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

Fifteenth Meeting
Montreal, 13-16 December 1994

PROJECT PROPOSALS: PERU

This document includes the following project proposals and the Fund Secretariat's Comments and Recommendations. The project proposals have been grouped by project sector. The agency responsible for the implementation of the project is also indicated. The project proposals are presented in the order indicated below. The Fund Secretariat's Comments and Recommendations are presented at the front of the document.

Refrigeration

- Elimination of CFC 11 and 12 in the manufacture of domestic refrigerators at Industrias Alfa S.A. — UNDP
- Elimination of CFC 11 and 12 in the manufacture of domestic refrigerators at Andina Industrial S.A. — UNDP
- Elimination of CFC 11 and 12 in the manufacture of domestic refrigerators at Coldex S.A. — UNDP
- Elimination of CFC 11 and 12 in the manufacture of domestic refrigerators at Industrias Lenche S.A. (Inlensa) — UNDP
- Elimination of CFC 11 and 12 in the manufacture of domestic refrigerators at Industrias Reunidas S.A. (Inresa) — UNDP
- Elimination of CFC 11 and 12 in the manufacture of domestic refrigerators at Industrial Selva S.A. (Indusel) — UNDP

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Peru
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Six Companies (Industries Alfa, Andina Industrial, Coldex, Indusel, Inlensa and Inresa)
BUDGET:	US $2,112,701
INCREMENTAL COSTS:	US $1,520,868 Incremental capital cost US $ 591,833 Incremental operational cost
ODS PHASEOUT:	148 MT of CFC-12 and CFC-11
COST EFFECTIVENESS[1]:	US $6.14/Kg. ODP
PROJECT DURATION:	1.5 years
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	Grupo de Trabajo para Implementacion del programa Pais (GTIPP)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. These projects cover the conversion of both the refrigeration and foaming systems in six domestic refrigeration enterprises to HFC-134a and HCFC-141b respectively. They represent approximately 94 per cent of domestic refrigerator and freezer production in Peru in this sector. Implementation of these projects will result in elimination of 148 MT of ODS.

2. The requested capital costs cover the replacement and modification of existing

[1] Determined as the ratio of incremental costs to the estimated annual saving of ODP ($/ODP$_{kg}$).

equipment. Process development engineering and model redesign will be assisted by externally qualified experts.

3. The use of HCFC-141b for foam blowing is a transitional technology, while cyclopentane can be considered as a final solution. However, cyclopentane is a highly flammable chemical and not easily available in Peru yet. In the circumstances, the choice of technology is considered to be justified.

4. The project includes incremental operating costs. for a six-month period, for both the refrigeration and foaming systems.

5. The cost-effectiveness of the project group is average.

6. Five of the six enterprises are 100 per cent locally owned. The sixth, Inresa, is 77.13 per cent owned by Article 5 countries. The project as proposed includes a reduction in incremental costs in proportion to the percentage overseas ownership.

SECRETARIAT'S RECOMMENDATION

7. The Fund Secretariat recommends final approval of the project and approval of US $2,112,701 in incremental costs as itemized in the following table.

Company	Production Units/yr	CFC Consump. MT/yr	Capital Cost US $	Incremental Operating Cost US $	Total US $	Local Owner-ship	Grant US $
Alfa	6,400	7.4	222,000	30,727	252,727	100%	252,727
Andina	4,454	5.7	206,000	23,816	229,816	100%	229,816
Coldex	59,857	74.2	477,000	271,966	748,966	100%	748,966
Indusel	36,000	38.3	253,500	158,548	412,098	100%	412,098
Inlensa	8,700	6.1	168,000	33,443	201,443	100%	201,443
Inresa	24,050	18.1	252,000	95,013	347,013	77.13%	267,641
TOTAL:	139,461	149.8	1,578,500	613,563	2,192,063		2,112,691

PROJECT COVER SHEET

COUNTRY:	**PERU**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators (Six Companies)
SECTOR COVERED:	Domestic Refrigeration
ODS USE IN SECTOR:	161.2 tons ODS (July 93 - June 94)
PROJECT IMPACT (ODP):	136.6 ODP tons
TOTAL PROJECT COST:	US$ 2,112,701
INCREMENTAL CAPITAL COST:	US$ 1,520,868
INCREMENTAL OPERATING COST:	US$ 591,833
PROPOSED MLF GRANT:	US$ 2,112,701
UNIT ABATEMENT COST:	6.14 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Grupo de Trabajo para Implementacion del Programa Pais (GTIPP)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	July 1994

PROJECT SUMMARY:

Five out of six companies (Alfa, Andina, Coldex, Inlensa, Selva) are 100% Peruvian-owned company manufacturing domestic refrigerators and freezers for the local market. The sixth company (Inresa) is 77.13% owned by Article-5 countries. The companies currently use 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. This project will eliminate the use of CFC 11 and CFC 12 by conversion to the use of HCFC 141b as the insulation foam blowing agent and HFC 134a as the refrigerant respectively. The project will eliminate 136.6 ODP tons/yr (based on July 1993 - June 1994 figures). Funds requested will be used to change the existing production lines, and for 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 and Bert Veenendaal, in collaboration with the Peru GTIPP.

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

PROJECT OF THE GOVERNMENT OF PERU

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFCs used by six manufacturers of domestic refrigerators and freezers. The CFCs which will be eliminated include CFC 11, used as a blowing agent for producing thermal insulating foams, and CFC 12, used as a refrigerant in the production of domestic refrigerators and freezers.

2. SECTOR BACKGROUND.

Peru's Country Programme (CP) for the Phase-out of Ozone Depleting Substances (ODS) under the Montreal Protocol is currently in the course of preparation with assistance from UNEP. This work commenced in July 1994 and it is anticipated that the CP will be presented to the 15th Meeting of the Executive Committee of the Multilateral Fund in December 1994. At the time of preparation of this project proposal there is very little data available from the CP preparation activities relating to ODS consumption in Peru.

Historical data on ODS consumption in Peru is not readily available, due to the customs tariff codes (Nabandina) in use up to end March 1992 which grouped ODS together as follows:

29.02.01.06	-	CFC 11, CFC 12, HCFC 22, (plus HCFC 123, HCFC 141b and others)
29.02.01.11	-	Carbon tetrachloride
29.02.01.99	-	CFC 113, CFC 114, CFC 115, Halon 1211, Halon 1301 (plus others)

Data based on this classification is therefore of limited value for establishing historical CFC 11 and CFC 12 consumption due to the inclusion of HCFC 22.

Since April 1992, new customs tariff codes (Nandina) have been used which classify the ODS individually. The May - December 1992 import statistics annualised suggest some 112 tons of CFC 11 and 240 tons of CFC 12 were imported in 1992. There are no recorded exports of CFCs.

In 1993, the import statistics based on the Nandina tariff codes show that some 75 tons of CFC 11 and 195 tons of CFC 12 were imported into Peru. Again there are no recorded exports. However, most consumers of CFC 11 in rigid PU foam manufacture in Peru import a polyol/CFC 11 pre-mix which does not show under the Nandina import tariff codes.

From discussions with the principal ODS suppliers, the 1993 imports are considered to contain significant purchases for stocking (in the face of uncertainty regarding Peru's ratification of the Montreal Protocol), and thus they may not reflect actual CFC 11 and CFC 12 consumption in Peru in 1992 and 1993. In preparing these project proposals, the following data for the 12 months July 1993 to June 1994, inclusive, was established as the best estimate of current CFC consumption in the domestic refrigeration sector. The enterprises shown in bold type represent those enterprises for whom ODS elimination project proposals are being presented to the Montreal Protocol Multilateral Fund.

ENTERPRISE	PRODUCTION VOLUME	ODS CONSUMPTION (tes)	
		CFC 11	CFC 12
Industrias Alfa	6,400	6.2	1.3
Andina Industrial	4,454	4.4	1.3
Coldex	59,857	61.9	12.3
Cometa	1,350	1.2	0.4
Formetal *	1,500	1.6	0.5
Indusel	36,000	31.1	7.2
Inlensa	8,700	3.4	2.7
Inresa	24,050	13.3	4.8
Master Service **	1,800	1.6	0.5
Precision **	4,800	4.3	1.2
TOTALS	148,911	129.0	32.2

Notes:

* Foametal not producing in 1994 due to corporate problems and production/consumption data is an estimate only.

** New enterprises which commenced production end 1993/early 1994 and production/consumption data is an estimate only

The SIX enterprises for whom ODS phase-out projects have been prepared represent 93.7% of domestic refrigerator/freezer production, and 93.3% of CFC 11 and 91.9% of CFC 12 consumption respectively, in the manufacture of domestic refrigerator/freezers in Peru in the period July 1993 - June 1994.

It should be noted that whilst all the domestic refrigerator/freezer manufacturers use PU foam as insulation material, two enterprises, **Industrias Lenche S.A.** and **Industrias Reunidas S.A.**, use glass-fibre for part of their model range.

It is estimated that of the approximately 149,000 domestic refrigerators and freezers manufactured in Peru in the period July 1993 to June 1994, over 99% were sold in the Peruvian market.

With increasing political and social stability and confidence, and the consequent effect on the domestic economy, the household refrigeration manufacturing sector is showing dramatic growth in 1994 versus 1993. However, this is from a very low 1993 base level, the lowest in almost a decade, and refrigerator production levels have some considerable way to go before they return to their earlier peak levels of production in 1986. Growth rates of 15% per annum are forecast for the next several years.

As indicated in the above table, the manufacture of domestic refrigerators in Peru is presently shared between 10 companies:

Coldex S.A.
Industrias Reunidas S.A. (Inresa)
Industrial Selva S.A. (Indusel)
Industrias Alfa S.A.
Industrias Lenche S.A. (Inlensa)
Andina Industrial S.A. (Hotex)
Construcciones Metalicas COMETA S.A. (See Note 1.)
Formetal S.A. (See Note 2.)
Master Service S.A. (See Note 3.)
Industrias Precision S.A. (See Note 3.)

Note 1. **Construcciones Metalicas COMETA S.A.** declined assistance in the preparation of a project proposal for funding from the MLF to eliminate their ODS consumption.

Note 2. In 1993 it is estimated that **Formetal S.A.** produced some 3,500 domestic freezers but the enterprise has not produced during 1994 due to internal corporate problems which has effectively closed the factory (albeit temporarily). For this reason they are not included in this group of ODS phase-out project proposals.

Note 3. Both **Master Service S.A.** and **Industrias Precision S.A.** only started production of domestic freezers in late 1993/early 1994. They are not included in this group of ODS phase-out project proposals pending further evaluation regarding their eligibility for financial assistance from the MLF.

The industry imports most raw materials and parts. Compressors are mainly supplied by Embraco and Sicom of Brazil, with a small number also sourced from L'Unite Hermetique of France and Unidade Hermetica of Spain.

Uninhibited growth in the manufacture of domestic refrigerators and freezers would lead to an estimated consumption in the year 2000 of 300 tons per year of CFC 11 and of 75 tons per year of CFC 12. The Grupo de Trabajo para la Implementacion del Programa Pais for the reduction and elimination of ODS (GTIPP), with the assistance of UNDP, has designed a strategy for the elimination of CFC 11 and CFC 12 in this sector beginning early 1995. Approval of the projects by the MLF in December 1994 would bring the implementation of this

strategy well in line with the target. With accompanying national legislation against the use of CFCs in the manufacture of domestic refrigerators, a complete phase-out of the use of CFCs in the manufacture of domestic refrigerators in Peru can be achieved in 1996.

3. PROJECT DESCRIPTION

3.1. Replacement of CFC 11 with HCFC 141b.

The companies will transfer to HCFC 141b as an interim step to an ODS-free system. The injection machine for the rigid insulation foam should be a high pressure machine that will be able to process the higher viscosities and mixing requirements of the low ODS systems, and also any of the developing ODS-free systems.

This will require equipment replacement and training at each of the companies. They will also require test-runs before being able to start industrial production with the new technology. These activities will include training of staff in worker-safety related to HCFC 141b.

Operational Costs for six months are requested, to be paid following approval of the project.

