EP

United Nations
Environment
Programme

Distr.
LIMITED

UNEP/OzL.Pro/ExCom/13/28
26 June 1994

ORIGINAL: ENGLISH

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

Thirteenth Meeting
Montreal, 25-27 July 1994

PROJECT PROPOSALS: COLOMBIA

This document includes the following project proposals and the Fund Secretariat's Comments and Recommendations:

- Elimination of CFC in the manufacture of domestic refrigerators in Colombia;
- Elimination of the use of ODS in the polystyrene foam sector.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Colombia	
PROJECT TITLE:	Elimination of CFC in the manufacture of Domestic Refrigerators in Colombia at Household Refrigerator Companies: a) Corelsa b) Haceb c) Icasa d) Polarix e) Andinos (Compressor Manufacturer)	
BUDGET:	Capital Costs:	
	a) Corelsa	US $434,200
	b) Haceb	US $288,930
	c) Icasa	US $709,000
	d) Polarix	US $257,417[1]
	e) Andinos	US $313,648[2]
	Operational Costs:[3]	
	a) Corelsa	US $800,314
	b) Haceb	US $2,094,904
	c) Icasa	US $1,334,546
	d) Polarix	US $1,118,805[1]
INCREMENTAL COST:	a) Corelsa	US 1,234,514
	b) Haceb	US $2,383,834
	c) Icasa	US $2,043,546
	d) Polarix	US $1,376,222[1]
	e) Andinos	US $313,648[2]
ODS PHASE-OUT:	a) Corelsa	22 ODP T
	b) Haceb	69 ODP T
	c) Icasa	72 ODP T
	d) Polarix	63 ODP T
	e) Andinos	N/A

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[1] Adjusted to reflect the local ownership of 51 per cent.

[2] Adjusted to reflect the local ownership of 61.2 per cent.

[3] Calculated for two years of operation.

COST EFFECTIVENESS:	a) Corelsa	US $56.11 per kg ODP saved
	b) Haceb	US $34.55 per kg ODP saved
	c) Icasa	US $28.38 per kg ODP saved
	d) Polarix	US $42.80 per kg ODP saved
	e) Andinos	N/A

PROJECT DURATION: One year

IMPLEMENTING AGENCY: UNDP

NATIONAL COORDINATING AGENCY : National Committee for Protection of the Ozone Layer

TECHNICAL REVIEW COMPLETED: YES _X_ NO _

SECRETARIAT'S COMMENTS

1. This project covers the conversion of four domestic refrigerator manufacturing plants to HFC-134a refrigerant and HCFC-141b blowing agent and the conversion of one compressor manufacturing plant to HFC-134 technology.

2. Implementation of this project will result in the phase-out of 226 ODP tonnes which represent 82 per cent of ODS consumption in the domestic refrigeration sector in Colombia.

3. Capital costs cover the replacement and modification of existing equipment to make it compatible with new refrigerant and blowing agent. In general, the requested allocations for capital costs are at the lowest level in comparison with similar conversion projects approved by the Executive Committee so far. It can be explained by the availability of high pressure foaming equipment compatible with HCFC-141b and by applying modification of existing equipment rather than replacement with new ones.

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

5. Incremental operational costs are associated with new HFC-134a compressor, refrigeration system optimization, higher cost of refrigerant and blowing agent, extra costs for polyurethane foam due to increased density, and resistible inner liner material. Incremental operational costs are calculated at US $5,348,569 for two years of operation. They represent 73 per cent of the total project cost.

6. All refrigerator manufacturing companies will use HFC-134a compressors produced by Andinos company. Andinos company will incur incremental operational costs in its production process. These costs have not been considered as eligible, since they will be passed

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Colombia
PROJECT TITLE:	Elimination of the Use of ODS in the Polystyrene Foams Sector at: a) Ajover b) Inaldes
PROJECT COST:	a) Incremental capital cost US $935,000 Incremental operational saving (US $353,000) b) Incremental capital cost US $645,000 Incremental operational saving (US $345,000) Pre-post assessment and contingency: US $190,000
INCREMENTAL COST:	US $1,072,000
ODS PHASE-OUT:	a) 190 tons CFC-12 in 1993 b) 130 tons CFC-12 in 1993
COST EFFECTIVENESS:	a) US $3.6 per kg ODP saved b) US $2.9 per kg ODP saved
PROJECT DURATION:	One year
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	Comisión Nacional para la Preservación de la Capa de Ozono
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. Ajover and Inaldes are involved in the manufacture of extruded polystyrene foam sheets. The Ajover company will substitute CFC-12 by using butane, and the Inaldes company will substitute CFC-12 by using carbon dioxide technology patented by Dow.

2. Incremental capital costs of Ajover relate to safety equipment and extruder modification and butane tank; those of Inaldes to replacement of the extruder system for carbon dioxide use. Net operational savings will be generated because the price of butane and carbon dioxide are less than that of CFC-12.

SECRETARIAT'S RECOMMENDATION

3. The Secretariat recommends final approval for the project for the amounts requested, i.e., US $1,072,000.

PROJECT COVER SHEET

COUNTRY: COLOMBIA

PROJECT TITLE: Elimination of CFC in the Manufacture of Domestic Refrigerators in Colombia.

SECTOR COVERED: DOMESTIC REFRIGERATOR MANUFACTURING

ODS USE IN SECTOR: 245 tons ODP (1993).

Five Participating Companies:	TOTAL	ANDINOS Compr.Man	CORELSA Refr.Man.	HACEB Refr.Man.	ICASA Refr.Man.	POLARIX Refr.Man.
ODP-Tons eliminated (1993)	226	0	22	69	72	63
Incremental Capital Cost (US$)	2,449,367	512,497	434,200	288,930	709,000	504,740
Incremental Operational Cost (US$)	6,423,500	0	800,314	2,094,904	1,334,546	2,193,736
TOTAL PROJECT COST (US$)	8,872,867	512,497	1,234,514	2,383,834	2,043,546	2,698,476
PROPOSED MLF GRANT (see note)	7,351,770	313,649	1,234,515	2,383,835	2,043,547	1,376,223
UNIT ABATEMENT COST (US$/kg)	13.2	N/A	21.4	15.9	10.9	9.5

Note: POLARIX is 51% owned by Article-5 Country. ANDINOS is 61,2% owned by Article-5 Countries.
Compr.Man = Compressor Manufacturer ; Refr.Man = Refrigerator Manufacturer

PROJECT DURATION: 1 year.
ECONOMIC LIFE: 10 years.

NATIONAL COORDINATING BODY: CPNO - Comite Nacional para la Preservacion de la Capa de Ozono.

IMPLEMENTING AGENCY: UNDP

APPRAISAL DATE: June 1994

PROJECT SUMMARY:

This project will eliminate the use of CFC's in the existing four domestic refrigerator manufacturers in Colombia. A local compressor plant (ANDINOS) will also receive assistance to convert their facility for the production of HFC-134a compressors. CFC-11 used as a blowing agent for producing thermal insulating foams in the four refrigerator manufacturing plants will be replaced by HCFC-141b. On the other hand, CFC-12 used as refrigerant will be replaced by HFC-134a. The project will eliminate 226 tons-ODP/yr (based on 1993 figures). Funds requested will be used to change the existing production lines, the cost of testing, pre-production trials, and training, as well as incremental operational costs resulting from the conversion to the new technology (2 years only).

TECHNICAL ASSESSMENT:

The foam part of the project was prepared by Mr. A. Gabella, the refrigerant part by Mr. Stuart Kelly in collaboration with the Comite Nacional para la Preservacion de la Capa de Ozono (CPNO) and the Asociación Nacional de Industriales (ANDI). The project has been reviewed and is supported respectively Mr. Bert Veenendaal (Foams) and by Dr. Lambert J.M. Kuijpers and Mr. Martiem Janssen from RE/GENT-Eindhoven (refrigerant). Their comments are attached.

