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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 PROPOSAL: VENEZUELA

This document includes the Comments and Recommendations from the Fund Secretariat on the following project:

- Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at INDUSTRIAS NUTAL C.A. — UNDP

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Venezuela
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at Industrias NUTAL C.A.
BUDGET:	Capital Costs: US $197,000 Operating Costs: US $21,821
INCREMENTAL COSTS:	US $218,821
ODS PHASE-OUT:	14.52 MT
COST EFFECTIVENESS:	US $15.07 per kg. ODP saved
PROJECT DURATION:	1.5 years
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	FONDOIN
TECHNICAL REVIEW COMPLETED:	YES X NO ____

SECRETARIAT'S COMMENTS

1. This evaluation sheet covers a project on the conversion of both the refrigeration and foaming systems in a commercial refrigeration enterprise, Industrias NUTAL to HFC-134a and HCFC-141b.

2. The refrigeration system conversion to HFC-134a will require re-design of the system, prototyping, optimization and pilot scale manufacturing, testing and training.

3. Conversion to HCFC-141b foaming technology was chosen by the company. It will require high pressure foam machines, test runs and training. HCFC-141b is a transitional chemical, however, the high pressure foam machines should be easily modified to be compatible with future zero-ODP blowing agents at a very moderate cost.

4. The Secretariat reviewed the project proposal to assess the eligibility and costs of requested equipment and other project components in the light of similar projects approved by the

Executive Committee. The Secretariat discussed with UNDP the incrementality of all costs components and their amounts.

5. Industrias Nutal purchased a second-hand 1970 vintage low-pressure machine in 1993 from Atlas Electrica, San Jose, Costa Rica, for US $6,000. This machine needs to be replaced with a high-pressure foaming machine to handle HCFC-141b operations. The cost of the project needs to be adjusted to reflect the baseline cost of foaming equipment. The difference in cost between a new low-pressure and high-pressure machine is recognized as eligible incremental cost. The cost of recycling machines constitutes double-counting, as the Executive Committee has already approved projects for recovery/recycling in Venezuela.

6. Atlas Electrica (in Costa Rica) submitted a project for retroactive funding of replacement of foaming machine sold to Industrias Nutal. Purchasing of second-hand CFC equipment raises the issue of monitoring the disposal of CFC equipment covered by Multilateral Fund projects to avoid double-counting.

7. Consequently it was agreed that a new project budget should be recommended for approval.

8. Operating costs have been reviewed. Costs associated with HFC-134a compressors supplied by the compressor manufacturing company (Vecomesa) have been deducted from incremental operating costs since a project for conversion of Vecomesa company has been submitted for approval at the 17th Meeting of the Executive Committee.

9. The calculated cost-effectiveness is US $8.51/kg. ODP which is below the threshold established by the Executive Committee for the commercial refrigerator subsector.

SECRETARIAT'S RECOMMENDATIONS

10. The Fund Secretariat recommends approval of the project and the approval of US $123,623 in incremental costs and recommends US $16,070 in support costs for UNDP.

11. The Secretariat further recommends that the Executive Committee urge the implementing agencies to establish a monitoring system on CFC equipment replaced with non-CFC equipment to avoid double-counting in ODS phaseout projects.

PROJECT COVER SHEET

COUNTRY:	**VENEZUELA**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at INDUSTRIAS NUTAL C.A.
SECTOR COVERED:	Commercial Refrigeration (Mfg)
ODS USE IN SECTOR:	113.95 tons ODS
PROJECT IMPACT (ODP):	14.52 ODP tons
TOTAL PROJECT COST:	US$ 218,821
INCREMENTAL CAPITAL COST:	US$ 197,000
INCREMENTAL OPERATING COST:	US$ 21,821
PROPOSED MLF GRANT:	US$ 218,821
UNIT ABATEMENT COST:	3.71 US$/Kg
COST EFFECTIVENESS:	15.07 US$/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:

INDUSTRIAS NUTAL C.A. is a 100% Venezuelan-owned company manufacturing unitary and non-unitary commercial refrigeration equipment and PU insulation panels. Currently, CFC 11 + CFC 12 are used as blowing agents in the production of rigid polyurethane insulation foam for the equipment cabinets and doors, and for the PU foam insulation panels. CFC 12 is used as the refrigerant. Based on 1994 figures, this project will eliminate 14.52 ODP tons/yr of CFCs 11 and 12 by conversion to 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 COMMERCIAL REFRIGERATION EQUIPMENT

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFCs used by INDUSTRIAS NUTAL C.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 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.