3.2. Replacement of CFC 12 with HFC 134a.

The conversion to HFC 134a requires the use of HFC 134a 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. A more detailed description of the existing equipment on which the technology change will impact is provided in para 5.2.3.

Operational Costs for six months are requested, to be paid following approval of the project.

4. TECHNOLOGY

4.1. Replacement of CFC 11 with HCFC 141b.

4.1.1. OVERVIEW

There are currently three main directions in the development of CFC-free systems for thermoset insulation foams:

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

In addition, compounds such as perfluoroalkanes, HCFC 123, fluorinated ethers and 2-chloropropane have been suggested, but the technology is not mature. Furthermore, the 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, is the one which will be applied in this project, and it employs technology that is closely related to the existing one. The final step to non-ODS technology in this process is not yet decided. One potential solution is HFC 356, but full water blown foam with improved cell structure remains an option in systems where dimensional changes, although costly, are possible.

The second one, the "gas" solution, utilizes a gaseous mixture of physical blowing agents, and always requires new equipment and extensive adjustments. The final step in this process is seen as the introduction of gaseous HFC's.

The third option, pentane technology, has recently been introduced in Europe. Pentanes are flammable and this means a careful review of manufacturing operations with respect to the safe handling of a flammable foam blowing agent. Their use may not be a practical option in the existing work environments of some enterprises. Several companies currently offer pentane technology packages, including equipment. UNDP requires, however, independent process safety review prior to, and after, installation.

4.1.2. SELECTION

Based on economic and environmental considerations, cyclopentane appears to be the best choice for domestic refrigerator and freezer applications. It combines an attractive price with zero ODP properties. Cyclopentane is not, however, presently available in Peru.

HCFC 22/142b was considered but was rejected on energy performance considerations.

The use of HCFC 141b is recognised by the companies as a CFC 11 replacement that is:

- proven technology in both processing and product performance
- environmentally acceptable
- readily available in the Peruvian market

The choice of high pressure foam dispensing equipment will facilitate the subsequent step to a final zero-ODP insulating foam system without major additional capital costs.

4.1.3. IMPACT ON PRODUCTION PROCESS

The use of reduced ABA/141b technology, with higher related viscosity of the polyol blend will be facilitated through the employment of high pressure foam production equipment.

HCFC 141b is moderately flammable in the gaseous state, but the liquid is not flammable. In the intended application, HCFC 141b/polyol blends should not pose any risk, but a monitoring check at commissioning will be performed to ensure safe worker exposure levels. Ventilation is to be installed where needed to ensure exposure levels are maintained below the recommended occupational exposure limit.

Foam density may have to be adjusted to obtain proper insulation values. For all companies except Inlensa, the liner material should be modified to be resistant to HCFC 141b. The companies intend to use high impact polystyrene (HIPS) in combination with an ethylene vinyl alcohol (EVOH) protective layer. Inlensa however, currently exclusively uses metal liners and, therefore, no change of liner material is required.

4.2. Replacement of CFC 12 with HFC 134a.

4.2.1. 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, having already been introduced commercially in many of the Developed Countries.

While hydrocarbon refrigerants are being used on a limited basis in at least one Developed Country, the technology is not considered as sufficiently developed to consider transfer to Peru at the present time. Safety issues associated with the use of flammable hydrocarbon refrigerants, and the absence of suitable compressors on a commercial scale further mitigate against the adoption of this technology 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.

4.2.2. SELECTION

The selected technology is HFC 134a. In the case of four companies Andina, Coldex, Inlensa, Selva, the existing technology was developed in-house. For Alfa, the CFC 12 technology was initially obtained from Admiral International Corporation, USA, and subequently further developed "in house". In the case of Inresa, the original CFC technology for refrigerator manufacture was obtained from Whirlpool-Merloni. This was subsequently developed by Inresa to meet local market needs in respect of refrigerator design.

The new HFC 134a based technology is being developed with assistance from compressor and refrigerant suppliers. The companies presently have no formal technology transfer agreements. Provision is 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 this project.

4.2.3. IMPACT ON 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 cost (see Annex A Part 2.).

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 Industrias Alfa will need to carefully re-assess production procedures and re-train production personnel as appropriate. Provision for this is made within the project proposal.

The conversion from CFC 12 to HFC 134a will take place on a model by model basis, so that Industrias Alfa S.A. 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 at Industrias Alfa.

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.

5. FINANCING PLAN

The six companies request reimbursement to the amount of the project costs of US$ 2,112,701

6. PROJECT IMPLEMENTATION

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

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

This project will eliminate the use of 136.6 ODP tons per year. This is based on figures for the 12 months, July 1993 - June 1994.

ANNEX 1 : ALFA

COUNTRY:	**PERU**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrias Alfa S.A.
SECTOR COVERED:	Domestic Refrigeration
ODS USE IN SECTOR:	161.2 tons ODS (July 93 - June 94)
PROJECT IMPACT (ODP):	6.8 ODP tons
TOTAL PROJECT COST:	US$ 252,727
INCREMENTAL CAPITAL COST:	US$ 222,000
INCREMENTAL OPERATING COST:	US$ 30,727
PROPOSED MLF GRANT:	US$ 252,727
UNIT ABATEMENT COST:	9.8 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Grupo de Trabajo para Implementacion del Programa Pais (GTIPP)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	July 1994

PROJECT SUMMARY:

Industrias Alfa S.A. is a 100% Peruvian-owned company manufacturing domestic refrigerators and freezers for the local market. Industrias Alfa S.A. 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. This project will eliminate the use of CFC 11 and CFC 12 by conversion to the use of HCFC 141b as the insulation foam blowing agent and HFC 134a as the refrigerant respectively. The project will eliminate 6.8 ODP tons/yr (based on July 1993 - June 1994 figures). Funds requested will be used to change the existing production lines, and for 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 and Bert Veenendaal, in collaboration with the Peru GTIPP.

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

PROJECT OF THE GOVERNMENT OF PERU

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE AND BACKGROUND.

See General Information Section.

2. ENTERPRISE BACKGROUND

Industrias Alfa S.A. is one of **TEN** enterprises presently manufacturing domestic refrigerators and freezers in Peru and they account for approximately **4%** of the total local production of such products. Industrias Alfa S.A. is 100 per cent Peruvian-owned.

More details on Industrias Alfa S.A. are given below:

CFC USE IN LAST 12 MONTHS: (July 1993 - June 1994)	6.2 tons CFC 11 1.3 tons CFC 12
FULL NAME:	Industrias Alfa S.A.
PLANT LOCATION:	Av. Materiales 3045, Lima, Peru
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Peru)
No. OF MODELS:	5
PRODUCTION IN LAST 12 MONTHS: July 1993 - June 1994	6,400 units
No. OF PRODUCTION LINES:	1
COMPRESSOR SUPPLIERS:	SICOM, Brazil
CONTACT PERSONS:	Ernesto Wong Chang - Gen Manager Marco Chang - Production Manager
TEL / FAX:	Tel: (51 14) 52 3712 Fax: (51 14) 52 4039

OTHER INFORMATION:
Industrias Alfa S.A. formerly manufactured domestic washing machines and cookers but is now solely enagaged in the production of domestic refrigerators and freezers. All production is sold in the Peruvian market. Industrias Alfa was established in 1962 and began refrigerator manufacturing operations in 1964. The company presently employs 92 persons, all engaged in the refrigerator

manufacturing and sales operations. This project encompasses all ODS consumption used in manufacturing operations at Industrias Alfa S.A.

The original CFC technology for refrigerator manufacture was obtained from Admiral International Corporation, USA. This was subsequently developed by Alfa to meet local market requirements with the introduction of new refrigerator models. Currently, Industrias Alfa has no formal technology transfer agreements with internationally recognised refrigerator manufacturers.

The following tables provide a summary of refrigerator and freezer production by Industria Alfa during the 12 month period July 1993 to June 1994 inclusive, as well as other relevant project data.

Model No.	Capacity Cubic Feet	Description	Production Volume	CFC 12 Charge Kgs	CFC 12 Consumption Kgs
RSL 13	13	SD Ref	1,940	0.180	349.2
RDT 15	15	DD Ref	1,886	0.170	320.6
RNF 16	16	DD Ref NF	612	0.190	116.3
FV 10	10	SD Frz	258	0.180	46.4
FH 12	12	Chest Frz	1,704	0.260	443.1
Total or Average			6,400	0.200	1,275.6

Model No.	Compressor HP & Price US$	Liner Type & Weight per Unit Kgs	PU Foam per Unit Kgs
RSL 13	1/6 31.82	HIPS 7.1	5.7
RDT 15	1/5 35.27	HIPS 6.0	7.6
RNF 16	1/4 36.45	HIPS 10.78	8.0
FV 10	1/4 36.45	HIPS 8.2	6.5
FH 12	1/4 36.45	HIPS 8.0	7.3
Weighted Average	Average Compressor Price = 34.70 US$	Average HIPS Liner Weight = 7.412 Kgs	Average Weight of PU Foam = 6.938 Kgs

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

3. PROJECT DESCRIPTION

Industrias Alfa 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 July 1993 - June 1994, and the ODP tons that will be eliminated by this project are shown in the following table:

Enterprise	CFC 11 (tes)	ODP tons eliminated (see Note*)	CFC 12 (tes)	Total ODP tons eliminated
Ind. Alfa	6.2	5.5	1.3	6.8

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

3.1. Replacement of CFC 11 with HCFC 141b.

The relevant existing equipment at Industrias Alfa S.A. on which the technology change to HCFC 141b will impact is as follows:

- 1 x Cannon C60 Fr2 low pressure Foam Injection Machine with a throughput of 60 Kg/min. This equipment was purchased in 1990.

3.2. Replacement of CFC 12 with HFC 134a.

The relevant existing equipment at Industrias Alfa S.A. on which the technology change to HFC 134a will impact is as follows:

- 1 x Danfoss (Model 118x2150) Automatic R12 charging machine,
- 4 x Kinney Model KC-5 Vacuum Pumps, 5 M3/hr capacity
- 1 x Balzer Vacuum Pump, 8 M3/hr capacity
- 1 x Balzer LSG 010 Refrigerant leak detector

Note:
All the 4 Kinney vacuum pumps are in use, the Balzer vacuum pump is in stand-by duty. The combined vacuum pump capacity is considerably in excess of production volume requirements and this capacity can be adequately maintained by the provision of only 4 replacement vaccum pumps. From the 4 vacuum pumps requested, two will be purchased new to allow for continuous production while retrofitting is being carried out. Two vacuum pumps will be retrofitted.