PROJECT OF THE GOVERNMENT OF COLOMBIA

ELIMINATION OF CFC IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFC used at the existing manufacturers of domestic refrigerators. The CFC's which will be eliminated include CFC-11 used as a blowing agent for producing thermal insulating foams as well as CFC-12 used as a refrigerant in the production of domestic refrigerators.

2. SECTOR BACKGROUND.

Colombia's Country Programme for the Phase-out of Ozone Depleting Substances under the Montreal Protocol was approved in March 1994.

CFC-11 consumption for thermal insulation in the domestic refrigeration sector in 1993 amounted to 169 tons. Besides of being used for thermal insulation of refrigerators, CFC-11 is also used in Colombia for the manufacture of integral skin, shoe soles, rigid foam for acoustic insulations and constructions.

CFC-12 consumption in 1992 amounted to 1374 tons, out of which 105 tons were used for the manufacture of domestic refrigerators. This estimate was subsequently identified as containing 10 to 15% inadvertent losses, plus some incorrect end-use allocation. The figures used in the project (76 tons) are based on the most recent data available for 1993.

About 422,000 domestic refrigerators were manufactured in 1993. A rapid growth (10 to 20%) is anticipated in this sector. For the period June 93 to May 94 the figure grew to 449,000 refrigeration units already. The manufacture of domestic refrigerators in Colombia is shared between four companies:

- Corporacion de Electrodomesticos S.A. (CORELSA)
- Industrias Haceb S.A. (HACEB)
- ICASA S.A. (ICASA)
- Polarix Electrodomesticos S.A. (POLARIX)

The industry imports some raw materials and parts. Compressors are mainly supplied by "COMPRESORES ANDINOS", a company that produced 330,000 hermetic compressors in 1993, 291,000 of which were used in the domestic refrigeration sector.

Uninhibited growth in the manufacture of domestic refrigerators would lead to an estimated consumption in the year 2000 of 350 tons per year of CFC-11 and of 275 tons per year of CFC-12. CPNO, with the assistance of ANDI and UNDP, has designed a strategy for the elimination of CFC-12 in this sector beginning late 1994 / early 1995. Approval of the projects by the MLF in July 1994 would bring the implementation of this strategy well in line with the target.

A complete phaseout of the use of CFCs as refrigerant in the manufacture of domestic refrigerators in Colombia will be achieved in 1996.

3. ENTERPRISE BACKGROUND

CORELSA, HACEB, ICASA and POLARIX are presently the only enterprises manufacturing domestic refrigerators in Colombia and all four companies are encompassed by this project. Three are 100 per cent nationally owned, whilst the ownership of POLARIX is 51% Mexican and 49% Dutch.

COMPRESORES ANDINOS supplies about 70% of the compressors used by the above-mentioned four companies (the rest being imported). The enterprise is 33.3% Colombian owned, the remaining equity being 27.9% Ecuadorian and 38.8% Brazilian owned. However, the Brazilian part is a wholly owned subsidiary of a US compressor manufacturing company (Tecumseh Products Co, Michigan) and thus this percentage is not eligible for any financing by the Multilateral Fund.

More details on ANDINOS and the individual refrigerator manufacturers are given in the tables on this and the following page respectively.

COMPRESORES ANDINOS:

Amount Requested from MLF:	US$ 313,648
Plant Located in:	BOGOTA
Ownership:	33.28% COLOMBIAN, 27.92% ECUADORIAN, 38.80% BRAZILIAN
No. of Compressors Models:	9
Current Production Capacity:	400,000 units p.a.
1993 Production Volume:	330,000 units
Contact Persons:	ARMANDO HENAO SANTAMARIA, General Manager JAIRO ARIAS MOLINA, Production Manager
Tel/Fax:	Tel. 775 11 47 - 775 11 67 Fax. (57 1) 775 12 62

Other Information: The 38.80% Brazilian owned equity of Compresores Andinos S.A. belongs to Sociedad Intercontinental de Motorcompresores Hermeticos (SICOM) Limitada, which in turn is a wholly owned subsidiary of TECUMSEH Corporation of Michigan, USA. This reduces the eligibility of Compresores Andinos for funding from the Montreal Protocol Multilateral Fund to only 61.20% of the project cost.

Compresores Andinos manufacture compressors using Tecumseh technology and they comply with Tecumseh Standards throughout all stages of their manufacturing operation. The products are marketed bearing the "Tecumseh" brand name. The incremental capital costs requested by Compresores Andinos in the current project will assist ANDINOS in the conversion of the existing production capacity to manufacture an equivalent number of HFC-134a compressors.

Compresores Andinos also manufacture hermetic compressors for companies in the commercial refrigeration sector who manufacture food storage and display cabinets, unitary commercial refrigeration equipment, etc. Production for this purpose in 1993 was approximately 30,000 CFC-12 compressors. A project to eliminate the use of ODS in the commercial refrigeration sector is also being prepared on a sectoral basis including the principal commercial refrigeration equipment manufacturers and Compresores Andinos. In the proposed commercial refrigeration sector project, there will be NO request from Compresores Andinos for additional capital investment costs.

Description of the four Domestic Refrigerator Manufacturers:

COMPANY	CORELSA	HACEB	ICASA	POLARIX
CFC use in 93	22 tons	69 tons	72 tons	63 tons
Amount Requested	1,192,229	2,172,407	2,048,547	1,306,428
Full name:	Corporacion de Electrodomesticos S.A.	Industrias Haceb S.A.	ICASA S.A.	Polarix Electrodomesticos S.A.
Plant located in	Bogota	Medellin	Bogota	Manizales
Ownership	100% Colombian	100% Colombian	100% Colombian	51% Mexican, 49% Dutch
No. of models made	9	8	16 (incl. 5 coolers)	10
Refrig Units in last 12 months.	53,845	140,144	100,000	155,000
Contact Persons	Alvaro Enrique Gomez General Manager	Hernan Alberto Marin Qual. Control Manager	Hect. Hern. Lamprea Production Engineer	Augusto Toro E. Plant Manager
Tel/fax	775.2300 / 775.2714	274.0100 / 274.3452	260.4756 / 262.3559	86.4010/ 968-86.6327
Other Information (general)	Corporacion de Electrodomesticos S.A. produces major appliances covering Colombian markets as well as exporting to 12 countries of the region. CORELSA started its operations in 1977 and employs 1280 people. Among CORELSA 's production lines there is use of CFC's in the areas of household refrigerators and bottled water dispensers.	Industrias HACEB S.A. supplies the Colombian home appliances market. The main plant at Medellin generates 2000 direct work posts and produces 800,000 appliances per year, including heating and refrigeration equipment. Equipment is certified per ISO-7371 and IEC-335-1.2 norms.	ICASA is a domestic appliance manufacturer. It has 1050 employees. Indirect employment reaches 10,000. 5% of production is exported to Venezuela and Peru. It started production 37 years ago. Apart from domestic refrigerators, ICASA produces cookers, washing machines etc. The facilities have 3300 m² area. The company has been operating in refrigeration equipment for over 38 years.	Polarix Electodomesticos S.A. is a domestic appliances manufacturer. Its 440 employees are Colombian, mainly from Manizales. Indirect employment reaches 5,000. All production is sold in "Pacto Andino" markets, 90% of sales are in Colombia.
Additional Information on Foam Equipment	One outdated high-pressure machine is presently used.	The company intends to phase out in two phases. Presently, HACEB uses <u>high-pressure</u> foaming equipment.	Present foam production uses low pressure equipment.	Present foam production uses low-pressure equipment.