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, however, based on the 1994 calender year data for Industrias Nutal because the enterprise re-structured it's product range during 1993. (An accompanying project for Pinova S.A. uses 1993 data).

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

INDUSTRIAS NUTAL C.A. manufactures a range of unitary commercial freezers and bottle coolers, as well as building and installing "walk-in" cold rooms using semi-hermetic compressor based systems from Copeland and Tecumseh. They also build, supply, install and service semi-hermetic condensing units for the commercial refrigeration sector. Industrias Nutal is a 100% Venezuelan owned enterprise.

TOTAL CFC USE IN 1994:	5.04 tons CFC 11 } Factory 3.15 tons CFC 12 } Consumption 16.25 tons CFC 12 Instal. & Service
FULL NAME:	INDUSTRIAS NUTAL C.A.
ADDRESS:	Av. Ppal de Macaracuay Edif. Torre California, Piso 7-Of 7, Caracas (1070), Venezuela.
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Venezuela)
No. OF MODELS:	8 (unitary equipment)
PRODUCTION IN 1994:	3,152 units
No. OF PRODUCTION LINES:	2
COMPRESSOR SUPPLIERS:	Vecomesa, Venezuela L'Unite Hermetique, France Embraco, Brazil Copeland
CONTACT PERSONS:	Luis Cortizo C. - President Rafael Valverde - Plant Manager Luis M. Cortizo A. - Vice President
TEL / FAX:	Tel: (58 2) 257 0651/9962/7370 Fax: (58 2) 257 9306

Industrias Nutal C.A. was founded in 1987 and was initially involved with the non-unitary commercial refrigeration sector, manufacturing evaporators and condensers, assembling condensing units, and distributing, installing and servicing non-unitary commercial refrigeration systems. This included the manufacture of metal clad PU foam insulation panels used for the manufacture of "walk-in cold rooms. In addition, Industrias Nutal also manufacture refrigerant filter/driers.

In 1993 Industrias Nutal diversified into the manufacture of a range of unitary commercial bottle coolers and freezers which are marketed under the "Mr Frio" brand-name. This is the major growth part of the company. The assembly and sale of non-unitary condensing units declined by 33% to 6,318 units in 1994 from 9,444 units in 1993.

The current unitary product range comprises 5 bottle coolers and 3 chest freezers. All production is sold within Venezuela.

The bottle cooler and freezer designs and technology were developed "in-house". Industrias Nutal has no technology transfer or licensing agreements with any internationally recognised commercial refrigeration equipment manufacturers.

Industrias Nutal presently employs 125 persons, 110 of whom are engaged in refrigeration related activities.

This project encompasses all ODS consumption used in the manufacture of bottle coolers, freezers, and PU insulation panels at Industrias Nutal C.A. It also includes provision to reduce ODS consumption in the non-unitary commercial refrigeration sector, 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 Industrias Nutal.

The following tables provide a summary of bottle cooler and freezer production by Industrias Nutal C.A. during the 12 month period January to December 1994 inclusive.

Model No.	Capacity Cu ft	Description	Production Volume	R 12 Charge Kgs	R12 Consumption Kgs
MF-B1	10.0	Bot Cooler	380	0.450	171.0
MF-B2	17.0	Bot Cooler	489	0.510	249.4
MF-B3	27.0	Bot Cooler	563	0.567	319.2
TQT-2	17.0	Bot Cooler	211	0.510	107.6
TQT-3	28.0	Bot Cooler	205	0.569	116.6
MFC-09	9.0	Chest Frz	426	0.510	
MFC-15	15.0	Chest Frz	443	0.567	217.3
MFC-20	20.0	Chest Frz	435	0.624	251.2
					271.4
Totals or Weighted Average			3,152	0.540	1,703.7