4. PROJECT COSTS

4.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAMING MACHINE	100,000
TRAINING, TEST TRIALS AND TECHNOLOGY TRANSFER	10,000
CONTINGENCIES (10%)	11,000
Subtotal (US$)	**121,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (1 unit)	25,000
NEW VACUUM PUMPS (2 units)	6,000
RETROFITTED VACUUM PUMPS (2 units)	1,000
LEAK DETECTION EQUIPMENT (1 unit)	5,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION, & RELIABILITY TEST TRIALS (5 models)	35,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	9,000
Subtotal (US$)	**101,000**

TOTAL INCREMENTAL CAPITAL COST (US$)	**222,000**

4.2 INCREMENTAL OPERATING COSTS

The calculation of the incremental operating cost is based on a six month period using 50% of the actual production for the period July 1993 to June 1994 inclusive and ignoring growth. Paragraph 5 provides detailed explanations on how the incremental operational costs were obtained, the costs are summarized below:

PHASE-OUT OF CFC 11 for Materials (see para 5.1):	**17,434**
PHASE-OUT OF CFC 12 for Materials (see para 5.2):	**13,293**
TOTAL INCREMENTAL OPERATING COST (US$)	**30,727**

4.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational)	**252,727**
% Article 5.1 Country Ownership	**100%**
FUNDING REQUESTED FROM MLF (US$)	**252,727**

4.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	**222,000**
b. Capital Recovery Factor (10% p.a.)	**0.16275**
c. Incremental Operating Costs	**30,727**
d. ODS Reduction (ODP Kgs July 93 - June 94)	**6,800**
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	**9.8**

THE PROJECT UNIT ABATEMENT COST IS 9.8 US$/Kg

5. INCREMENTAL OPERATIONAL COST CALCULATIONS

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

Industrias Alfa S.A.	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced	[redacted]	[redacted]	[redacted]
a. Kg Polyol	0.360	0.374	0.014
b. MDI	0.500	0.500	-
c. Kg Blowing Agent	0.140	0.126	(0.014)
Prices in US$/Kg	[redacted]	[redacted]	[redacted]
d. Polyol	2.50	2.60	0.10
e. MDI	2.00	2.00	-
f. Blowing Agent	1.80	4.00	2.20
g. Liner (Type: HIPS with EVOH Protection)	2.00	2.20	0.20
Cost per Kg of Foam Produced	[redacted]	[redacted]	[redacted]
h. = a. x d. Polyol	0.900	0.972	0.072
i. = b. x e. MDI	1.000	1.000	-
j. = c. x f. Blowing Agent	0.252	0.504	0.252
k. = h+i+j Total Cost per Kg of Foam	2.152	2.476	0.324
Materials Used per Refrigerator	[redacted]	[redacted]	[redacted]
l. Kg of Foam per Refrigerator (avg)	6.938	7.632	0.694
m. Kg of Liner material per refrigerator (avg)	7.412	7.412	-
Cost per Refrigerator	[redacted]	[redacted]	[redacted]
n. = l. x k. for Foam	14.931	18.897	3.966
o. = m. x g. for Liner	14.824	16.306	1.482
p. = n. + o. Total per Refrigerator	29.755	35.203	5.448
q. = No. of Refrigerators (see Note 1.)	3,200		
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)	**17,434**		

(see also Note 1. below)

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

Industrias Alfa S.A.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.33	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.20	0.18	
c. No. of Refrigerators Produced (see Note 1.)	3,200	3,200	
1d. Cost for Refrigerant = a x b x c	1,491	5,184	3,693
2. Compressors			
a. Cost per Compressor (see Note 2.)	32.88	35.68	
b. No. of Compressors (see Note 1.)	3,200	3,200	
2c. Cost for Compressors = a x b	105,216	114,176	8,960
3. Condensers			
a. Cost per Condenser	N/C	N/C	
b. No. of Condensers (see Note 1.)			
3c. Cost for Condensers = a x b	N/C	N/C	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.39	0.49	
b. No. of Filter/Dryers (see Note 1.)	3,200	3,200	
4c. Cost for Filter/Dryers = a x b	1,248	1,568	320
5. Capillary Tubes			
a. Cost per Capillary Tube	0.70	0.80	
b. No. of Capillary Tubes (see Note 1.)	3,200	3,200	
5c. Cost for Capillary Tubes = a x b	2,240	2,560	320
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)		13,293	

Note 1. Figures in the above tables are based on the actual production volume for the 12 month period July 1993 to June 1994 obtained from Industrias Alfa 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 and compressor prices used in the above tables are weighted average (National) prices.

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.

Country of origin: PERU

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrias Alfa S.A.

Sector/sub-sector Domestic refrigeration

Relationship to country program (UNDP, country program is 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
In domestic refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.

Industrias Alfa S.A. does not have a formal technology transfer agreement. However, the company is in the process of developing 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.

Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of 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 the manufacturer is essential for the conversion process. Costs of equipment, training, testing and external support are reasonable.
Operational costs are reasonable and correctly applied.
If the UAC value is calculated for the refrigerant part separately a value of 27.5 USD is obtained which is relatively high compared to other, similar, projects (of course, this is mainly due to the very small scale of the company).

Implementation timeframe	Reasonable.
Relevance and adequacy of information provided	Sufficient
Recommendations	Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands
22-October-1994

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

TECHNICAL REVIEW

PREPARED BY: Dr Hubert Creyf
UNDP Foam Sector Project Reviewer

DATE: 21 October 1994

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1. **COUNTRY:** Peru

2. **PROJECT TITLE:** Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrias Alfa S.A.
Note: This review deals only with the foam blowing agent conversion.

3. **(SUB) SECTOR:** Domestic Refrigeration -- Foamed Plastics

4. **CP RELATIONSHIP:** Peru's CP is currently under preparation. The consultant preparing this project has met the UNEP representative involved in this exercise. The extensive background section of this project will be used in the CP which will be finalized by UNEP in the next few months.

5. **TECHNOLOGY:** The different technical possibilities to replace CFC 11 in the insulating foam of domestic refrigerators are well descibed.

The logical choice is HCFC 141b since this cell gas presents only a small loss (±10%) in lambda value versus CFC 11. It must be remembered that the wall thickness in refrigeration is a constant feature, so that it is important to use the best insulating material in order to keep electricity costs as low as possible.

ANNEX 2 : ANDINA

COUNTRY:	**PERU**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Andina Industrial S.A.
SECTOR COVERED:	Domestic Refrigeration
ODS USE IN SECTOR:	161.2 tons ODS (July 93 - June 94)
PROJECT IMPACT (ODP):	5.2 ODP tons
TOTAL PROJECT COST:	US$ 229,816
INCREMENTAL CAPITAL COST:	US$ 206,000
INCREMENTAL OPERATING COST:	US$ 23,816
PROPOSED MLF GRANT:	US$ 229,816
UNIT ABATEMENT COST:	11 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Grupo de Trabajo para Implementacion del Programa Pais (GTIPP)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	July 1994

PROJECT SUMMARY:

Andina Industrial S.A. is a 100% Peruvian-owned company manufacturing domestic refrigerators and freezers for the local market. Andina Industrial 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. This project will eliminate the use of CFC 11 and CFC 12 by conversion to the use of HCFC 141b as the insulation foam blowing agent and HFC 134a as the refrigerant respectively. The project will eliminate 5.2 ODP tons/yr (based on July 1993 - June 1994 figures). Funds requested will be used to change the existing production lines, and for 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 and Bert Veenendaal, in collaboration with the Peru GTIPP.

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

PROJECT OF THE GOVERNMENT OF PERU

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE AND BACKGROUND.

See General Information Section.

2. ENTERPRISE BACKGROUND

Andina Industrial S.A. is one of TEN enterprises presently manufacturing domestic refrigerators and freezers in Peru and they account for approximately 3% of the total local production of such products. Andina Industrial S.A. is 100 per cent Peruvian-owned. More details on Andina Industrial S.A. are given below:

CFC USE IN LAST 12 MONTHS: (July 1993 - June 1994)	4.4 tons CFC 11 1.3 tons CFC 12
FULL NAME:	Andina Industrial S.A.
PLANT LOCATION:	Los Telares 259, Urb Vulcano, Ate Lima
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Peru)
No. OF MODELS:	6
PRODUCTION IN LAST 12 MONTHS: July 1993 - June 1994	4,454 units
No. OF PRODUCTION LINES:	1
COMPRESSOR SUPPLIERS:	SICOM (29%) EMBRACO (51%), Brazil and UNIDADE HERMETICA (21%), Spain
CONTACT PERSONS:	Aron Fleishman - Director Enrique Horna - Assistant Juan Semosain - Planner
TEL / FAX:	Tel: (51 14) 36 6560 Fax: (51 14) 37 8657

OTHER INFORMATION:
Andina Industrial S.A. manufactures a range of domestic appliances including refrigerators and freezers. All production is sold in the Peruvian market. Andina Industrial was established in 1969 and began it's refrigerator manufacturing operations in 1991. The

6.	**ENVIRONMENTAL IMPACT:**	HCFC 141b presents a relatively low ODP (0.11) and an acceptable GWP. During production, the TLV (500 ppm) must be respected.
7.	**PROJECT COSTS:**	The project costs as presented are realistic and can be accepted. The cost to remove one ton of ODP is US$ 30,443.
8.	**IMPLEMENTATION:**	The 1.5 year proposed, refers to the refrigeration part. The replacement of CFC 11 by HCFC 141b can be performed in a shorter period.
9.	**RECOMMENDATION:**	Approval is recommended.

company presently employs 125 persons, of which some 87 are engaged in the refrigeration part of Andina's business. This project encompasses all ODS consumption used in manufacturing operations at Andina Industrial.

The existing CFC technology was developed "in house" with the assistance of compressor and refrigerant suppliers. The CFC replacement technology will be developed by the same process. Currently, Andina Industrial has no formal technology transfer agreements with internationally recognised refrigerator manufacturers.

The following tables provide a summary of refrigerator and freezer production by Andina Industrial S.A. during the 12 month period July 1993 to June 1994 inclusive, as well as other relevant project data.

Model No.	Capacity Cubic Feet	Description	Production Volume	CFC 12 Charge Kgs	CFC 12 Consumption Kgs
Mod-1	11.3	SD Frz	1,782	0.290	516.8
Mod-2	11.3	DD Frz	1,336	0.290	387.4
Mod-3	11.3	DD Frz(G)	223	0.290	64.7
Mod-4	15.0	SD Frz	445	0.350	155.8
Mod-5	15.0	DD Frz	445	0.350	155.8
Ref-6	10.0	DD Ref	223	0.230	51.3
Total or Average			4,454	0.299	1,331.8

Model No.	Compressor HP & Price US$		Liner Type & Weight per Unit Kgs		PU Foam per Unit Kgs
Mod-1	1/5	32.47	HIPS	4.3	6.7
Mod-2	1/5	32.47	HIPS	4.7	6.7
Mod-3	1/5	32.47	HIPS	2.7	5.5
Mod-4	1/4	34.62	HIPS	5.2	8.6
Mod-5	1/4	34.62	HIPS	5.7	8.6
Ref-6	1/6	31.10	HIPS	12.5	6.5
Weighted Average	Average Compressor Price = 32.83 US$		Average HIPS Liner Weight = 4.981 Kgs		Average Weight of PU Foam = 7.01 Kgs

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

3. PROJECT DESCRIPTION

Andina Industrial S.A. 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 July 1993 - June 1994, and the ODP tons that will be eliminated by this project are shown in the following table:

Enterprise	CFC 11 (tes)	ODP tons eliminated (see Note*)	CFC 12 (tes)	Total ODP tons eliminated
Andina	4.4	3.9	1.3	5.2

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

3.1. Replacement of CFC 11 with HCFC 141b.

The relevant existing equipment at Andina Industrial S.A. on which the technology change to HCFC 141b will impact is as follows:

- 1 x low pressure Foam Injection Machine of local manufacture

3.2. Replacement of CFC 12 with HFC 134a.

The relevant existing equipment at Andina Industrial S.A. on which the technology change to HFC 134a will impact is as follows:

- 1 x Semi-automatic (Danfoss Copy) R12 charging machine,
- 5 x Robinair Model 15601 Vacuum Pumps, 10 M3/hr capacity
- 2 x Canadian Control Power System Leak Seeker L780 hand held leak detectors

Note: All the 5 Robinaire vacuum pumps are in use. The combined vacuum pump capacity is considerably in excess of production volume requirements and this capacity can be adequately maintained by the provision of only 3 replacement vacuum pumps. Two will be purchased new to allow for continuous production while retrofitting is being carried out. One vacuum pump will be retrofitted.