4. PROJECT DESCRIPTION

All four domestic refrigerator manufacturing companies presently use CFC-11 for the production of rigid isolating foams needed for the refrigerator cabinets and doors, and used CFC-12 as refrigerant. The total consumption in 1993 was as reflected in the following table:

	CFC-11 in tons	CFC-11 ODP eliminated (see note *)	CFC-12 in tons	Total ODP eliminated in tons
CORELSA	15	13	9	22
HACEB	50	45	24	69
ICASA	64	57	15	72
POLARIX	40	35	28	63
	169	150	76	226

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

4.1. Replacement of CFC-11 with HCFC-141b.

All companies will transfer to HCFC-141b as a first step to an ODS-free system. The foam machines for the rigid insulation should be high pressure machines 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 CORELSA, ICASA and POLARIX. In the case of ICASA and POLARIX, low-pressure systems are in use which will have to be replaced. CORELSA is using an outdated high-pressure machine, which is not able to produce all formulas with HCFC-141b. Furthermore, CORELSA's current machine is not able to utilize other replacement chemicals like cyclopentane which may be needed for the future phase-out of HCFC-141b. Regarding HACEB, a suitable high-pressure system is in use and does not need replacement.

All companies will 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 Cost for two years are requested to cover the transitional period.

4.2. Replacement of CFC-12 with HFC-134a.

All companies will change to HFC-134a. This conversion 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.

Key to the success of CFC-12 elimination is the local availability of HFC-134a compressors. The only national manufacturer of small hermetic compressors is COMPRESORES ANDINOS who have committed to the conversion of their compressor manufacturing operations to be able to provide the necessary volume of HFC-134a compressors commencing Q3 1994.

It should be noted that COMPRESORES ANDINOS have already made a substantial part of the investment necessary in order to be able to supply the Colombian market with HFC-134a compressors commencing Q3 1994. Incremental operating costs are passed on to the four refrigerator manufacturers (see annexes for calculation methods).

5. TECHNOLOGY

5.1. Replacement of CFC-11 with HCFC-141b.

5.1.1. OVERVIEW AND SELECTION

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, 152a
CFC-11 > Cyclopentane

In addition, compounds such as perfluoroalkanes, HCFC-123, fluorinated ethers and 2-chloropropane have been suggested, but are immature in technology, limited available or toxicologically suspect.

The first solution--the "liquid" solution-- is the one which will be applied in this project, and employs technology that is closely related to the existing one. The final step 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, specifically in "lesser demanding" systems such as water heaters, where dimensional changes--although costly-- are possible. The second one--the "gas" solution--utilizes a gaseous mixture of physical blowing agents, requires always new equipment, and extensive adjustments. The final step in this process is seen as the introduction of (gaseous) HFC's. The third solution, Cyclo-pentane technology has recently been introduced commercially in Germany. Its flammable character requires safety conditions and limits its use. Based on economic environmental considerations, cyclopentane would be the best choice for these applications. The compound is however not available in Colombia.

A combination of water-blown technology and the use of HCFC-141b is identified bv the Colombian industry as an alternative that is proven technology, environmentally acceptable and available in the Colombian market. The choice of high pressure equipment will facilitate the subsequent step to a truly ODP-free system without major additional capital costs.

5.2.1. IMPACT ON PRODUCTION PROCESS

The use of reduced CFC technology will be facilitated through the employment of high pressure foam production equipment.

5.2. Replacement of CFC-12 with HFC-134a.

5.2.1. OVERVIEW AND SELECTION

HFC-134a has become universally accepted as the 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.

All the four Colombian domestic refrigerator manufacturing companies developed their own CFC-12 based technology "in house", and all intend to develop the HFC-134a technology themselves with assistance from equipment and refrigerant suppliers. All the companies commenced their HFC-134a technology development activities in mid 1993.

Whilst 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 Colombia 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.

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.

COMPRESORES ANDINOS is 38.8% owned by Sicom Limitada, of Brazil, which in turn is a wholly owned subsidiary of Tecumseh Products Co., a major US compressor manufacturer. COMPRESORES ANDINOS thus has access to the necessary technology to be able to successfully manufacture HFC-134a compressors.

5.2.2. IMPACT ON PRODUCTION PROCESS

HFC-134a, like CFC-12, is non flammable. HFC-134a has also been the subject of toxicological testing and is considered safe in use in industrial applications. At the present time the Occupational Exposure Limit (OEL)/Threshold Limit Value (TLV) for HFC-134a is comparable to that of CFC-12 and thus no changes from current practices are required.

There will be an approximately 5% reduction in the mass charge of HFC-134a compared with CFC-12 for a refrigerator system of the same capacity.

System cleanliness and moisture content is paramount to the successful manufacture of HFC-134a refrigerators. One effect

HCFC-141b is moderately flammable. For the intended purpose, the blends should not cause any risk, but a monitoring check at commissioning will be performed to ensure safe exposure levels. Ventilation is to be installed where needed.

Current open pre-mixing procedures should be replaced by automated, pressurised ones where applicable. This will save up to 20% ABA.

Densities may have to be adjusted to obtain proper insulation values.

The liner should be resistant to HCFC-141b.

Recently at an OORG meeting, an-in depth discussion on the use of HCFC-141b and consequences on the liner was held. It concludes that HCFC-141b technology is commercially proven, offers high-insulation performance and constitutes a viable intermediate step to zero-ODS technology. It however requires an appropriate plastic liner. More information is attached herewith in annex E.

of this will be the need for a careful re-assessment of production procedures and personnel re-training as appropriate.

The chemical stability of HFC-134a/synthetic lubricant systems in domestic refrigerators, and hence the long term performance of the appliance, are sensitive to moisture content and certain chlorinated impurities. This requires that CFC-12 and HFC-134a handling equipment be carefully segregated, and it calls for better evacuation of the system prior to refrigerant charging. The conversion from CFC-12 to HFC-134a will take place on a model by model basis, so that all four manufacturers will be producing both CFC-12 and HFC-134a refrigerators during the implementation phase of this project. This is feasible as all manufacturers have several production lines. It means that there is a requirement for new system evacuation equipment and refrigerant charging equipment at all refrigerator manufacturers.

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.

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS

6.1.1. Capital Cost for the Manufacture of HFC-134a Compressors (Compresores Andinos) (US$).

Description	Total Cost
A. Equipment Needed.	
Dehydrating Equipment, Oil purifier, oil & gas dosers	109,730
Compressor Sealing Equipment	13,500
New Final Test Cabinet (Hi-Potential, Voltmeter, Starter, and Nitrogen Charger) Treatment	20,000
Tunnel (case degreasing, cleaning, and chemical treatments)	90,000
Finishing Tunnel (cleaning, drying, mounting and welding)	120,000
Calorimeter and other	8,586
Quality Control Lab Instruments	5,090
Quality Control Lab equipment for Pull-down	18,000
Technical Assistance	60,000
SUB TOTAL	444,906
B. Training and Trials.	
Training	15,000
Trials	6,000
SUB TOTAL	21,000
CONTINGENCIES (10% of Capital Cost)	46,591
TOTAL	512,497

6.1.2. Capital Cost for the Refrigerator Manufacturers - CFC-11 (US$).

Budget Item	CORELSA	HACEB	ICASA	POLARIX
High Pressure Foaming Machine	1 Unit 131,000	N/A	2 Units 262,000	1 unit: 131,000
Pre-Mixing Unit	70,000	N/A	65,000	N/A: buys pre-mixed material
Ventilation System for 141b	1 unit 10,000	1 unit 10,000	2 units 20,000	1 unit: 10,000
Training (500 US$ per person)	10 people: 5,000	5 people 2,500	10 people: 5,000	10 people: 5,000
Test Trials (1000 US$ per trial, 3 trials per model)	9 refrig. models: 27,000	8 refrig. models: 24,000	16 models incl. 5 coolers: 48,000	10 refrig.models: 30,000
Contingencies (10%)	24,000	3,500	40,000	17,000
Subtotal Incr. Capital Cost	267,000	40,000	440,000	193,000