Model No.	PU Foam per Unit Kgs	Cabinet & Door Liner per Unit Kgs HIPS	R12 Compressor HP & Price US$	R134a Compressor HP & Price US$
MF-B1	3.963	(metal)	1/5A 36.63	1/5A 40.66
MF-B2	5.829	(metal)	1/4A 39.98	1/4A 44.38
MF-B3	7.433	(metal)	1/3A 41.44	1/3A 46.00
TQT-2	5.829	(metal)	1/4A 39.98	1/4A 44.38
TQT-3	7.433	(metal)	1/3A 41.44	1/3A 46.00
MFC-09	5.097	1.70	1/5B 35.10	1/5B 38.96
MFC-15	7.101	2.20	1/4B 41.84	1/4B 46.44
MFC-20	9.900	2.69	1/3B 43.99	1/3B 48.83
Totals or Weighted Average	6.637	0.910	40.09	44.50

In 1994, Industrias Nutal produced 1,436 metal clad PU foam insulation panels. With a weight of 8.8 Kgs of foam per panel this activity consumed 1.90 tons of CFC 11.

Industrias Nutal installed around 40% of the 6,318 condensing units that they produced in 1994 and the CFC 12 consumption involved was 4.55 tons. The rest of the production was sold for installation by the end user or other independent commercial refrigeration engineers. In addition, Nutal also consumed 11.70 tons of CFC 12 for service and maintenance of existing equipment.

4. PROJECT DESCRIPTION

Industrias Nutal presently uses CFCs 11 and 12 for the production of rigid insulating foams needed for the bottle cooler and freezer

cabinets and doors, and the PU foam insulation panels for the "walk-in" cold rooms. CFC 12 is used as refrigerant. They also consumed 16.25 tons of CFC 12 in the installation and servicing of non-unitary commercial refrigeration equipment. Industrias Nutal can influence the choice of refrigerant for new non-unitary equipment and the ODS consumption of 4.55 tons of CFC 12 for this purpose is included in the project. It is estimated that 20% of the 11.70 tons of CFC 12 consumed for servicing, some 2.34 tons, can be eliminated by the provision of five small "Recovery & Recycle" machines and this is, therefore, also included in the project.

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:

CFC 11 consumed (tons)	ODP tons eliminated * see Note	CFC 12 consumed (tons)	ODP tons eliminated	Total ODP tons eliminated
5.04	4.49	19.39	10.03	14.52

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

Industrias Nutal C.A. has selected HCFC 141b to replace CFC 11 as an interim step to a final ODS-free system. HCFC 141b will be used as the blowing agent for the PU insulation foam in the manfacture of both the commercial refrigerators and insulation panels.

It is recognised by Nutal that HCFC 141b is not a final solution, and that a further, future, change will be required to a zero-ODP technology.

A replacement high pressure will, therefore, be required which can 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.

Production trials, technology transfer/technical assistance and training associated with the technology change to HCFC 141b will be required which 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 domestic and commercial refrigeration sectors and the technology is mature. This is the CFC replacement technology selected by Industrias Nutal.

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.

In the case of the unitary equipment manufactured by Industrias Nutal, this will also involve 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.

For the non-unitary equipment that Nutal installs, appropriately sized HFC 134a compressors will be sourced from Copeland, acording to the required 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. Details of the existing equipment on which the technology change will impact are provided in Section 5.2.3.

To enable Nutal 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.

Incremental Operational Costs associated with the technology change from CFC 12 to HFC 134a for the unitary equipment 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, pentane technology appears to be the best choice for commercial refrigeration applications where the insulation properties of the foam are sometimes less critical than in a domestic refrigeration application. Pentane technology combines an attractive price with zero-ODP, near-zero GWP properties, and acceptable foam insulation qualities. Industrias Nutal 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, and with the enterprise absorbing the incremental Operational Costs. However, whilst recognising both the environmental and economic benefits of cyclo-pentane versus HCFC 141b, Nutal selected HCFC 141b as a first stage, interim, replacement for CFC 11.