4. PROJECT COSTS

4.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAMING MACHINE	100,000
TRAINING, TEST TRIALS, TECHNOLOGY TRANSFER	10,000
CONTINGENCIES (10%)	11,000
Subtotal	**121,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (1 off)	25,000
NEW VACUUM PUMPS (1 units)	3,000
RETROFITTING VACUUM PUMPS (2 units)	500
LEAK DETECTION EQUIPMENT (2 off)	1,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION, & RELIABILITY TEST TRIALS (4 models)	28,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	7,500
Subtotal (US$)	**85,000**
TOTAL INCREMENTAL CAPITAL COST (US$)	**206,000**

4.2 INCREMENTAL OPERATING COSTS

The calculation of the incremental operating cost is based on a six month period using 50% of the actual production for the period July 1993 to June 1994 inclusive and ignoring growth. Paragraph 5 provides detailed explanations on how the incremental operational costs were obtained, the costs are summarized below:

PHASE-OUT OF CFC 11 for Materials (Para 5.1):	**10,712**
PHASE-OUT OF CFC 12 for Materials (Para 5.2):	**13,104**
TOTAL INCREMENTAL OPERATING COST (US$)	**23,816**

4.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational)	**229,816**
% Article 5.1 Country Ownership	**100%**
FUNDING REQUESTED FROM MLF (US$)	**229,816**

4.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	**206,000**
b. Capital Recovery Factor (10% p.a.)	**0.16275**
c. Incremental Operating Costs	**23,816**
d. ODS Reduction (ODP Kgs July 93 - June 94)	**5,200**
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	**11.02**

THE PROJECT UNIT ABATEMENT COST IS 11 US$/Kg

5. INCREMENTAL OPERATIONAL COST CALCULATIONS

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

Andina Industrial S.A.	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced	[redacted]	[redacted]	[redacted]
a. Kg Polyol	0.360	0.374	0.014
b. MDI	0.500	0.500	-
c. Kg Blowing Agent	0.140	0.126	(0.014)
Prices in US$/Kg	[redacted]	[redacted]	[redacted]
d. Polyol	2.50	2.60	0.10
e. MDI	2.00	2.00	-
f. Blowing Agent	1.80	4.00	2.20
g. Liner (Type: HIPS with EVOH Protection)	2.00	2.20	0.20
Cost per Kg of Foam Produced	[redacted]	[redacted]	[redacted]
h. = a. x d. Polyol	0.900	0.972	0.072
i. = b. x e. MDI	1.000	1.000	-
j. = c. x f. Blowing Agent	0.280	0.504	0.224
k. = h+i+j Total Cost per Kg of Foam	2.180	2.476	0.296
Materials Used per Refrigerator	[redacted]	[redacted]	[redacted]
l. Kg of Foam per Refrigerator (avg)	7.01	7.71	0.44
m. Kg of Liner material per refrigerator (avg)	4.98	4.98	-
Cost per Refrigerator	[redacted]	[redacted]	[redacted]
n. = l. x k. for Foam	15.28	19.09	3.81
o. = m. x g. for Liner	9.96	10.96	1.00
p. = n. + o. Total per Refrigerator	25.24	30.05	4.81
q. = No. of Refrigerators (see Note 1.)	2,227		
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)	**10,712**		

(see also Note 1. below)

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

Andina Industrial S.A.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.33	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.299	0.269	
c. No. of Refrigerators Produced (see Note 1.)	2,227	2,227	
1d. Cost for Refrigerant = a x b x c	1,552	5,392	3,840
2. Compressors			
a. Cost per Compressor (see Note 2.)	32.88	35.68	
b. No. of Compressors (see Note 1.)	2,227	2,227	
2c. Cost for Compressors = a x b	73,224	79,459	6,235
3. Condensers			
a. Cost per Condenser	13.60	14.70	
b. No. of Condensers (see Note 1.)	2,227	2,227	
3c. Cost for Condensers = a x b	30,287	32,737	2,450
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.78	0.90	
b. No. of Filter/Dryers (see Note 1.)	2,227	2,227	
4c. Cost for Filter/Dryers = a x b	1,737	2,004	267
5. Capillary Tubes			
a. Cost per Capillary Tube	1.04	1.18	
b. No. of Capillary Tubes (see Note 1.)	2,227	2,227	
5c. Cost for Capillary Tubes = a x b	2,316	2,628	312
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)		13,104	

Note 1. Figures in the above tables are based on the actual production volume for the 12 month period July 1993 to June 1994 obtained from Andina Industrial 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 and compressor prices used in the above tables are weighted average (National) prices.

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.

Country of origin: PERU

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Andina Industrial S.A.

Sector/sub-sector Domestic refrigeration

Relationship to country program (UNDP, country program is 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
In domestic refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.

Andina Industrial S.A. does not have a formal technology transfer agreement. However, the company is in the process of developing 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.

Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of 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.

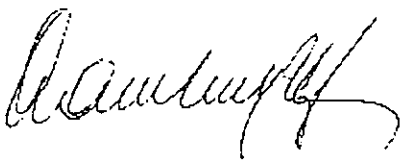
Project costs
The equipment requested by the manufacturer is essential for the conversion process. Costs of equipment, training, testing and external support are reasonable.
Operational costs are reasonable and correctly applied.
If the UAC value is calculated for the refrigerant part separately a value of 23.3 USD is obtained which is relatively high compared to other, similar, projects (of course, this is mainly due to the very small scale of the company).

Implementation timeframe Reasonable.

Relevance and adequacy of information provided Sufficient

Recommendations Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands
22-October-1994



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

TECHNICAL REVIEW

PREPARED BY: Dr Hubert Creyf
UNDP Foam Sector Project Reviewer

DATE: 21 October 1994

1.	**COUNTRY:**	Peru
2.	**PROJECT TITLE:**	**Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Andina Industrial S.A.** **Note: This review deals only with the foam blowing agent conversion.**
3.	**(SUB) SECTOR:**	Domestic Refrigeration -- Foamed Plastics
4.	**CP RELATIONSHIP:**	**Peru's CP is currently under preparation. The consultant preparing this project has met the UNEP representative involved in this exercise. The extensive background section of this project will be used in the CP which will be finalized by UNEP in the next few months.**
5.	**TECHNOLOGY:**	**The different technical possibilities to replace CFC 11 in the insulating foam of domestic refrigerators are well descibed.** **The logical choice is HCFC 141b since this cell gas presents only a small loss (±10%) in lambda value versus CFC 11. It must be remembered that the wall thickness in refrigeration is a constant feature, so that it is important to use the best insulating material in order to keep electricity costs as low as possible.**

6.	**ENVIRONMENTAL IMPACT:**	HCFC 141b presents a relatively low ODP (0.11) and an acceptable GWP. During production, the TLV (500 ppm) must be respected.
7.	**PROJECT COSTS:**	The project costs as presented are realistic and can be accepted. The cost to remove one ton of ODP is US$ 42,234.
8.	**IMPLEMENTATION:**	The 1.5 year proposed, refers to the refrigeration part. The replacement of CFC 11 by HCFC 141b can be performed in a shorter period.
9.	**RECOMMENDATION:**	Approval is recommended.

ANNEX 3 -- COLDEX

COUNTRY:	**PERU**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Coldex S.A.
SECTOR COVERED:	Domestic Refrigeration
ODS USE IN SECTOR:	161.2 tons ODS (July 93 - June 94)
PROJECT IMPACT (ODP):	67.4 ODP tons
TOTAL PROJECT COST:	US$ 748,966
INCREMENTAL CAPITAL COST:	US$ 477,000
INCREMENTAL OPERATING COST:	US$ 271,966
PROPOSED MLF GRANT:	US$ 748,966
UNIT ABATEMENT COST:	5.2 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Grupo de Trabajo para Implementacion del Programa Pais (GTIPP)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	July 1994

PROJECT SUMMARY:

Coldex S.A. is a 100% Panamian-owned company manufacturing domestic refrigerators and freezers in Peru for the Peruvian domestic market. Coldex 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. This project will eliminate the use of CFC 11 and CFC 12 by conversion to the use of HCFC 141b as the insulation foam blowing agent and HFC 134a as the refrigerant respectively. The project will eliminate 67.4 ODP tons/yr (based on July 1993 - June 1994 figures). Funds requested will be used to change the existing production lines, and for 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 and Bert Veenendaal, in collaboration with the Peru GTIPP.

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

PROJECT OF THE GOVERNMENT OF PERU

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE AND BACKGROUND.

See General Information Section.

2. ENTERPRISE BACKGROUND

Coldex S.A. is one of **TEN** enterprises presently manufacturing domestic refrigerators in Peru and they account for approximately **40%** per cent of the total local production of such products. Coldex S.A. is 100 per cent owned by an Article 5.1 Country (Panama). More details on Coldex S.A. are given below:

CFC USE IN LAST 12 MONTHS: (July 1993 - June 1994)	61.9 tons CFC 11 12.3 tons CFC 12
FULL NAME:	Coldex S.A.
PLANT LOCATION:	Av. Elmer Faucett # 3551, Callao
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Panama)
No. OF MODELS:	7
PRODUCTION IN LAST 12 MONTHS: (July 1993 - June 1994)	59,857 units
No. OF PRODUCTION LINES:	2
COMPRESSOR SUPPLIER:	SICOM, Brazil
CONTACT PERSONS:	Oscar Kaplan - President Raul Coronel Marega - Ops Manager Miguel Kuhn - Marketing Manager
TEL / FAX:	Tel: (51 14) 52 8570 (51 14) 52 0337 Fax: (51 14) 52 0342

OTHER INFORMATION:
Coldex S.A. was founded in 1964 and is mainly engaged in the production of domestic refrigerators and freezers, although they also assemble a small number of washing machines and cookers. All production is sold in the Peruvian market. The company presently

employs 368 persons, 350 of whom are engaged the refrigerator business. This project encompasses all ODS consumption used in refrigerator and freezer manufacturing operations at Coldex S.A. The existing CFC technology was developed "in house" with the assistance of compressor and refrigerant suppliers. The CFC replacement technology will be developed by the same process. Currently, Coldex S.A. has no formal technology transfer agreements with internationally recognised refrigerator manufacturers.

The following tables provide a summary of refrigerator and freezer production by Coldex S.A. during the 12 month period July 1993 to June 1994 inclusive, as well as other relevant project data.

Model No.	Capacity Cubic Feet	Description	Production Volume	CFC 12 Charge Kgs	CFC 12 Consumption Kgs
R10	10	SD Ref	7,248	0.175	1,268.4
R102P	10	DD Ref	11,768	0.175	2,059.4
R15	15	SD Ref	12,553	0.195	2,447.8
R152P	15	DD Ref	9,200	0.215	1,978.0
R2T	16	DD Ref/Frz	9,146	0.285	2,606.6
RT18	18	DD Ref NF	1,050	0.250	262.5
CH10	8	Chest Frz	8,892	0.185	1,645.0
Total or Average			59,857	0.205	12,267.7

Model No.	Compressor HP & Price US$		Liner Type & Weight per Unit Kgs		PU Foam per Unit Kgs
R10	1/8	29.53	HIPS	5.525	4.95
R102P	1/8	29.53	HIPS	5.620	4.65
R15	1/5	31.28	HIPS	7.120	5.65
R152P	1/5	31.28	HIPS	8.210	6.54
R2T	1/5	31.28	HIPS	6.150	7.36
RT18	1/3	39.71	HIPS	13.950	8.93
CH10	1/5	31.28	HIPS	1.850	6.67
Weighted Average	Average Compressor Price = 30.87 US$		Average HIPS Liner Weight = 5.96 Kgs		Average Weight of PU Foam = 5.98 Kgs

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

3. PROJECT DESCRIPTION

Coldex S.A. 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 July 1993 - June 1994, and the ODP tons that will be eliminated by this project are shown in the following table:

Enterprise	CFC 11 (tes)	ODP tons eliminated (see Note*)	CFC 12 (tes)	Total ODP tons eliminated
Coldex	61.9	55.1	12.3	67.4

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

3.1. Replacement of CFC 11 with HCFC 141b.

The relevant existing equipment at Coldex S.A. on which the technology change to HCFC 141b will impact is as follows:

- 1 x Cannon C100 RF2 low pressure foam injection machine with a capacity of 50 - 100 Kg/min. (Purchased 1991)
- 1 x Cannon C3 RF2 low pressure foam injection machine with a capacity of 2.5 - 5 Kg/min. (Purchased 1986)
- 1 x Drothon low pressure foam injection machine with a capacity of 50 - 100 Kg/min. (Purchased 1973)

3.2. Replacement of CFC 12 with HFC 134a.

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

- 2 x Danfoss Model 118 x 2017 complete charging boards
- 30 x Edwards Vacuum Pumps (20 M3/hr capacity)
- 2 x Leybold HLD 4000 R12 leak detectors
- 1 x Leybold D-Tek hand held leak detector

Note: Coldex presently has 26 vacuum pumps installed on carousel arrangements on their two refrigerator production lines (13 on each) with 4 vacuum pumps on standby duty. Four pumps will be purchased new to allow for continuous production while retrofitting is being carried out. 22 vacuum pumps will be retrofitted.