6.1.3. Capital Cost for the Refrigerator Manufacturers - CFC-12 (US$).

Budget Item	CORELSA	HACEB	ICASA	POLARIX
REFRIGERANT CHARGING EQUIPMENT	2 items: 75,000	2 items: 100,000	2 items: 100,000	2 items: 100,000
VACUUM PUMPS	included in above amount.	10 items: 31,500 Retrofit 15 items: 4,800	8 items: 35,600	7 items: 21,700
LEAK DETECTION EQUIPMENT	8 hand held: 8,000	6 hand held: 6,000	8 fixed: 44,000	8 fixed: 40,000
OTHER EQUIPMENT ITEMS	N/A	N/A	N/A	Refrigerant Pumps: 16,700
TRAINING	4,000	4,000	15,000	5,000
TEST TRIALS	65,000	80,000	50,000	100,000
CONTINGENCIES (10% of capital cost)	15,200	22,630	24,400	28,340
SUB TOTAL (US$)	167,200	248,930	269,000	311,740

6.1.4. Total Capital Cost (US$).

The totals of the above three tables are summarized as follows:

	ANDINOS	CORELSA	HACEB	ICASA	POLARIX
Total Capital Cost	512,497	434,200	288,930	709,000	504,740
% Article-5 Ownership	61.2	100	100	100	51
Capital Cost Requested:	313,648	434,200	288,930	709,000	257,704

6.2 INCREMENTAL OPERATIONAL COSTS

The calculation is based on a two-year period (1995-96) using 1993 production figures and ignoring growth (estimated at 10%).

It should be noted that the project already underwent numerous downward revisions. All projects originally included four years incremental operational costs, including projected growth rates for this period. Further to the 12th executive committee meeting in March 1994, it was decided to take out growth for the four years period. In addition, it was then decided to cut the number of years requested from four to two. Thereafter, capital costs which were incurred by the compressor manufacturer before Colombia became a party to the Montreal Protocol and for which a retroactive payment was requested in an earlier version of the document were withdrawn from the project resulting in another decrease of US$ 455,000. Then it was decided not to pay operational costs originally allocated to Compresores Andinos, and instead to distribute a reduced amount to the four refrigeration manufacturers instead.

All above-mentioned project decreases combined add up to over 5.2 million US$, so that the requested amount at present equals 7.35 million US$ with an overall unit abatement cost of US$ 13.2 per kg.

The following provides some clarification as to the ANDINOS Compressor manufacturer. Prices for compressors (imported and ANDINOS) were originally obtained from each company, and verified by UNDP's consultant and ANDI (Asociación Nacional de Industriales). Compresores Andinos is the only compressor manufacturer in Colombia. The second table of annex C shows that most refrigeration manufacturers intend to buy both ANDINOS and imported compressors. The prices of the present ANDINOS CFC-12 compressors are on average 3.4 US$/compressor higher than imported ones (37.55 - 34.13). The reason of the higher cost for ANDINOS compressors is because ANDINOS is geared to the size of the Colombian market and that their production levels are 10 to 20 times lower than similar companies such as in the USA and in Brazil. However it is important to note that all prices in this document are without taxes, and that the end-user will pay a 15% higher tax on imported compressors. In other words, if prices would have included taxes, the competitive position of ANDINOS would look better than shown in annex C.

Detailed calculations have been carried out on the incremental costs that ANDINOS will be faced with when switching to HFC-134a compressors, and amount to 6.92 US$. This figure takes the proposed grant for capital incremental cost that this project will provide into account. However, since ANDINOS is only 61.2 % owned by article-5 countries, the incremental cost used for ANDINOS compressors in table 3 of annex C amounts to 4.23 US$/compressor only. Using estimated data of prices of imported compressors, as well as estimated figures on demand of ANDINOS and imported compressors, an average figure of 3.93 US$ per compressor was obtained. As already mentioned, this amount will be applied to the four refrigerator manufacturers, rather than to ANDINOS.

Annexes B and C provide detailed explanations on how the incremental operational costs were obtained, and are summarized in the following tables.

6.2.1. Operational Cost for the Refrigerator Manufacturers (CFC-11).

	CORELSA	HACEB	ICASA	POLARIX
a. Cost for Materials (see annex B)	260,103	579,884	461,494	686,541
b. Savings related to Cleaning of Mixing Head	0	0	-5,000	-5,000
Subtotal Incremental Operational Cost	260,103	579,884	456,494	681,541

6.2.2. Operational Cost for the Refrigerator Manufacturers (CFC-12)

(see annex B)	CORELSA	HACEB	ICASA	POLARIX
Incremental Operational Cost Subtotals	540,211	1,515,020	878,052	1,512,195

6.2.3. Total Incremental Operational Cost.

	CORELSA	HACEB	ICASA	POLARIX
Sum of above two tables	800,314	2,094,904	1,334,546	2,193,736
% Article-5 Ownership	100	100	100	51
Incremental Operational Cost Requested	800,314	2,094,904	1,334,546	1,118,805

6.3. TOTAL PROJECT INCREMENTAL COSTS (CAPITAL + OPERATIONAL)

	ANDINOS	CORELSA	HACEB	ICASA	POLARIX
Total Cost (Capital+Operational)	313,649	1,234,514	2,383,834	2,043,547	1,376,223
GRAND TOTAL ALL COMPANIES	7,351,770				

6.4 UNIT ABATEMENT COST

6.4.1 Individual Unit Abatement Costs for the Four Refrigerator Manufacturers (US$/Kg)

	CORELSA	HACEB	ICASA	POLARIX
a. Capital Investment Costs	434,200	286,930	709,000	257,417
b. Capital Recovery Factor (10% p.a.)	0.16275	0.16275	0.16275	0.16275
d. Incremental Operating Costs	800,314	2,094,904	1,334,546	1,118,805
e. ODS Reduction (ODP Kgs 1993)	22,000	69,000	72,000	63,000
f. Unit Abatement Cost (US$/Kg) [(a*b + d/2)] / d	21.4	15.9	10.9	9.5

Note: Polarix relatively low Unit Abatement Cost is due to its 51% Article-5 Ownership.

6.4.2 Unit Abatement Cost for the Total Project encompassing all the Five Companies (US$/Kg)

	TOTAL FOR FIVE COMPANIES IN PROJECT
a. ODS Reduction Investment Costs	2,003,196
b. Capital Recovery Factor (10% p.a.)	0.16275
d. Incremental Operating Costs (1996)	5,348,569
e. ODS Reduction (ODP Kgs 1993)	226,000
f. UNIT ABATEMENT COST (US$/Kg)	13.2

7. FINANCING PLAN

The companies are requesting reimbursement to the amount of the project costs of US$ 7,351,770. See above tables and Annex A for distribution of funds according to company.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

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

8.2 SCHEDULE

TASK	TIME TO COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
MLF Approval	x					
Procurement preparation	xx	x				
Vendor selection		xx				
2. Installation						
Arrival, Customs,		xx				
Machine installation		x	x			
3. Start-Up						
Machine start-up			x			
Trials, training			xxx			
Certification			x	xx		

9. PROJECT IMPACT

This project will eliminate the use of 226 tons of CFC's, (1993 base) in the first year of implementation.

10. ANNEXES

ANNEX A: SUMMARY BUDGET TABLE
ANNEX B: INDIVIDUAL COMPANY INCREMENTAL OPERATIONAL COSTS
ANNEX C: CLARIFICATION ON CALCULATION OF OPERATIONAL COSTS
ANNEX D: TECHNICAL REVIEWS
ANNEX E: OORG DISCUSSION PAPER ON THE HCFC-141B AND RELATED LINER TECHNOLOGIES.

