- Incremental operational costs are reasonable and correctly applied (for six months).
- If the UAC values are calculated for the refrigerant conversion part of the projects separately, then the following values are obtained:

Coresmelt Valencia	15 USD/kg/y
Frigilux	19 USD/kg/y
Madosa	6 USD/kg/y (only 25 % local ownership)
Muebles Eterna	78 USD/kg/y

  Besides the value for Eterna, these values are reasonable compared to other, similar, projects. The high UAC value for Muebles Eterna is caused by the small size of the company. For Vecomesa an artificial UAC value of 2.9 USD/kg/y (41.35 % country ownership) is calculated based on the current compressor production and an average charge of the appliances to be produced with these compressors of 0.1 kg. The resulting UAC value is relatively low compared to other, similar, projects.
- The foreign ownership of the different companies is correctly taken into account.

Implementation timeframe

Reasonable.

Relevance and adequacy of information provided

Sufficient information was obtained from the project proposal together with comments from the UNDP consultant and the companies.

Recommendations

Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands
15-February-1995

Kuijpers L.J.M.,
University Eindhoven, The Netherlands