4. PROJECT COSTS

4.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAMING MACHINE (80-120 kg/min)	125,000
HIGH PRESSURE FOAMING MACHINE (60 kg/min)	110,000
ADDITIONAL MIXING HEAD	25,000
TRAINING, TEST TRIALS, TECHNOLOGY TRANSFER	13,000
CONTINGENCIES (10%)	27,000
Subtotal (US$)	**300,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (2 units)	66,000
NEW VACUUM PUMPS (4 units)	12,000
RETROFITTED VACUUM PUMPS (22 units)	11,000
LEAK DETECTION EQUIPMENT (3 units)	12,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION, & RELIABILITY TEST TRIALS (7 models)	40,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	16,000
Subtotal (US$)	**177,000**
TOTAL INCREMENTAL CAPITAL COST (US$)	**477,000**

4.2 INCREMENTAL OPERATING COSTS

The calculation of the incremental operating cost is based on a six month period using 50% of the actual production for the period July 1993 to June 1994 inclusive and ignoring growth. Paragraph 5 provides detailed explanations on how the incremental operational costs were obtained, the costs are summarized below:

PHASE-OUT OF CFC 11 for Materials (see para 5.1):	**150,538**
PHASE-OUT OF CFC 12 for Materials (see para 5.2):	**121,428**
TOTAL INCREMENTAL OPERATING COST (US$)	**271,966**

4.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational)	**748,000**
% Article 5.1 Country Ownership	**100%**
FUNDING REQUESTED FROM MLF (US$)	**748,966**

4.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	**477,000**
b. Capital Recovery Factor (10% p.a.)	**0.16275**
c. Incremental Operating Costs	**271,966**
d. ODS Reduction (ODP Kgs July 93 - June 94)	**67,400**
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	**5.18**

THE PROJECT UNIT ABATEMENT COST IS 5.18 US$/Kg

5. INCREMENTAL OPERATIONAL COST CALCULATIONS

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

Coldex S.A.	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.322	0.339	0.017
b. MDI	0.505	0.505	-
c. Kg Blowing Agent	0.173	0.156	(0.017)
Prices in US$/Kg			
d. Polyol	2.50	2.60	0.10
e. MDI	2.00	2.00	-
f. Blowing Agent	1.80	4.00	2.20
g. Liner (Type: HIPS with EVOH Protection)	2.00	2.20	0.20
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.805	0.881	0.076
i. = b. x e. MDI	1.010	1.010	-
j. = c. x f. Blowing Agent	0.311	0.624	0.313
k. = h+i+j Total Cost per Kg of Foam	2.126	2.515	0.389
Materials Used per Refrigerator			
l. Kg of Foam per Refrigerator (average)	5.98	6.58	0.60
m. Kg of Liner material per refrigerator (avg)	5.96	5.96	-
Cost per Refrigerator			
n. = l. x k. for Foam	12.71	16.55	3.84
o. = m. x g. for Liner	11.92	13.11	1.19
p. = n. + o. Total per Refrigerator	24.63	29.66	5.03
q. = No. of Refrigerators (see Note 1.)	29,928		
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)	**150,538**		

(see also Note 1. below)

5.2. Incremental Costs resulting from replacing the CFC12 Refrigerant with HFC 134a (US$)

Coldex S.A.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.33	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.205	0.185	
c. No. of Refrigerators Produced (see Note 1.)	29,928	29,928	
1d. Cost for Refrigerant = a x b x c	14,295	49,830	35,535
2. Compressors			
a. Cost per Compressor (see Note 2.)	32.88	35.68	
b. No. of Compressors (see Note 1.)	29,928	29,928	
2c. Cost for Compressors = a x b	984,033	1,067,831	83,798
3. Condensers			
a. Cost per Condenser	N/C	N/C	
b. No. of Condensers (see Note 1.)			
3c. Cost for Condensers = a x b	N/C	N/C	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.38	0.45	
b. No. of Filter/Dryers (see Note 1.)	29,928	29,928	
4c. Cost for Filter/Dryers = a x b	11,373	13,468	2,095
5. Capillary Tubes			
a. Cost per Capillary Tube	N/C	N/C	
b. No. of Capillary Tubes (see Note 1.)			
5c. Cost for Capillary Tubes = a x b	N/C	N/C	-
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)		121,428	

Note 1. Figures in the above tables are based on the actual production volume for the 12 month period July 1993 to June 1994 obtained from Coldex 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 and compressor prices used in the above tables are weighted average (National) prices.

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.

Country of origin: PERU

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Coldex S.A.

Sector/sub-sector Domestic refrigeration

Relationship to country program (UNDP, country program is 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
In domestic refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.

Coldex S.A. does not have a formal technology transfer agreement. However, the company is in the process of developing 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.

Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

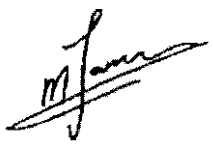
Environmental impact
HFC-134a has an ODP of zero and a GWP of 0.27. For domestic refrigeration a GWP of this magnitude is negligible.

Project costs
The equipment requested by the manufacturer is essential for the conversion process. Costs of equipment, training and testing are reasonable.
Operational costs are reasonable and correctly applied.
If the UAC value is calculated for the refrigerant part separately a value of 14.2 USD is obtained which is a reasonable number compared to other, similar, projects.

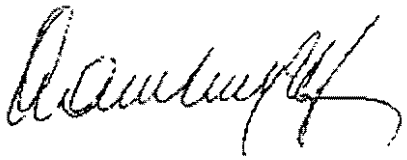
Implementation timeframe Reasonable.

Relevance and adequacy of information provided Sufficient

Recommendations Approval as proposed



Janssen M.J.P.,
Eindhoven, The Netherlands
22-October-1994



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

TECHNICAL REVIEW

PREPARED BY: Dr Hubert Creyf
UNDP Foam Sector Project Reviewer

DATE: 21 October 1994

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1. **COUNTRY:** Peru

2. **PROJECT TITLE:** Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Coldex S.A.
Note: This review deals only with the foam blowing agent conversion.

3. **(SUB) SECTOR:** Domestic Refrigeration -- Foamed Plastics

4. **CP RELATIONSHIP:** Peru's CP is currently under preparation. The consultant preparing this project has met the UNEP representative involved in this exercise. The extensive background section of this project will be used in the CP which will be finalized by UNEP in the next few months. The company is Panamanian owned, but since Panama is an article 5 country, it is eligible for funding.

5. **TECHNOLOGY:** The different technical possibilities to replace CFC 11 in the insulating foam of domestic refrigerators are well descibed.

The logical choice is HCFC 141b since this cell gas presents only a small loss (±10%) in lambda value versus CFC 11. It must be remembered that the wall thickness in refrigeration is a constant feature, so that it is important to use the best insulating material in order to keep electricity costs as low as possible.

6.	**ENVIRONMENTAL IMPACT:**	**HCFC 141b presents a relatively low ODP (0.11) and an acceptable GWP. During production, the TLV (500 ppm) must be respected.**
7.	**PROJECT COSTS:**	**The project costs as presented are realistic and can be accepted. The cost to remove one ton of ODP is US$ 10,355.**
8.	**IMPLEMENTATION:**	**The 1.5 year proposed, refers to the refrigeration part. The replacement of CFC 11 by HCFC 141b can be performed in a shorter period.**
9.	**RECOMMENDATION:**	**Approval is recommended.**

ANNEX 4 - INRESA

COUNTRY:	**PERU**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrias Reunidas S.A. (Inresa)
SECTOR COVERED:	Domestic Refrigeration
ODS USE IN SECTOR:	161.2 tons ODS (July 93 - June 94)
PROJECT IMPACT (ODP):	16.6 ODP tons
TOTAL PROJECT COST:	US$ 347,013
INCREMENTAL CAPITAL COST:	US$ 252,000
INCREMENTAL OPERATING COST:	US$ 95,013
PROPOSED MLF GRANT:	US$ 267,641 (77.13%)
UNIT ABATEMENT COST:	6.32 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Grupo de Trabajo para Implementacion del Programa Pais (GTIPP)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	July 1994

PROJECT SUMMARY:

Industrias Reunidas S.A. (Inresa) is a 77.13% Article 5.1 country-owned company manufacturing domestic refrigerators and freezers for the Peruvian market. Industrias Reunidas S.A. 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. This project will eliminate the use of CFC 11 and CFC 12 by conversion to the use of HCFC 141b as the insulation foam blowing agent and HFC 134a as the refrigerant respectively. The project will eliminate 16.6 ODP tons/yr (based on July 1993 - June 1994 figures). Funds requested will be used to change the existing production lines, and for 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 and Bert Veenendaal, in collaboration with the Peru GTIPP.
Reviewed by:	L.J.M. Kuijpers/M.J.P. Janssen (Refrigeration) and H. Creyf (Foam). Their comments are attached.

PROJECT OF THE GOVERNMENT OF PERU

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE AND BACKGROUND.

See General Information Section.

3. ENTERPRISE BACKGROUND

Industrias Reunidas S.A. (INRESA) is one of **TEN** enterprises presently manufacturing domestic refrigerators and freezers in Peru and they account for approximately **16%** of the total local production of such products. Industrias Reunidas S.A. is 77.13 per cent owned by Article 5.1 countries, the ownership shares being as follows: 56.31% Peru, 20.82% Panama, 22.87% USA.

More details on Industrias Reunidas S.A. are given below:

CFC USE IN LAST 12 MONTHS: (July 1993 - June 1994)	13.3 tons CFC 11 4.8 tons CFC 12
FULL NAME:	Industrias Reunidas S.A.
PLANT LOCATION:	Av. Argentina No. 5260 - Callao
% ARTICLE 5 COUNTRY OWNERSHIP:	77.13% (Peru & Panama)
No. OF MODELS:	5
PRODUCTION IN LAST 12 MONTHS: July 1993 - June 1994	24,050 units
No. OF PRODUCTION LINES:	2
COMPRESSOR SUPPLIERS:	EMBRACO, Brazil
CONTACT PERSONS:	Pedro de Solminhac Ruiz - Gen Mgr Jose Torres R. - Asst Production Mgr
TEL / FAX:	Tel: (51 14) 52 6553, Fax: 51 9016

OTHER INFORMATION:
Industrias Reunidas S.A. was founded in 1941 and manufactures a wide range of domestic appliances and related equipment, including domestic refrigerators. All production is sold in the Peruvian market. The company presently employs 555 persons, 126 of whom are engaged in the refrigeration part of the business. This project

encompasses all ODS consumption used in refrigerator manufacturing operations at Industrias Reunidas S.A.

The original CFC technology for refrigerator manufacture was obtained from Whirlpool-Merloni. This was subsequently developed by Industrias Reunidas to meet local market needs in respect of refrigerator design. Currently, Industrias Reunidas has no formal technology transfer agreements with internationally recognised refrigerator manufacturers.

It should be noted that the company only uses PU foam insulation in a part (13,620 out of 24,050 units) of it's refrigerator production, for the rest glass-fibre is used. This is taken into account in the incremental operational cost calculations.

The following tables provide a summary of refrigerator production by Industrias Reunidas S.A. during the 12 month period July 1993 to June 1994 inclusive, as well as other relevant project data.