ANNEX A : SUMMARY BUDGET TABLE

		Total	ANDINOS Compr.Manuf.	CORELSA Refr.Manuf.	HACEB Refr.Manuf.	ICASA Refr.Manuf.	POLARIX Refr.Manuf.
a. CFC Consumption (ODP Tons)	CFC-11	150	0	13	45	57	35
	CFC-12	76	0	9	24	15	28
	Both	226	0	22	69	72	63
b. Incremental Capital Cost	CFC-11	940,000	0	267,000	40,000	440,000	193,000
	CFC-12	1,509,367	512,497	167,200	248,930	269,000	311,740
	Both	2,449,367	512,497	434,200	288,930	709,000	504,740
c. Incremental Operational Cost	CFC-11	1,978,022	0	260,103	579,884	456,494	681,541
	CFC-12	4,445,478	0	540,211	1,515,020	878,052	1,512,195
	Both	6,423,500	0	800,314	2,094,904	1,334,546	2,193,736
d. Total Incremental Cost (d = b + c)	CFC-11	2,918,022	0	527,103	619,884	896,494	874,541
	CFC-12	5,954,845	512,497	707,411	1,763,950	1,147,052	1,823,935
	Both	8,872,867	512,497	1,234,514	2,383,834	2,043,546	2,698,476
e. Ownership in Art-5 Countries		0.82857	0.612	1	1	1	0.51
f. Capital Conv. Factor (10 yrs)		0.16275	0.16275	0.16275	0.16275	0.16275	0.16275
g. Proposed MLF Grant (g = d X e)	CFC-11	2,489,497	0	527,103	619,884	896,494	446,016
	CFC-12	4,862,268	313,648	707,411	1,763,950	1,147,052	930,207
	Both	7,351,770	313,649	1,234,515	2,383,835	2,043,547	1,376,223
g. Unit Abatement Cost g=(b*f+c/2)*e/(a*1000)	CFC-11	6.3	N/A	13.[illegible]	6.6	5.3	5.4
	CFC-12	26.9	N/A	33.0	33.3	32.2	14.7
	Both	13.2	N/A	21.4	15.9	10.9	9.5

Annex B.1.1 -- Calculation of the Incremental Operating Cost for CORELSA

1. The Elimination of CFC-11 as Blowing Agent for Thermal Insulatin Foams.

CORELSA === CORELSA === CORELSA === CORELSA ==	CFC-11	HCFC-141b	Difference
Use per kg of Foam produced.			
a. kg Polyol	0.380	0.380	0.000
b. kg MDI	0.544	0.593	0.049
c. kg Blowing Agent	0.076	0.035	(0.041)
Prices in US$/kg			
d. Polyol	2.50	2.65	0.15
e. MDI	2.00	2.00	0.00
f. Blowing Agent	1.80	4.00	2.20
g. Polystyrene for Liner	2.00	2.20	0.20
Cost per kg of foam produced			
h. = a x d. Polyol	0.950	1.007	0.057
i. = b x e. MDI	1.088	1.186	0.098
j. = c x f. Blowing Agent	0.137	0.140	0.003
k. = h+i+j, Total per kg foam	2.175	2.333	0.158
Material used per Refrigerator			
l. kg of foams per unit (average)	4.50	4.95	0.45
m. kg of polystyrene per unit (average)	5.11	5.11	0.00
Cost per Refrigeration Unit			
n. = l x k. for foams	9.787	11.548	1.762
o. = m x g. for polystyrene	10.220	11.242	1.022
p. = n + o. Total per unit	20.007	22.790	2.784
q. Nr of Refrig Units/year (based on 1993 production)			53,845
r. Total Incremental Cost per year (US$)			149,891
s. NPV at 10% (s = 0.909 x r + 0.909 x 0.909 x r)			260,103

2. The Elimination of CFC-12 as Refrigerant.

CORELSA === CORELSA === CORELSA === CORELSA ==	CFC-12	HFC-134a	Difference
1. Refrigerant			
a. Price per kg Refrigerant	2.40	11.00	
b. Kg per Refrigerator (average)	0.171	0.162	
c. Number of Refrigerators per year (see note 1)	53,845		
d. Cost for Refrigerant d= a x b x c	22,098	95,952	73,854
2. Compressors			
a. Cost per Compressor (see note 2)	36.49	40.42	
b. Number of Compressors per year (see note 1)	53,845		
d. Cost for Compressors c = a x b	1,964,804	2,176,415	211,611
3. Condensors			
a. Cost per Condensor	3.00	3.32	
b. Number of Condensors per year (see note 1)	53,845		
d. Cost for Condensor c = a x b	161,535	178,765	17,230
4. Filter/Dryer			
a. Cost per Filter/Dryer	0.41	0.50	
b. Number of Filter/Dryers per year (see note 1)	53,845		
d. Cost for Filter/Dryer c = a x b	22,076	26,923	4,846
5. Capillary Tubes			
a. Cost per Capillary Tube	0.38	0.45	
b. Number of Capillary Tubes per year (see note 1)	53,845		
d. Cost for Capillary Tube c = a x b	20,461	24,230	3,769
e. Total per year			311,310
f. NPV at 10% (f = 0.909 x e + 0.909 x 0.909 x e)			540,211

Note 1: Figures for 1995/96 are based on production figures of the last 12 months prior to submitting the proposal. Expected growth in the sector was not taken into account further to a decision by the 12th Executive Committee Meeting.

Note 2: An average was obtained using all reported data on incremental costs for imported and locally produced compressors. See annex C. on calculation method.

Annex B.2.1 -- Calculation of the Incremental Operating Cost for HACEB

1. The Elimination of CFC-11 as Blowing Agent for Thermal Insulatin Foams.

HACEB === HACEB === HACEB === HACEB === HACEB	CFC-11	HCFC-141b	Difference
Use per kg of Foam produced.			
a. kg Polyol	0.396	0.396	0.000
b. kg MDI	0.505	0.574	0.069
c. kg Blowing Agent	0.099	0.043	(0.056)
Prices in US$/kg			
d. Polyol	2.50	2.65	0.15
e. MDI	2.00	2.00	0.00
f. Blowing Agent	1.80	4.00	2.20
g. Polystyrene for Liner	2.00	2.20	0.20
Cost per kg of foam produced			
h. = a x d. Polyol	0.990	1.049	0.059
i. = b x e. MDI	1.010	1.148	0.138
j. = c x f. Blowing Agent	0.178	0.172	(0.006)
k. = h+i+j, Total per kg foam	2.178	2.369	0.191
Material used per Refrigerator			
l. kg of foams per unit (average)	3.280	3.680	0.400
m. kg of polystyrene per unit (average)	4.048	4.048	0.000
Cost per Refrigeration Unit			
n. = l x k. for foams	7.144	8.719	1.575
o. = m x g. for polystyrene	8.096	8.906	0.810
p. = n + o. Total per unit	15.240	17.625	2.384
q. Nr of Refrig Units/year (based on 1993 production)			140,144
r. Total Incremental Cost per year (US$)			334,173
s. NPV at 10% (s = 0.909 x r + 0.909 x 0.9u9 x r)			579,884

Annex B.2.2 -- Calculation of the Incremental Operating Cost for HACEB

2. The Elimination of CFC-12 as Refrigerant.

HACEB === HACEB === HACEB === HACEB === HACEB	CFC-12	HFC-134a	Difference
1. Refrigerant			
a. Price per kg Refrigerant	2.40	11.00	
b. Kg per Refrigerator (average)	0.193	0.183	
c. Number of Refrigerators per year (see note 1)	140,144		
d. Cost for Refrigerant d= a x b x c	64,915	282,110	217,195
2. Compressors			
a. Cost per Compressor (see note 2)	36.49	40.42	
b. Number of Compressors per year (see note 1)	140,144		
d. Cost for Compressors c = a x b	5,113,855	5,664,620	550,766
3. Condensors			
a. Cost per Condensor	5.31	5.84	
b. Number of Condensors per year (see note 1)	140,144		
d. Cost for Condensor c = a x b	744,165	818,441	74,276
4. Filter/Dryer			
a. Cost per Filter/Dryer	0.54	0.65	
b. Number of Filter/Dryers per year (see note 1)	140,144		
d. Cost for Filter/Dryer c = a x b	75,678	91,094	15,416
5. Capillary Tubes			
a. Cost per Capillary Tube	0.57	0.68	
b. Number of Capillary Tubes per year (see note 1)	140,144		
d. Cost for Capillary Tube c = a x b	79,882	95,298	15,416
e. Total per year			873,069
f. NPV at 10% (f = 0.909 x e + 0.909 x 0.909 x e)			1,515,020

Note 1: Figures for 1995/96 are based on production figures of the last 12 months prior to submitting the proposal. Expected growth in the sector was not taken into account further to a decision by the 12th Executive Committee Meeting.