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

- Industrias Nutal is a small family owned enterprise with limited technical resources at management level. While the enterprise has the necessary refrigeration engineering skills, it is concerned that it does not presently have the technical capacity to safely manage cyclo-pentane foam blowing technology on an ongoing basis.

- the factory location is on the outskirts of Caracas and skilled labor is not readily available. Whilst this is not critical in simple assembly operations, the Nutal workforce is still at a low point on the learning curve with respect to the PU foaming operations.

- Industrias Nutal realistically does not see itself as a "pioneer" in introducing cyclo-pentane technology in Venezuela and it is aware of the decisions of the larger companies (Madosa and Coresmalt) to move initially to HCFC 141b as the CFC 11 replacement.

- HCFC 141b technology can be introduced quickly, with minimal disruption and plant downtime. This is an important factor for Nutal whose business is in a rapid expansion phase.

The selection of HCFC 141b technology as the immediate replacement for CFC 11 by Nutal 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. Nutal 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 Nutal 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.

Some of the freezer models produced by Nutal use HIPS 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.

Industrias Nutal currently has one Admiral Model 2471 low pressure PU foam dispensing machine with a single mixing head and a maximum throughput of 45 Kgs/min. This is a 1970 vintage machine which was purchased from Atlas Electrica S.A., San Jose, Costa Rica, in 1993. Polyol and CFC 11 are purchased as a pre-mix.

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 provision for this is included in the project budget.

Production trials, testing, technology transfer/technical assistance, and training will also be required.

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 selected technology is HFC 134a. The CFC 12 based technology used by Industrias Nutal for the range of unitary equipment was developed "in-house" with assistance from compressor, component, and refrigerant suppliers. The refrigeration technology used for the non-unitary installations is basic technology augmented by the information supplied by Copeland relating to compressors. Nutal currently has no formal technology transfer agreements with internationally recognised commercial refrigeration equipment manufacturers or compressor suppliers.

The new HFC 134a based technology will be developed by the enterprise with assistance from compressor and refrigerant suppliers. Provision is therefore made within the project budget for formal technology assistance from compressor and refrigerant suppliers, as well as the relevant UNDP consultants, in order to ensure successful implementation of the projects.

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.

5.2.3.1 UNITARY EQUIPMENT MANUFACTURE

It is well understood that the chemical stability of HFC 134a/synthetic lubricant systems in unitary commercial refrigeration equipment, and hence the long term performance of the equipment, 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 unitary HFC 134a refrigeration equipment, Nutal 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 Nutal will be producing both CFC 12 and HFC 134a refrigeration equipment 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 some 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 existing equipment at Industrias Nutal employed in refrigerant charging of unitary equipment is as follows:

- 1 x TIF Programmable Electronic Charging Scale
- 2 x Kinney KC 8 Vacuum Pumps, 14.2 M3/hr capacity
- 1 x TIF 5050 hand-held electronic R12 leak detector

It is proposed that a new vacuum pump and hand-held leak detector be supplied for the factory charging of HFC 134a equipment. Provision is also made for retrofit of the existing vacuum pumps where considered feasible, or the funding provided for retrofitting will be used by Nutal towards the purchase of new vacuum pumps, at their own discretion. Considering both the anticipated increased production volume, and the need to avoid HFC 134a contamination, a self contained semi-automatic evacuation and refrigerant charging machine is strongly recommended. This is not, however, eligible for funding by the MLF.

5.2.3.2. NON-UNITARY EQUIPMENT INSTALLATION & COMMISSIONING

Industrias Nutal has an installation and service organisation based in Caracas with a team of five refrigeration engineers who install, commission, repair and service the company's non-unitary commercial refrigeration equipment. These engineers are equipped with the basics of manifold gauge charging sets, vacuum pumps, and hand held electronic leak detectors.

Replacement of CFC 12 with HFC 134a in new equipment

By design changes of the condensing units that Nutal install and the recommendation to use only HFC 134a, Nutal can dictate the selection of refrigerant to its customers. In order to eliminate the consumption of CFC 12 and to be able to convert their clients to R134a technology Industrias Nutal requires the following new equipment to be able to install, commission, and service new R134a installations:

5 x R134a manifold gauge charging sets
5 x 7 M3/hr portable vacuum pumps for R134a duty
5 x hand-held R134a electronic leak detectors

Retrofitting Existing CFC 12 Equipment to use HFC 134a

There is a need to retrofit some existing commercial refrigeration systems to R134a duty in order to prolong their useful lifetime.