Model No.	Capacity Cubic Feet	Description	Production Volume	CFC 12 Charge Kgs	CFC 12 Consumption Kgs
I-11	10	SD Ref	1,020	0.200	204.0
I-15	13	SD Ref	6,440	0.200	1,288.0
I-15DL	13	DD Ref	6,160	0.200	1,232.0
L-350	12	SD Ref	5,534	0.200	1,106.8
Dual Matic	14	DD Ref	4,896	0.200	979.2
Total or Average			24,050	0.200	4,810.0

Model No.	Compressor HP & Price US$	Liner Type & Weight per Unit Kgs	PU Foam per Unit Kgs
I-11	1/6 32.12	HIPS 4.39	4.40
I-15	1/6 32.12	HIPS 5.69	5.72
I-15DL	1/6 32.12	HIPS 5.69	5.61
L-350	1/6 32.12	Metal	Glass Fibre
Dual Matic	1/5 35.49	Metal	Glass Fibre
Weighted Average	Average Compressor Price = 32.81 US$	Average HIPS Liner Weight = 5.593 Kgs	Average Weight of PU Foam = 5.571 Kgs

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

3. PROJECT DESCRIPTION

Industrias Reunidas 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 July 1993 - June 1994, and the ODP tons that will be eliminated by this project are shown in the following table:

Enterprise	CFC 11 (tes)	ODP tons eliminated (see Note*)	CFC 12 (tes)	Total ODP tons eliminated
Reunidas	13.3	11.8	4.8	16.6

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

3.1. Replacement of CFC 11 with HCFC 141b.

The relevant existing equipment at Industrias Reunidas S.A. on which the technology change to HCFC 141b will impact is as follows:

- 1 x Cannon C60 Rf2 low pressure Foam Injection Machine with a throughput of 20-60 Kg/min. (Purchased in 1986)

3.2. Replacement of CFC 12 with HFC 134a.

The relevant existing equipment at Industrias Reunidas S.A. on which the technology change to HFC 134a will impact is as follows:

- 1 x A'Gramkow Multimax Automatic R12 charging machine
- 1 x A'Gramkow S/N Semi-automatic R12 charging station
- 6 x Stokes Model 149H-10 Vacuum Pumps, nominal 10 M3/hr capacity
- 1 x Ferret H-25 R12 Eelectronic leak detector

Note:
Most of the vacuum pumps in service will be retrofitted as is done in several similar projects approved by the executive committee in the past. From the 6 vacuum pumps requested, two will be purchased new to allow for continuous production while retrofitting is being carried out. Four vacuum pumps will be retrofitted.

4. PROJECT COSTS

4.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAMING MACHINE	100,000
TRAINING, TEST TRIALS, TECHNOLOGY TRANSFER	10,000
CONTINGENCIES (10%)	11,000
Subtotal	**121,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (2 units)	50,000
NEW VACUUM PUMPS (2 units)	6,000
RETROFITTING VACUUM PUMPS (4 units)	2,000
LEAK DETECTION EQUIPMENT (1 off)	6,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION, & RELIABILITY TEST TRIALS (5 models)	35,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	12,000
Subtotal (US$)	**131,000**

TOTAL INCREMENTAL CAPITAL COST (US$)	**252,000**

4.2 INCREMENTAL OPERATING COSTS

The calculation of the incremental operating cost is based on a six month period using 50% of the actual production for the period July 1993 to June 1994 inclusive and ignoring growth. Paragraph 5 provides detailed explanations on how the incremental operational costs were obtained, the costs are summarized below:

PHASE-OUT OF CFC 11 for Materials (see para 5.1):	**32,075**
PHASE-OUT OF CFC 12 for Materials (see para 5.2):	**62,938**
TOTAL INCREMENTAL OPERATING COST (US$)	**95,013**

4.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational)	**347,013**
% Article 5.1 Country Ownership	**77.13%**
FUNDING REQUESTED FROM MLF (US$)	**267,641**

4.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs (77.13%)	**194,368**
b. Capital Recovery Factor (10% p.a.)	**0.16275**
c. Incremental Operating Costs (77.13%)	**73,284**
d. ODS Reduction (ODP Kgs July 93 - June 94)	**16,600**
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	**6.32**

THE PROJECT UNIT ABATEMENT COST IS 6.32 US$/Kg

5. INCREMENTAL OPERATIONAL COST CALCULATIONS

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

Industrias Reunidas S.A. (Inresa)	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced	[redacted]	[redacted]	[redacted]
a. Kg Polyol	0.325	0.342	0.017
b. MDI	0.500	0.500	-
c. Kg Blowing Agent	0.175	0.158	(0.017)
Prices in US$/Kg	[redacted]	[redacted]	[redacted]
d. Polyol	2.50	2.60	0.10
e. MDI	2.00	2.00	-
f. Blowing Agent	1.80	4.00	2.20
g. Liner (Type: HIPS with EVOH Protection)	2.00	2.20	0.20
Cost per Kg of Foam Produced	[redacted]	[redacted]	[redacted]
h. = a. x d. Polyol	0.813	0.889	0.076
i. = b. x e. MDI	1.000	1.000	-
j. = c. x f. Blowing Agent	0.315	0.632	0.317
k. = h+i+j Total Cost per Kg of Foam	2.128	2.521	0.393
Materials Used per Refrigerator	[redacted]	[redacted]	[redacted]
l. Kg of Foam per Refrigerator (average)	5.571	6.128	0.557
m. Kg of Liner material per refrigerator (avg)	5.593	5.593	-
Cost per Refrigerator	[redacted]	[redacted]	[redacted]
n. = l. x k. for Foam	11.86	15.45	3.59
o. = m. x g. for Liner	11.19	12.31	1.12
p. = n. + o. Total per Refrigerator	23.05	27.76	4.71
q. = No. of Refrigerators (see Note 4.)		6,810	
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)		32,075	

(see also Notes 1. and 4. below)

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

Industrias Reunidas S.A. (Inresa)	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.33	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.20	0.18	
c. No. of Refrigerators Produced (see Note 1.)	12,025	12,025	
1d. Cost for Refrigerant = a x b x c	5,604	19,480	13,876
2. Compressors			
a. Cost per Compressor (see Note 2.)	32.88	35.68	
b. No. of Compressors (see Note 1.)	12,025	12,025	
2c. Cost for Compressors = a x b	395,382	429,052	33,670
3. Condensers			
a. Cost per Condenser	5.83	6.90	
b. No. of Condensers (see Note 1.)	12,025	12,025	
3c. Cost for Condensers = a x b	70,106	82,973	12,867
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.36	0.45	
b. No. of Filter/Dryers (see Note 1.)	12,025	12,025	
4c. Cost for Filter/Dryers = a x b	4,329	5,411	1,082
5. Capillary Tubes			
a. Cost per Capillary Tube	0.79	0.91	
b. No. of Capillary Tubes (see Note 1.)	12,025	12,025	
5c. Cost for Capillary Tubes = a x b	9,500	10,943	1,443
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)		62,938	

Note 1. Figures in the above tables are based on the actual production volume for the 12 month period July 1993 to June 1994 obtained from Industrias Reunidas 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 and compressor prices used in the above tables are weighted average (National) prices.

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.

Note 4. The calculation of incremental operational costs for the CFC 11

replacement takes account of the fact that only a part (57%) of Industrias Reunidas' production of refrigerators and freezers uses PU foam for insulation and HIPS for the refrigerator liner.

Country of origin: PERU

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrias Reunidas S.A. (Inresa)

Sector/sub-sector Domestic refrigeration

Relationship to country program (UNDP, country program is 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
In domestic refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.

Industrias Reunidas S.A. does not have a formal technology transfer agreement. However, the company is in the process of developing 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.

Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

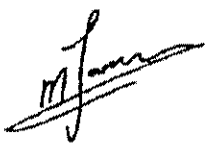
Environmental impact
HFC-134a has an ODP of zero and a GWP of 0.27. For domestic refrigeration a GWP of this magnitude is negligible.

Project costs
The equipment requested by the manufacturer is essential for the conversion process. Costs of equipment, training and testing are reasonable.
Operational costs are reasonable and correctly applied.
If the UAC value is calculated for the refrigerant part separately a value of 14.0 USD is obtained which is a reasonable number compared to other, similar, projects.
The foreign ownership of the company is correctly taken into account.

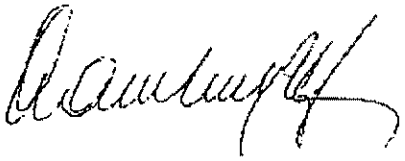
Implementation timeframe Reasonable.

Relevance and adequacy of information provided Sufficient

Recommendations Approval as proposed



Janssen M.J.P.,
Eindhoven, The Netherlands
22-October-1994



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

TECHNICAL REVIEW

PREPARED BY: Dr Hubert Creyf
UNDP Foam Sector Project Reviewer

DATE: 21 October 1994

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1. **COUNTRY:** Peru

2. **PROJECT TITLE:** Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrias Reunidas S.A. (Inresa)
   Note: This review deals only with the foam blowing agent conversion.

3. **(SUB) SECTOR:** Domestic Refrigeration -- Foamed Plastics

4. **CP RELATIONSHIP:** Peru's CP is currently under preparation. The consultant preparing this project has met the UNEP representative involved in this exercise. The extensive background section of this project will be used in the CP which will be finalized by UNEP in the next few months.

5. **TECHNOLOGY:** The different technical possibilities to replace CFC 11 in the insulating foam of domestic refrigerators are well descibed.

   The logical choice is HCFC 141b since this cell gas presents only a small loss (±10%) in lambda value versus CFC 11. It must be remembered that the wall thickness in refrigeration is a constant feature, so that it is important to use the best insulating material in order to keep electricity costs as low as possible.

6.	**ENVIRONMENTAL IMPACT:**	HCFC 141b presents a relatively low ODP (0.11) and an acceptable GWP. During production, the TLV (500 ppm) must be respected.
7.	**PROJECT COSTS:**	The project costs as presented are realistic and can be accepted. The cost to remove one ton of ODP is US$ 11,901.
8.	**IMPLEMENTATION:**	The 1.5 year proposed, refers to the refrigeration part. The replacement of CFC 11 by HCFC 141b can be performed in a shorter period.
9.	**RECOMMENDATION:**	Approval is recommended.

ANNEX 5 : LENCHE

COUNTRY:	**PERU**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrias Lenche S.A. (Inlensa)
SECTOR COVERED:	Domestic Refrigeration
ODS USE IN SECTOR:	161.2 tons ODS (July 93 - June 94)
PROJECT IMPACT (ODP):	5.7 ODP tons
TOTAL PROJECT COST:	US$ 201,443
INCREMENTAL CAPITAL COST:	US$ 168,000
INCREMENTAL OPERATING COST:	US$ 33,443
PROPOSED MLF GRANT:	US$ 201,443
UNIT ABATEMENT COST:	10.66 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Grupo de Trabajo para Implementacion del Pograma Pais (GTIPP)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	July 1994

PROJECT SUMMARY:

Industrias Lenche S.A. is a 100% Peruvian-owned company manufacturing domestic refrigerators and freezers for the Peruvian domestic market. Industrias Lenche S.A. 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. This project will eliminate the use of CFC 11 and CFC 12 by conversion to the use of HCFC 141b as the insulation foam blowing agent and HFC 134a as the refrigerant respectively. The project will eliminate 5.7 ODP tons/yr (based on 12 months, July 1993 - June 1994 figures). Funds requested will be used to change the existing production lines, and for 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 and Bert Veenendaal, in collaboration with the Peru GTIPP.

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

PROJECT OF THE GOVERNMENT OF PERU

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE AND BACKGROUND.

See General Information Section.

2. ENTERPRISE BACKGROUND

Industrias Lenche S.A. is one of TEN enterprises presently manufacturing domestic refrigerators in Peru and they account for approximately 6% of the total local production of such products. Industrias Lenche S.A. is 100 per cent owned by an Article 5.1 Country (Peru).

More details on Industrias Lenche S.A. are given below:

CFC USE IN LAST 12 MONTHS: (July 1993 - June 1994)	3.4 tons CFC 11 2.7 tons CFC 12
FULL NAME:	Industrias Lenche S.A.
PLANT LOCATION:	Av. Argentina 1051, Lima
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Peru)
No. OF MODELS:	10
PRODUCTION IN LAST 12 MONTHS: (July 1993 - June 1994)	8,700 units
No. OF PRODUCTION LINES:	1
COMPRESSOR SUPPLIER:	EMBRACO, Brazil
CONTACT PERSONS:	Humberto Lenche - General Manager
TEL / FAX:	Tel: (51 14) 31 5911 Fax: (51 14) 32 4976

OTHER INFORMATION:
Industrias Lenche S.A. was founded in 1982 and is solely engaged in the production of domestic refrigerators and freezers for sale in the Peruvian market. The company presently employs 150 persons. This project encompasses all ODS consumption used in refrigerator and freezer manufacturing operations at Industrias Lenche S.A.

The original CFC technology was developed "in-house" with the assistance of compressor and refrigerant equipment suppliers. The

CFC replacement technology will be developed by the same process. Currently, Lenche has no formal technology transfer agreements with internationally recognised refrigerator manufacturers.