Note 2: An average was obtained using all reported data on incremental costs for imported and locally produced compressors. See annex C. on calculation method.

Annex B.3.1 -- Calculation of the Incremental Operating Cost for ICASA

1. The Elimination of CFC-11 as Blowing Agent for Thermal Insulatin Foams.

ICASA ===ICASA ===ICASA ===ICASA ===ICASA ===	CFC-11	HCFC-141b	Difference
Use per kg of Foam produced.			
a. kg Polyol	0.393	0.393	0.000
b. kg MDI	0.532	0.581	0.049
c. kg Blowing Agent	0.075	0.034	(0.041)
Prices in US$/kg			
d. Polyol	2.50	2.65	0.15
e. MDI	2.00	2.00	0.00
f. Blowing Agent	1.80	4.00	2.20
g. Polystyrene for Liner	2.00	2.20	0.20
Cost per kg of foam produced			
h. = a x d. Polyol	0.983	1.041	0.059
i. = b x e. MDI	1.064	1.162	0.098
j. = c x f. Blowing Agent	0.135	0.136	0.001
k. = h+i+j, Total per kg foam	2.182	2.339	0.158
Material used per Refrigerator			
l. kg of foams per unit (average)	5.000	5.500	0.500
m. kg of polystyrene per unit (average)	3.500	3.500	0.000
Cost per Refrigeration Unit			
n. = l x k. for foams	10.908	12.867	1.959
o. = m x g. for polystyrene	7.000	7.700	0.700
p. = n + o. Total pèr unit	17.908	20.567	2.659
q. Nr of Refrig Units/year (based on 1993 production)			100,000
r. Total Incremental Cost per year (US$)			265,947
s. NPV at 10% (s = 0.909 x r + 0.909 x 0.909 x r)			461,494

Annex B.3.2 -- Calculation of the Incremental Operating Cost for ICASA

2. The Elimination of CFC-12 as Refrigerant.

ICASA === ICASA === ICASA === ICASA === ICASA	CFC-12	HFC-134a	Difference
1. Refrigerant			
a. Price per kg Refrigerant	2.40	11.00	
b. Kg per Refrigerator (average)	0.15	0.12	
c. Number of Refrigerators per year (see note 1)	100,000		
d. Cost for Refrigerant d= a x b x c	36,000	132,000	96,000
2. Compressors			
a. Cost per Compressor (see note 2)	36.49	40.42	
b. Number of Compressors per year (see note 1)	100,000		
d. Cost for Compressors c = a x b	3,649,000	4,042,000	393,000
3. Condensors			
a. Cost per Condensor	11.50	11.50	
b. Number of Condensors per year (see note 1)	100,000		
d. Cost for Condensor c = a x b	1,150,000	1,150,000	0
4. Filter/Dryer			
a. Cost per Filter/Dryer	0.50	0.67	
b. Number of Filter/Dryers per year (see note 1)	100,000		
d. Cost for Filter/Dryer c = a x b	50,000	67,000	17,000
5. Capillary Tubes			
a. Cost per Capillary Tube	0.47	0.47	
b. Number of Capillary Tubes per year (see note 1)	100,000		
d. Cost for Capillary Tube c = a x b	47,000	47,000	0
e. Total per year			506,000
f. NPV at 10% (f = 0.909 x e + 0.909 x 0.909 x e)			878,052

Note 1: Figures for 1995/96 are based on production figures of the last 12 months prior to submitting the proposal. Expected growth in the sector was not taken into account further to a decision by the 12th Executive Committee Meeting.

Note 2: An average was obtained using all reported data on incremental costs for imported and locally produced compressors. See annex C. on calculation method.

Annex B.4.1 -- Calculation of the Incremental Operating Cost for POLARIX

1. The Elimination of CFC-11 as Blowing Agent for Thermal Insulatin Foams.

POLARIX ===POLARIX ===POLARIX ===POLARIX ===PO	CFC-11	HCFC-141b	Difference
Use per kg of Foam produced.			
a. kg Polyol	0.377	0.377	0.000
b. kg MDI	0.540	0.596	0.056
c. kg Blowing Agent	0.083	0.037	(0.046)
Prices in US$/kg			
d. Polyol	2.50	2.65	0.15
e. MDI	2.00	2.00	0.00
f. Blowing Agent	1.80	4.00	2.20
g. Polystyrene for Liner	2.00	2.20	0.20
Cost per kg of foam produced			
h. = a x d. Polyol	0.943	0.999	0.057
i. = b x e. MDI	1.080	1.192	0.112
j. = c x f. Blowing Agent	0.149	0.148	(0.001)
k. = h+i+j, Total per kg foam	2.172	2.339	0.167
Material used per Refrigerator			
l. kg of foams per unit (average)	4.260	4.686	0.426
m. kg of polystyrene per unit (average)	4.220	4.220	0.000
Cost per Refrigeration Unit			
n. = l x k. for foams	9.252	10.961	1.708
o. = m x g. for polystyrene	8.440	9.284	0.844
p. = n + o. Total per unit	17.692	20.245	2.552
q. Nr of Refrig Units/year (based on 1993 production)			155,000
r. Total Incremental Cost per year (US$)			395,637
s. NPV at 10% (s = 0.909 x r + 0.909 x 0.909 x r)			686,541

51% ---> 350,136

2. The Elimination of CFC-12 as Refrigerant.

POLARIX === POLARIX === POLARIX === POLARIX ==	CFC-12	HFC-134a	Difference
1. Refrigerant			
a. Price per kg Refrigerant	2.40	11.00	
b. Kg per Refrigerator (average)	0.192	0.183	
c. Number of Refrigerators per year (see note 1)	155,000		
d. Cost for Refrigerant d= a x b x c	71,424	312,015	240,591
2. Compressors			
a. Cost per Compressor (see note 2)	36.49	40.42	
b. Number of Compressors per year (see note 1)	155,000		
d. Cost for Compressors c = a x b	5,655,950	6,265,100	609,150
3. Condensors			
a. Cost per Condensor	10.96	10.96	
b. Number of Condensors per year (see note 1)	155,000		
d. Cost for Condensor c = a x b	1,698,800	1,698,800	0
4. Filter/Dryer			
a. Cost per Filter/Dryer	0.53	0.67	
b. Number of Filter/Dryers per year (see note 1)	155,000		
d. Cost for Filter/Dryer c = a x b	82,150	103,850	21,700
5. Capillary Tubes			
a. Cost per Capillary Tube	0.66	0.66	
b. Number of Capillary Tubes per year (see note 1)	155,000		
d. Cost for Capillary Tube c = a x b	102,300	102,300	0
e. Total per year			871,441
f. NPV at 10% (f = 0.909 x e + 0.909 x 0.909 x e)			1,512,195
		51% --->	771,219

Note 1: Figures for 1995/96 are based on production figures of the last 12 months prior to submitting the proposal. Expected growth in the sector was not taken into account further to a decision by the 12th Executive Committee Meeting.

Note 2: An average was obtained using all reported data on incremental costs for imported and locally produced compressors. See annex C. on calculation method.

ANNEX C : Price averages for CFC-12 and for Compressors

Prices of CFC-12 as refrigerant.