The refrigeration engineers existing R12 evacuation, charging and leak detection equipment, together with the new equipment proposed in 4.2.2.1. will enable Industrias Nutal 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. Refrigerant charges typically range from 1.8 to 5 Kgs. Five "Recovery and Recycle" 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.).

Recovery and Recycling of CFC 12 during Servicing

The same refrigeration engineers carry out "on-site" maintenance and service operations and it is estimated that the provision of "Recovery and Recycle" equipment can eliminate approximately 20% of the annual R12 consumption for servicing.

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAMING MACHINE (45 Kgs/min)	100,000
TRAINING, TEST TRIALS & TECHNOLOGY TRANSFER	10,000
CONTINGENCIES (10%)	11,000
Subtotal (US$)	121,000

CAPITAL COST FOR CFC 12 PHASE-OUT

NEW VACUUM PUMPS (Factory - 1 off)	3,000
RETROFITTING VACUUM PUMPS (Factory - 2 off)	1,000
R134a LEAK DETECTION EQUIPMENT (Factory - 1 off)	500
R134a MANIFOLD GAUGE SETS & HOSES (5 off)	1,000
NEW VACUUM PUMPS (5 off)	6,000
R134a LEAK DETECTION EQUIPMENT (5 off)	2,500
R12 RECOVERY & RECYCLE MACHINES (5 off)	15,000
TRAINING	3,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION & RELIABILITY TEST TRIALS (6 models)	25,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	12,000
CONTINGENCIES (10%)	7,000
Subtotal (US$)	76,000
TOTAL INCREMENTAL CAPITAL COST (US$)	197,000

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.):	10,117
PHASE-OUT OF CFC 12	
Costs for Materials (see Annex A. Part 2.):	11,704
TOTAL INCREMENTAL OPERATING COST (US$)	21,821

6.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational) (US$)	218,821
% Article 5.1 Country Ownership	100%
FUNDING REQUESTED FROM MLF (US$)	**218,821**

6.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	197,000
b. Capital Recovery Factor (10% p.a.)	0.16275
c. Incremental Operating Costs	21,821
d. ODS Reduction (ODP Kgs Jan - Dec 1994)	14,520
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	3.71

THE PROJECT UNIT ABATEMENT COST IS 3.71 US$/Kg

6.5 COST EFFECTIVENESS (US$/Kg)

TOTAL PROJECT COST	=	218,821 US$
LESS PROJECT SAFETY RELATED COSTS	=	n/a
TOTAL ODS ELIMINATED	=	14,520 ODP Kgs
PROJECT COST EFFECTIVENESS	=	15.07 US$/Kg

THE PROJECT COST EFFECTIVENESS IS 15.07 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

Industrias Nutal C.A. requests reimbursement from the MLF of the sum of US$ 218,821, representing the incremental Capital and Operatinal Costs of this ODS elimination project, correctly taking into account the 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			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 14.52 ODP tons per year.

10. ANNEXES

Annex A. - Incremental Operational Cost Calculations.
Annex B. - Project Technical Reviews.
Annex C. - Letter from Industrias Nutal relating to the selection of HCFC 141b technology.