It should be noted that the company only uses PU foam for insulation in their range of domestic freezers. For insulation of the domestic refrigerators, Industrias Lenche uses glass-fibre. The 8,700 units produced in the 12 months July 1993-June 1994 consisted of 4,595 freezers (53%) and 4,105 refrigerators (47%). This is taken into account in the incremental operational cost calculations.

The following tables provide a summary of refrigerator and freezer production by Industrias Lenche S.A. during the 12 month period July 1993 to June 1994 inclusive, as well as other project data.

Model No.	Capacity Cubic Feet & Litres	Description	Production Volume	CFC 12 Charge Kgs	CFC 12 Consumption Kgs
RD 10	10 cu ft	Ref	950	0.170	161.5
RD 11	11 cu ft	Ref	360	0.180	64.8
RD 12	12 cu ft	Ref	1,820	0.180	327.6
RD 14	14 cu ft	Ref	325	0.260	84.5
RD 15	15 cu ft	Ref	325	0.280	91.0
CV 11	11 cu ft	Ref	325	0.340	110.5
CPA 230	230 litres	Chest Frz	325	0.320	104.0
CPA 330	330 litres	Chest Frz	2,450	0.390	955.5
CPA 340	340 litres	Chest Frz	1,460	0.430	627.8
CPA 450	450 litres	Chest Frz	360	0.490	176.4
Total or Average			8,700	0.311	2,703.6

Model No.	Compressor HP & Price US$	Liner Type & Weight per Unit Kgs	PU Foam per Unit Kgs
RD 10	1/6 33.63	Metal Liner	N/A
RD 11	1/6 33.63	::	N/A
RD 12	1/6 33.63	::	N/A
RD 14	1/5 37.46	::	N/A
RD 15	1/5 37.46	::	N/A
CV 11	1/5 37.46	::	N/A
CPA 230	1/4 38.15	::	4.0
CPA 330	1/4 38.15	::	5.5
CPA 340	1/4 38.15	::	5.7
CPA 450	1/3 42.39	::	8.0
Weighted Average	Average Compressor Price = 36.62 US$	-	Average Weight of PU Foam = 5.65 Kgs

Key: SD = Single Door DD = Double Door
Ref = Refrigerator Frz = Freezer

3. PROJECT DESCRIPTION

Industrias Lenche 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 July 1993 - June 1994, and the ODP tons that will be eliminated by this project are shown in the following table:

Enterprise	CFC 11 (tes)	ODP tons eliminated (see Note*)	CFC 12 (tes)	Total ODP tons eliminated
Ind. Lenche	3.4	3.0	2.7	5.7

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

3.1. Replacement of CFC 11 with HCFC 141b.

The relevant existing equipment at Industrias Lenche S.A. on which the technology change to HCFC 141b will impact is as follows:

- 1 x very basic, locally manufactured, low pressure foam injection machine with a throughput of approximately 12 Kg/min. Operation is by overpressure and in absence of metering pumps throughput adjustment is manual.

3.2. Replacement of CFC 12 with HFC 134a.

The relevant existing equipment at Industrias Lenche S.A. on which the technology change to HFC 134a will impact is as follows:

- 1 x automatic R12 charging machine (local Danfoss copy)
- 12 x Edwards dual-stage high vacuum pumps, 20 M3/hr capacity
- 1 x Leybold Heraeus Leak-Seeker 1351 R12 leak detector

Note:
Only 4 of the vacuum pumps are installed for use, the remainder are on stand-by duty. Whilst the vacuum pumps are of variable vintage and condition and pump changeover is frequent, the total vacuum pump capacity is significantly in excess of what is required for the enterprises production volume. The project includes for both the provision of 2 new vacuum pumps, and the retrofit of the 2 most recently acquired pumps, which will be more than adequate for current production/production capacity levels.

4. PROJECT COSTS

4.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

Note: The Multilateral Fund advised that in view of the very small volume of foam consumed at Lenche, no full size high pressure machine could be provided for the project. Instead, it is proposed to install a small pressurized foam dispenser system. Although this system is normally used for packaging foam, it is a good solution for small scale companies. Funds were included for the necessary technology transfer and testing of this methodology.

However, in case the company still prefers to purchase a full fledged high-pressure foaming machine (price around US$ 120,000), it can apply the approved level of US$ 65,000 to this purchase, and pay the remaining balance themselves.

HIGH PRESSURE FOAMING MACHINE (including dry wet testing, spare parts etc)	15,000
TESTS ON PHYSICAL PROPERTIES OF THE FOAM (including insulation values at Inlensa before and after conversion as well as comparison tests at a company that uses conventional dispenser equipment)	15,000
TRAINING, TRIALS	10,000
TECHNOLOGY TRANSFER	20,000
CONTINGENCIES (10%)	6,000
Subtotal	**66,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (1 off)	25,000
VACUUM PUMPS (2 new + 2 retrofit)	7,000
LEAK DETECTION EQUIPMENT (1 off)	5,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION, & RELIABILITY TEST TRIALS (5 models)	35,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	10,000
Subtotal (US$)	**102,000**

TOTAL INCREMENTAL CAPITAL COST (US$)	**168,000**

4.2 INCREMENTAL OPERATING COSTS

The calculation of the incremental operating cost is based on a six month period using 50% of the actual production for the period July 1993 to June 1994 inclusive and ignoring growth. Paragraph 5 provides detailed explanations on how the incremental operational costs were obtained, the costs are summarized below:

PHASE-OUT OF CFC 11 for Materials (see Para 5.1):	**7,188**
PHASE-OUT OF CFC 12 for Materials (see Para 5.2):	**26,255**
TOTAL INCREMENTAL OPERATING COST (US$)	**33,443**

4.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational)	**201,443**
% Article 5.1 Country Ownership	**100%**
FUNDING REQUESTED FROM MLF (US$)	**201,443**

4.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	**168,000**
b. Capital Recovery Factor (10% p.a.)	**0.16275**
c. Incremental Operating Costs	**33,443**
d. ODS Reduction (ODP Kgs July 93 - June 94)	**5,700**
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	**10.66**

THE PROJECT UNIT ABATEMENT COST IS 10.66 US$/Kg

5. INCREMENTAL OPERATIONAL COST CALCULATIONS

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

Industrias Lenche S.A. (Inlensa)	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.370	0.383	0.013
b. MDI	0.500	0.500	-
c. Kg Blowing Agent	0.130	0.117	(0.013)
Prices in US$/Kg			
d. Polyol	2.50	2.60	0.10
e. MDI	2.00	2.00	-
f. Blowing Agent	1.80	4.00	2.20
g. Liner (Type: Metal)	N/A	N/A	N/A
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.925	0.996	0.71
i. = b. x e. MDI	1.000	1.000	-
j. = c. x f. Blowing Agent	0.234	0.468	0.234
k. = h+i+j Total Cost per Kg of Foam	2.159	2.464	0.305
Materials Used per Freezer			
l. Kg of Foam per Freezer (average)	5.65	6.22	0.57
m. Kg of Liner material per Freezer (average)	N/A	N/A	N/A
Cost per Freezer			
n. = l. x k. for Foam	12.198	15.326	3.128
o. = m. x g. for Liner	-	-	-
p. = n. + o. Total per Freezer	12.198	15.326	3.128
q. = No. of Freezers (see Note 4.)	2,298		
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)	7,188		

(see also Notes 1. and 4. below)

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

Industrias Lenche S.A. (Inlensa)	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.33	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.311	0.280	
c. No. of Refrigerators Produced (see Note 1.)	4,350	4,350	
1d. Cost for Refrigerant = a x b x c	3,152	10,962	7,810
2. Compressors			
a. Cost per Compressor (see Note 2.)	32.88	35.68	
b. No. of Compressors (see Note 1.)	4,350	4,350	
2c. Cost for Compressors = a x b	143,028	155,208	12,180
3. Condensers			
a. Cost per Condenser	15.00	16.20	
b. No. of Condensers (see Note 1.)	4,350	4,350	
3c. Cost for Condensers = a x b	65,250	70,470	5,220
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.45	0.56	
b. No. of Filter/Dryers (see Note 1.)	4,350	4,350	
4c. Cost for Filter/Dryers = a x b	1,957	2,436	479
5. Capillary Tubes			
a. Cost per Capillary Tube	0.88	1.01	
b. No. of Capillary Tubes (see Note 1.)	4,350	4,350	
5c. Cost for Capillary Tubes = a x b	3,828	4,394	566
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)		26,255	

Note 1. Figures in the above tables are based on the actual production volume for the 12 month period July 1993 to June 1994 obtained from Industrias Lenche 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 and compressor prices used in the above tables are weighted average (National) prices.

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.

Note 4. The calculation of incremental operational costs for the CFC 11 replacement takes account of the fact that only a part (53%) of Industrias Lenche's production of refrigerators and freezers uses PU foam for insulation. All the refrigerators and freezers have metal liners.

Country of origin: PERU

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrias Lenche S.A. (Inlensa)

Sector/sub-sector Domestic refrigeration

Relationship to country program (UNDP, country program is 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
In domestic refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.

Industrias Lenche S.A. does not have a formal technology transfer agreement. However, the company is in the process of developing 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.

Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of 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.

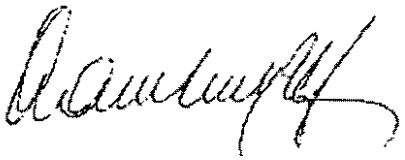
Project costs
The equipment requested by the manufacturer is essential for the conversion process. Costs of equipment, training, testing and external support are reasonable.
Operational costs are reasonable and correctly applied.
If the UAC value is calculated for the refrigerant part separately a value of 16.7 USD is obtained which is a reasonable number compared to other, similar, projects.

Implementation timeframe Reasonable.

Relevance and adequacy of information provided Sufficient

Recommendations Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands
22-October-1994



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

TECHNICAL REVIEW

PREPARED BY: Dr Hubert Creyf
UNDP Foam Sector Project Reviewer

DATE: 21 October 1994

1.	**COUNTRY:**	Peru
2.	**PROJECT TITLE:**	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrias Lenche S.A. (Inlensa) Note: This review deals only with the foam blowing agent conversion.
3.	**(SUB) SECTOR:**	Domestic Refrigeration -- Foamed Plastics
4.	**CP RELATIONSHIP:**	Peru's CP is currently under preparation. The consultant preparing this project has met the UNEP representative involved in this exercise. The extensive background section of this project will be used in the CP which will be finalized by UNEP in the next few months.
5.	**TECHNOLOGY:**	The different technical possibilities to replace CFC 11 in the insulating foam of domestic refrigerators are well descibed. The logical choice is HCFC 141b since this cell gas presents only a small loss (±10%) in lambda value versus CFC 11. It must be remembered that the wall thickness in refrigeration is a constant feature, so that it is important to use the best insulating material in order to keep electricity costs as low as possible.

6.	**ENVIRONMENTAL IMPACT:**	**HCFC 141b presents a relatively low ODP (0.11) and an acceptable GWP. During production, the TLV (500 ppm) must be respected.**
7.	**PROJECT COSTS:**	**The project costs as presented are realistic and can be accepted. The cost to remove one ton of ODP is US$ 51,396. The high cost can be explained in view of the fact that Lenche is a smaller ODP consumer than the other Peruvian companies considered.**
8.	**IMPLEMENTATION:**	**The 1.5 year proposed, refers to the refrigeration part. The replacement of CFC 11 by HCFC 141b can be performed in a shorter period.**
9.	**RECOMMENDATION:**	**Approval is recommended.**

OTHER INFORMATION:

Industrial Selva S.A. was founded in 1984 and is solely engaged in the production of domestic refrigerators and freezers. All production is sold in the Peruvian market. The company presently employs 340 persons. This project encompasses all ODS consumption used in refrigerator and freezer manufacturing operations at Industrial Selva S.A.

The existing CFC technology was developed "in-house" with the assistance of compressor and refrigerant suppliers. The CFC replacement technology will be developed by the same process. Currently, Industrial Selva S.A. has no formal technolgy transfer agreements with internationally recognised refrigerator manufacturers.

The following tables provide a summary of refrigerator and freezer production by Industrial Selva S.A. during the 12 month period July 1993 to June 1994 inclusive, as well as other relevant project data.