	Nr of kg per Refrigerators	Nr of Refrigerators	Price of CFC-12	Total US$
Corelsa	0.171	102,000	3.48 >	60,698
Haceb	0.193	252,000	1.92 >	93,381
Icasa	0.150	200,000	2.50 >	75,000
Polarix	0.192	290,000	2.16 >	120,269
Average/Total	0.180	844,000	2.40 <	349,348

The average CFC-12 price used throughout the project is therefore 2.4 US$/kg

Prices of CFC-12 Compressors reported by each company

	Locally Produced (see note 1)		Imported (see note 3)		Totals
Corelsa	39.02	20,000	31.60	82,000	33.05
Haceb	35.90	228,000	35.90	24,000	35.90
Icasa	41.60	44,000	35.18	156,000	36.59
Polarix	38.13	290,000	37.00	0	38.13
Average/Total	37.55	582,000	34.13	262,000	36.49

Calculation of Average Incremental Costs for Compressors

	Local Compressors (see note 2)		Imported (see note 3)		Totals
Corelsa	4.23	20,000	2.84	82,000	3.11
Haceb	4.23	228,000	3.60	24,000	4.17
Icasa	4.23	44,000	3.42	156,000	3.60
Polarix	4.23	290,000	3.60	0	4.23
Average/Total	4.23	582,000	3.25	262,000	3.93

Note 1: All prices above makes it look as if prices of imported compressors are lower than prices of locally made compressors. This is explained by the fact that production volumes at ANDINOS compressors are 10 to 20 times lower than production at factories in USA or Brazil. However, it is important to note that an import tax of 15% is charged to imported compressors, so that the after tax prices look much more favourable for ANDINOS than the figures shown above.

Note 2: This price was calculated based on the incremental operational cost that ANDINOS will be faced with to switch from CFC-12 compressors to HFC-134a compressors. The incremental cost arrived at is 6.92 US$ per compressor. However, ANDINOS being only 61.2% owned by Article-5 Countries, the incremental cost for an ANDINOS compressor was reduced accordingly, eventhough the funds will be allocated to the refrigeration manufacturers.

Note 3: All prices were provided by the various companies concerned, and verified by the Ministry of Planning in Colombia and with the Asociacion Nacional de Industrial de Industriales. Production figures in this table are based on 1993 data.

TECHNICAL REVIEW

JVE

RECEIVED JUN 20 1994

1301

PREPARED BY: Bert Veenendaal
UNDP Sector Expert (Foams)

DATE: June 18, 1994

1. COUNTRY OF ORIGIN: COLOMBIA

2. PROJECT TITLE: Elimination of CFC's in the Domestic Refrigeration Sector (CFC-11 part)

3. (SUB)SECTOR: Foamed Plastics

4. CP RELATIONSHIP: Included

5. TECHNOLOGY: Reduced CFC foam technology followed or combined with HCFC-141b is a viable intermediate step to zero-ODS foams. It is commercially proven. offers relative good insulation performance. It requires an appropriate plastic liner, which influences the cost. The use in these projects is supported as cyclopentane is currently not available in Colombia. The technology is available through chemical suppliers or external experts

6. ENVIRONMENTAL IMPACT: The implementation of the transitional step constitutes 95% ODP reduction, but the installed equipment allows without substantial additional investments the completion to non-ODS technology at a later stage. HCFC-141b is moderately flammable has a low TLV. The project commissioning should include an IH and safety audit

7. PROJECT COSTS: All essential cost components are identified and quantified
There appear no elements that are not incremental
The capital cost are reasonable and adequate. The need of process ventilation is still not fully clear. The IH/safety audit could be used to address this issue
There is no net-scrap value to be expected
The capacity will not be increased by

this investment
The individual cost components are, on suggestion by the reviewer standardized and regional prices in stead of local prices are used where local prices are unusual high (due to taxes, availability or other reasons)
No savings are to be expected
Comparative review of individual cost components with other projects shows (with help of the Secretariat) nothing out of the ordinary

8 IMPLEMENTATION: Adequate and feasible

9. RECOMMENDATION: Approval as proposed is recommended with the stipulation to provide the Secretariat with the results of the IH/safety audit (allows to judge the need of ventilation in future projects)

Country of origin: COLOMBIA

Project title: Elimination of CFC-12 as Refrigerant in the Manufacture of Domestic Refrigerators and Replacement with HFC-134a

Sector/sub-sector Domestic refrigeration

Relationship to country program

Technology

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

The compressor manufacturer (Andinos S.A.) is for a part indirectly owned by the Tecumseh Corporation, USA and uses Tecumseh technology for the production of their compressors; this will also hold for the future HFC-134a compressors. The products are even marketed under the Tecumseh brand name. Therefore an adequate technology transfer can be expected and a successful implementation of the project.

The four appliance manufacturers (Coreisa, Haceb, Icasa and Polarix) do not have a real "technology transfer partner". However, all of them have already done development work on HFC-134a and are ready for pilot production. They are aware of typical HFC-134a application problems and expect to get further assistance from equipment and refrigerant suppliers. Due to this assistance, a successful project implementation can probably be anticipated.

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. In a domestic refrigeration application a GWP of this magnitude is negligible.

Project costs

The equipment requested by the manufacturers is essential for the conversion process.

The incremental investment costs claimed by the compressor manufacturer are high but realistic. Incremental investment costs of the appliance manufacturer are lower than average in this field.

With respect to the incremental operational costs claimed, following remarks are made:

- The compressor produced by Andinos has a high incremental cost (6.92 USD) compared to other compressors on the market (from 2 to 5 USD). This is stated to be caused by the relatively low production volume.
- The HFC-134a price has been set at 11 USD/kg which is the current price as quoted by some major suppliers on the local market. Whether this will be the future price is questionable.
- Incremental operational costs for some other circuit components (e.g. filters) are reasonable.
- An important aspect to be noted is that only two years of operational costs are being claimed and not the regular four years as has been the case in similar projects.

The funding requested correctly takes into account the ownership of the companies. The incremental operational costs are correctly distributed between the compressor manufacturer and its customers, the appliance manufacturers.

The total cost effectiveness of the project is quite poor if the number is observed (40.32 USD/kg) but it must be stressed that in this number the manufacturing of both the appliance and the compressor is integrated. Other projects often relate to only one of both. If these would be added together, generally similar values for the cost effectiveness would be obtained.

Implementation timeframe

The proposed implementation time frame (totally one year) is probably too strict.

Relevance and adequacy of information provided

The project description contains most of the necessary information. Some outstanding issues were satisfactorily commented by the UNDP consultant. Altogether sufficient information for an appropriate judgment is present.

Recommendations

Approval as proposed

Janssen M.J.P.,
Eindhoven,
the Netherlands

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

TECHNICAL REVIEW

PREPARED BY: Bert Veenendaal
UNDP Sector Expert (Foams)

DATE: June 18, 1994

1. **COUNTRY OF ORIGIN:** COLOMBIA

2. **PROJECT TITLE:** Elimination of CFC's in the Domestic Refrigeration Sector (CFC-11 part)

3. **(SUB)SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** Included

5. **TECHNOLOGY:** Reduced CFC foam technology followed or combined with HCFC-141b is a viable intermediate step to zero-ODS foams. It is commercially proven. offers relative good insulation performance. It requires an appropriate plastic liner, which influences the cost. The use in these projects is supported as cyclopentane is currently not available in Colombia. The technology is available through chemical suppliers or external experts

6. **ENVIRONMENTAL IMPACT:** The implementation of the transitional step constitutes 95% ODP reduction, but the installed equipment allows without substantial additional investments the completion to non-ODS technology at a later stage. HCFC-141b is moderately flammable has a low TLV. The project commissioning should include an IH and safety audit

7. **PROJECT COSTS:** All essential cost components are identified and quantified
There appear no elements that are not incremental
The capital cost are reasonable and adequate. The need of process ventilation is still not fully clear. The IH/safety audit could be used to address this issue
There is no net-scrap value to be expected
The capacity will not be increased by

this investment
The individual cost components are, on suggestion by the reviewer standardized and regional prices in stead of local prices are used where local prices are unusual high (due to taxes, availability or other reasons)
No savings are to be expected
Comparative review of individual cost components with other projects shows (with help of the Secretariat) nothing out of the ordinary