ANNEX A. INCREMENTAL OPERATIONAL COST CALCULATIONS

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

INDUSTRIAS NUTAL C.A.	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.350	0.365	0.015
b. MDI	0.500	0.500	-
c. Kg Blowing Agent	0.150	0.135	(0.015)
Prices in US$/Kg			
d. Polyol	2.61	2.74	0.13
e. MDI	2.15	2.15	-
f. Blowing Agent	2.00	4.00	2.00
g. Liner (Type: HIPS with EVOH Protection)	1.72	1.90	0.18
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.914	1.000	0.086
i. = b. x e. MDI	1.075	1.075	-
j. = c. x f. Blowing Agent	0.300	0.540	0.240
k. = h+i+j Total Cost per Kg of Foam	2.289	2.615	0.326
Materials Used per Bottle Cooler/Freezer			
l. Kg of Foam per Bottle Cooler/Freezer (avg)	6.637	7.301	0.664
m. Kg of Liner material per Freezer (avg)	0.910	0.910	-
n. Kg of Foam per Insulation Panel	8.800	9.680	0.880
Cost per BC/Freezer/Insulation Panel			
o. = l. x k. for Bottle Cooler/Freezer Foam	15.192	19.092	3.900
p. = m. x g. for Freezer Liner	1.565	1.729	0.164
q. = n. x k. for Insulation Panel Foam	20.143	25.313	5.170
r. = o. + p. Total per Refrigerator	16.757	20.821	4.064
s. = No. of Bottle Coolers/Freezers (Note 1.)		1,576	
Incremental Operating Cost (BC/Freezers) US$		6,405	
t. = No. of Insulation Panels (Note 1.)		718	
Incremental Operating Cost (Panels) US$		3,712	
TOTAL INCREMENTAL OPERATIONAL COST (US$)		10,117	

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

INDUSTRIAS NUTAL C.A.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.60	8.50	
b. Kg of Refrigerant per BC/Freezer (avg)	0.540	0.486	
c. No. of BC/Freezers Produced (see Note 1.)	1,576	1,576	
1d. Cost for Refrigerant = a x b x c	2,213	6,511	4,298
2. Compressors			
a. Cost for Compressor (see Note 2.)	36.77	41.08	
b. No. of Compressors (see Note 1.)	1,576	1,576	
2c. Cost for Compressors = a x b	57,950	64,742	6,792
3. Condensers			
a. Cost per Condenser	N/C	N/C	
b. No. of Condensers	1,576	1,576	
3c. Cost for Condensers = a x b	-	-	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.400	0.530	
b. No. of Filter/Dryers (see Note 1.)	1,576	1,576	
4c. Cost for Filter/Dryers = a x b	630	835	205
5. Capillary Tubes			
a. Cost per Capillary Tube (average)	1.041	1.301	
b. No. of Capillary Tubes (see Note 1.)	1,576	1,576	
5c. Cost for Capillary Tubes = a x b	1,641	2,050	409
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)		11,704	

Notes relating to the calculation of the Incremental Operating Costs

Note 1. Figures in the above tables are based on the actual production volumes for unitary Bottle Coolers/Freezers and PU insulation panels for the 12 month period January to December 1994 obtained from Industrias Nutal 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 Manufacturers of commercial Refrigeration Equipment. NUTAL C.A.

3.(Sub)Sector:

Commercial Refrigeration.
This review covers only the foam part.

4.CP-Relationship:

The Venezuelan CP for ODS phase-out is actually in preparation.It will be presented to the 16th Meeting of the Executive Committee of the MLF in March 1995.
The strategy for CFC reduction in commercial refrigeration was designed by FONDOIN, assisted by UNDP.

5.Technology:

INDUSTRIAS NUTAL states that the change to cyclopentane is excluded for safety reasons and because of the less efficiency of this gas as an insulant.This may be true for the local circumstances.
NUTAL mentions, besides the less energetic efficiency of cyclopentane also that its productionline being longer than 100 m a safe and efficient extraction of gases is difficult to realise.It is further referred to the USA and Europe, where also HCFC 141b is currently used.
High pressure foam injection machines will be used, in order to obtain a correct mixture of the chemicals.
The proposed technology can, in the given understanding, be accepted.

6.Environmental Impact:

The ODP of HCFC 141b is .11, versus 1.0 for CFC11.The GWP of HCFC 141b is 10% of the GWP of CFC11. The smog potential of HCFC141B is 1. versus .1 for CFC11.(as a reference: pentane 500)

7.Project Costs:

A HP foaming machine of USD 100,000 is proposed, which can be accepted.The incremental costs can be accepted as presented in the project.

This means that the cost for removal of 1 kg ODS in the foam part of the project is USD 131,117/4,490, or USD 29.2.

8.Implementation:

Three semesters is an acceptable implementation period.

9.Recommendation:

From a technical point of view, it is proposed to accept the project as presented.

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 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