Model No.	Capacity Cubic Feet	Description	Production Volume	CFC 12 Charge Kgs	CFC 12 Consumption Kgs
KR 15	15 cu ft	DD Ref	15,000	0.190	2,850
KR 12	12 cu ft	DD Ref	8,000	0.180	1,440
EC 200	7 cu ft	Chest Frz	4,000	0.210	840
EC 280	10 cu ft	Chest Frz	9,000	0.230	2,070
Total or Average			36,000	0.200	7,200

Model No.	Compressor HP & Price US$		Liner Type & Weight per Unit Kgs		PU Foam per Unit Kgs
KR 15	1/5	36.00	HIPS	7.90	6.30
KR 12	1/6	33.00	HIPS	5.90	5.00
EC 200	1/6	33.00	HIPS	1.30	6.00
EC 280	1/5	36.00	HIPS	1.80	8.00
Weighted Average	Average Compressor Price = 35.00 US$		Average HIPS Liner Weight = 5.20 Kgs		Average Weight of PU Foam = 6.40 Kgs

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

3. PROJECT DESCRIPTION

Industrial Selva 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 July 1993 - June 1994, and the ODP tons that will be eliminated by this project are shown in the following table:

Enterprise	CFC 11 (tes)	ODP tons eliminated (see Note*)	CFC 12 (tes)	Total ODP tons eliminated
Ind. Selva	31.1	27.7	7.2	34.9

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

3.1. Replacement of CFC 11 with HCFC 141b.

The relevant existing equipment at Industrial Selva S.A. on which the technology change to HCFC 141b will impact is as follows:

- 1 x Admiral low pressure foam injection machine for the refrigerator bodies
- 1 x Valentini low pressure foam injection machine for the refrigerator doors

3.2. Replacement of CFC 12 with HFC 134a.

The relevant existing equipment at Industrial Selva S.A. on which the technology change to HFC 134a will impact is as follows:

- 1 x Danfoss Automatic R12 charging station
- 10 x Robinair (model 15402) Vacuum Pumps, nominal 5 M3/hr capacity
- 2 x Danfoss Vacuum Pumps, nominal 8 M3/hr capacity
- 3 x Leybold hand-held R12 leak detectors

Note:
One of the 2 Danfoss vacuum pumps and 2 of the Robinair vacuum pumps are in stand-by duty. From the nine vacuum pumps in service, seven will be retrofitted as is done in several similar projects approved by the executive committee in the past. Two will be purchased new to allow for continuous production while retrofitting is being carried out.

ANNEX 6: SELVA

COUNTRY:	**PERU**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrial Selva S.A. (Indusel)
SECTOR COVERED:	Domestic Refrigeration
ODS USE IN SECTOR:	161.2 tons ODS (July 93 - June 94)
PROJECT IMPACT (ODP):	34.9 ODP tons
TOTAL PROJECT COST:	US$ 412,098
INCREMENTAL CAPITAL COST:	US$ 253,500
INCREMENTAL OPERATING COST:	US$ 158,598
PROPOSED MLF GRANT:	US$ 412,098
UNIT ABATEMENT COST:	5.72 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Grupo de Trabajo para Implementacion del Programa Pais (GTIPP)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	July 1994

PROJECT SUMMARY:

Industrial Selva S.A. is a 100% Peruvian-owned company manufacturing domestic refrigerators and freezers for the local market. Industrial Selva S.A. 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. This project will eliminate the use of CFC 11 and CFC 12 by conversion to the use of HCFC 141b as the insulation foam blowing agent and HFC 134a as the refrigerant respectively. The project will eliminate 34.9 ODP tons/yr (based on July 1993 - June 1994 figures). Funds requested will be used to change the existing production lines, and for 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 and Bert Veenendaal, in collaboration with the Peru GTIPP.

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

PROJECT OF THE GOVERNMENT OF PERU

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE AND BACKGROUND.

See General Information Section.

2. ENTERPRISE BACKGROUND

Industrial Selva S.A. is one of **TEN** enterprises presently manufacturing domestic refrigerators and freezers in Peru and they account for approximately **24%** of the total local production of such products. Industrial Selva S.A. is 100 per cent Peruvian-owned.

More details on Industrial Selva S.A. are given below:

CFC USE IN LAST 12 MONTHS: (July 1993 - June 1994)	31.1 tons CFC 11 7.2 tons CFC 12
FULL NAME:	Industrial Selva S.A.
PLANT LOCATION:	Factory: Carretera Federico Basadre Km 8.2 Pucalpa. Office: Calle 4 #150 ATE - Lima
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Peru)
No. OF MODELS:	4
PRODUCTION IN LAST 12 MONTHS: July 1993 - June 1994	36,000 units
No. OF PRODUCTION LINES:	1
COMPRESSOR SUPPLIERS:	EMBRACO, Brazil
CONTACT PERSONS:	Santiago Planas - Executive Director Carlos Torres Llosa - Director Gino Rostagno - Development Manager
TEL / FAX:Tel:	Tel: (51 64) 57 1927 (Pucalpa) Tel: (51 14) 37 3300 (Lima) Fax: (51 64) 57 1927 (Pucalpa) Fax: (51 14) 37 4389 (Lima)

4. PROJECT COSTS

4.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAMING MACHINE (60 to 80 kg/min)	115,000
1 ADDITIONAL MIXING HEAD	20,000
TRAINING, TEST TRIALS, TECHNOLOGY TRANSFER	10,000
CONTINGENCIES (10%)	15,000
Subtotal	**160,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (1 unit)	25,000
NEW VACUUM PUMPS (2 units)	6,000
RETROFITTED VACUUM PUMPS (7 units)	3,500
LEAK DETECTION EQUIPMENT (3 units)	2,400
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION, & RELIABILITY TEST TRIALS (4 models)	28,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	8,600
Subtotal (US$)	**93,500**
TOTAL INCREMENTAL CAPITAL COST (US$)	**253,500**

4.2 INCREMENTAL OPERATING COSTS

The calculation of the incremental operating cost is based on a six month period using 50% of the actual production for the period July 1993 to June 1994 inclusive and ignoring growth. 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 Para 5.1):	**83,466**
PHASE-OUT OF CFC 12	
Costs for Materials (see Para 5.2):	**75,132**
TOTAL INCREMENTAL OPERATING COST (US$)	**158,598**

4.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational)	**412,098**
% Article 5.1 Country Ownership	**100%**
FUNDING REQUESTED FROM MLF (US$)	**412,098**

6.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	**253,500**
b. Capital Recovery Factor (10% p.a.)	**0.16275**
c. Incremental Operating Costs	**158,598**
d. ODS Reduction (ODP Kgs July 93 - June 94)	**34,900**
e. Unit Abatement Cost (US$/Kg) [(a x b) + d] /e	**5.72**

THE PROJECT UNIT ABATEMENT COST IS 5.72 US$/Kg

5. INCREMENTAL OPERATIONAL COST CALCULATIONS

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

Industrial Selva S.A. (Indusel)	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced	[redacted]	[redacted]	[redacted]
a. Kg Polyol	0.363	0.376	0.013
b. MDI	0.502	0.502	-
c. Kg Blowing Agent	0.135	0.122	(0.013)
Prices in US$/Kg	[redacted]	[redacted]	[redacted]
d. Polyol	2.50	2.60	0.10
e. MDI	2.00	2.00	-
f. Blowing Agent	1.80	4.00	2.20
g. Liner (Type: HIPS with EVOH Protection)	2.00	2.20	0.20
Cost per Kg of Foam Produced	[redacted]	[redacted]	[redacted]
h. = a. x d. Polyol	0.908	0.978	0.070
i. = b. x e. MDI	1.004	1.004	-
j. = c. x f. Blowing Agent	0.243	0.488	0.245
k. = h+i+j Total Cost per Kg of Foam	2.155	2.470	0.315
Materials Used per Refrigerator	[redacted]	[redacted]	[redacted]
l. Kg of Foam per Refrigerator (average)	6.40	7.04	0.64
m. Kg of Liner material per refrigerator (avg)	5.20	5.20	-
Cost per Refrigerator	[redacted]	[redacted]	[redacted]
n. = l. x k. for Foam	13.792	17.389	3.597
o. = m. x g. for Liner	10.400	11.440	1.040
p. = n. + o. Total per Refrigerator	24.192	28.829	4.637
q. = No. of Refrigerators (see Note 1.)		18,000	
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)		83,466	

(see also Note 1. below)

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

Industrial Selva S.A. (Indusel)	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.33	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.200	0.180	
c. No. of Refrigerators Produced (see Note 1.)	18,000	18,000	
1d. Cost for Refrigerant = a x b x c	8,388	29,160	20,772
2. Compressors			
a. Cost per Compressor (see Note 2.)	32.88	35.68	
b. No. of Compressors (see Note 1.)	18,000	18,000	
2c. Cost for Compressors = a x b	591,840	642,240	50,400
3. Condensers			
a. Cost per Condenser	N/C	N/C	
b. No. of Condensers (see Note 1.)			
3c. Cost for Condensers = a x b	N/C	N/C	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.60	0.70	
b. No. of Filter/Dryers (see Note 1.)	18,000	18,000	
4c. Cost for Filter/Dryers = a x b	10,800	12,600	1,800
5. Capillary Tubes			
a. Cost per Capillary Tube	0.80	0.92	
b. No. of Capillary Tubes (see Note 1.)	18,000	18,000	
5c. Cost for Capillary Tubes = a x b	14,400	16,560	2,160
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)		**75,132**	

Note 1. Figures in the above tables are based on the actual production volume for the 12 month period July 1993 to June 1994 obtained from Industrial Selva 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 and compressor prices used in the above tables are weighted average (National) prices.

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.

Country of origin: PERU

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrial Selva S.A.

Sector/sub-sector Domestic refrigeration

Relationship to country program (UNDP, country program is 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
In domestic refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.

Industrial Selva S.A. does not have a formal technology transfer agreement. However, the company is in the process of developing 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.

Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of 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.

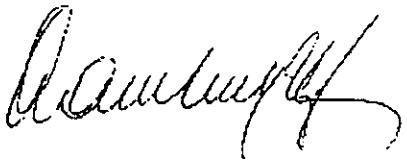
Project costs
The equipment requested by the manufacturer is essential for the conversion process. Costs of equipment, training, testing and external support are reasonable.
Operational costs are reasonable and correctly applied.
If the UAC value is calculated for the refrigerant part separately a value of 13.8 USD is obtained which is a reasonable number compared to other, similar, projects.

Implementation timeframe Reasonable.

Relevance and adequacy of information provided Sufficient

Recommendations Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands
22-October-1994



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

TECHNICAL REVIEW

PREPARED BY: Dr Hubert Creyf
UNDP Foam Sector Project Reviewer

DATE: 21 October 1994

1.	**COUNTRY:**	Peru
2.	**PROJECT TITLE:**	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Industrial Selva S.A. (Indusel) Note: This review deals only with the foam blowing agent conversion.
3.	**(SUB) SECTOR:**	Domestic Refrigeration -- Foamed Plastics
4.	**CP RELATIONSHIP:**	Peru's CP is currently under preparation. The consultant preparing this project has met the UNEP representative involved in this exercise. The extensive background section of this project will be used in the CP which will be finalized by UNEP in the next few months.
5.	**TECHNOLOGY:**	The different technical possibilities to replace CFC 11 in the insulating foam of domestic refrigerators are well descibed. The logical choice is HCFC 141b since this cell gas presents only a small loss (±10%) in lambda value versus CFC 11. It must be remembered that the wall thickness in refrigeration is a constant feature, so that it is important to use the best insulating material in order to keep electricity costs as low as possible.

6.	**ENVIRONMENTAL IMPACT:**	**HCFC 141b presents a relatively low ODP (0.11) and an acceptable GWP. During production, the TLV (500 ppm) must be respected.**
7.	**PROJECT COSTS:**	**The project costs as presented are realistic and can be accepted. The cost to remove one ton of ODP is US$ 13,122.**
8.	**IMPLEMENTATION:**	**The 1.5 year proposed, refers to the refrigeration part. The replacement of CFC 11 by HCFC 141b can be performed in a shorter period.**
9.	**RECOMMENDATION:**	**Approval is recommended.**