8 IMPLEMENTATION: Adequate and feasible

9. RECOMMENDATION: Approval as proposed is recommended with the stipulation to provide the Secretariat with the results of the IH/safety audit (allows to judge the need of ventilation in future projects)

PROJECT COVER SHEET

COUNTRY:	COLOMBIA
PROJECT TITLE:	Elimination of the Use of ODS in the Polystyrene Foams Sector
SECTORS COVERED:	Polystyrene Foams
ODS USE IN SECTOR:	320t CFC-12 in 1993
PROJECT IMPACT:	Phaseout of 320t CFC-12 (320t ODP) per Year (base 1993)
PROJECT DURATION:	One Year
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	Incremental capital cost: USD 1,770,000 Incremental operating benefit: USD 698,000
PROPOSED MLF GRANT:	USD 1,072,000
COST EFFECTIVENESS:	USD 0.15/kg/y
COORDINATING NATIONAL BODY:	Comission Nacional para la Preservacion de la Capa de Ozono (CNPO)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	March 5, 1994

PROJECT SUMMARY

This project will phaseout CFC-12 consumption in the manufacture of extruded polystyrene (XPS) foam sheet in Colombia by converting to mature non ODS technologies (carbon dioxide/butane). Two companies, "Manufacturas Ajover Ltda" (AJOVER) and "Industria Nacional de Desechables" (INALDES), who share together the Colombian XPS production, participate in this project. The companies will provide considerable investments from own resources to cover costs related to relocation, expansion of capacity and improved product quality.

Prepared by: Dennis Unaa, Foams Expert (XPS/PE)
Reviewed by: Bert Veenendaal, UNDP Senior Foams Sector Expert

PROJECT OF THE GOVERNMENT OF COLOMBIA

ELIMINATION OF THE USE OF ODS IN THE POLYSTYRENE FOAM SECTOR

1. PROJECT OBJECTIVE

The objective of this project is (i) to phaseout the use of ozone depleting substances in the manufacture of extruded polystyrene foam sheet (XPS) in Colombia and (ii) to establish a model project that could subsequently be used for other sectors in Colombia.

2. SECTOR BACKGROUND

The 1993 CFC consumption in the Colombian industry reached an estimated 1700t. Of these, 320t or 16% were used as a foaming agent in the production of XPS foam sheet. Two companies, Manufacturas Ajover Ldta (**AJOVER**) and Industria Nacional de Desechables (**INALDES**) share the market in this fast growing (10-20%/y) sector. Corporate profiles for these companies are provided in Annex-A (AJOVER) and Annex-B (INALDES).

XPS products are predominantly used to serve the food market (egg cartons, meat trays, fast food shells, etc.).

3. PROJECT DESCRIPTION

The XPS industry has agreed to participate in the first batch of ODS phaseout projects in Colombia and to function as a model project for a consolidated sector approach.

AJOVER has selected replacement of CFC-12 by butane. Technology transfer, safety advice and production training will be provided through an external process expert. The project includes equipment modifications and extensive safety related expenses. The company will have to import butane from Venezuela as butane is currently not available in Colombia. This will cause significant shipping and handling cost. Recurrent incremental benefits are therefore substantially eliminated and not applied in the grant calculation.

The conversion will cause severe production flow problems at the existing location. The enterprise has therefore decided to relocate the production of XPS to a new plant. Any cost related to these activities will be born by the company itself.

INALDES has selected replacement of CFC by CO_2. This technology is available under license from Dow Chemical. Initially induced higher operating cost will be later on neutralized and ultimately reverted through in-house developed technology.

The manufacturer of the equipment has stated that retrofitting of the existing extruder will be virtually impossible. The project costs are therefore calculated on the purchase of a new extruded under substraction of the resale value of the existing equipment. The company wants to use the opportunity for relocation and capacity expansion. Any cost related to these activities will be born by the company itself.

4. TECHNOLOGY

4.1 OVERVIEW OF ALTERNATIVES

There are several options to replace CFCs in the production of XPS foam sheet, such as:

- o Atmospheric Gases,
- o Hydrocarbons,
- o HCFCs,
- o HFCs.

4.1.1 ATMOSPHERIC GASES

Nitrogen Gas is inert, nontoxic and noncombustible, but asphyxiant. The use is burdened by a low solubility in the resin and a relatively high density of the end product. New resin developments may make the use of nitrogen a more viable option in the future.
Berstorff Technology is based on a mixture of nitrogen and alcohol. This technology exhibits undefined risks in toxicity and fire. The resulting product has also a higher density.
Carbon dioxide gas is an asphyxiant, high energy consuming and moderately toxic gas. Carbon dioxide as a co-agent is proven technology. The uses of only CO_2 in XPS sheet is patented, and requires licensing.

4.1.2 HYDROCARBONS

N-pentane, butane, isopentane and isobutane are proven replacements. The technology is cost effective and results in product of acceptable quality. However, the flammability of hydrocarbons requires stringent safety precautions in the manufacturing process, resulting in the need for retrofitting. In addition, hydrocarbons are photochemically reactive and contribute to the formation of atmospheric ozone (smog).
Liquified petroleum gases (LPG) have also been proposed as replacement for CFCs in PE/PP and PS foams. LPG is, however toxic, flammable and not generally accepted for food packaging. If used, molecular sieves as purifier/deodorizer and a buffer for boiling point stabilization will be required.

4.1.3 HYDROCHLOROFLUOROCARBONS

HCFC-22, non-flammable, low in toxicity, thermal and chemical stable, has been proven effective. The compound has however an ODP, and only qualifies as an interim replacement.
HCFC-142b can be used alone or in combination with HCFC-22 to reduce the flammability. The price penalty is, however, considerable and equipment has to be modified to cope with the moderate flammability and the modified diffusivity of the compound.

HYDROFLUOROCARBONS

HFC-134a, non-flammable, low in toxicity and with no ODP, is just recently introduced in the market. The current pricing will prevent utilization in the very cost sensitive food serving and packaging applications. The utilization of HFC-134a in foams competes with the utilization as a refrigerant in appliances and automotive air conditioners.
HFC 152a is low in toxicity, moderately flammable and possesses no ODP. It appears to be a likely long term alternative. The compound's flammability will require modification of production equipment.

4.2 SELECTION

AJOVER has selected the use of butane. Butane is:

- Proven technology in processing and product performance,
- Environmentally acceptable,
- Low in toxicity,
- Adaptable to the existing equipment,
- Cost effective,

A draw back is its high flammability, requiring stringent safety precautions. Also, butane is currently not available in Colombia. The company has to import it from Venezuela causing considerable costs in shipping and handling.

The company is confident that this problem can be eliminated in time through the set-up of a local commercial distribution system.

INALDES HAS SELECTED the use of carbon dioxide. The technology, developed and patented by Dow Plastics, is based on recovered--i.c. not additionally generated-- CO_2. Carbon dioxide is:

- Non-toxic;
- Non-flammable;
- Low in cost;
- Environmentally friendly;
- Moderately soluble in polystyrene.

The drawbacks of this process are:

- o A rougher surface,
- o Restricted density range.

INALDES expects that it can ultimately deal with these deficiencies through in-house developed modifications.

4.3 IMPACT ON THE PRODUCTION PROCESS

The use of butane will require substantial changes in the production process and storage facilities. These may include but are not necessarily limited to:

- o Storage
  - o Separate, explosion proof storage of the butane tank.

- o Feeding Systems
  - o Injection systems for new additives,
  - o Replacement of the metering pump and injection system,
  - o New gaskets and seals.
  - o New pressure gauges.

- o Extrusion System
  - o Replacement or modification of the screw,
  - o Replacement or modification of the extrusion die.

- o Electrical Systems
  - o Installation of spark arresters,
  - o Sealing of electrical control cabinets,
  - o Explosion proof motors and switches.

- o Auxiliary Safety Devices
  - o Ventilation system to prevent the accumulation of hydrocarbon vapors,
  - o Monitoring and alarm systems for hydrocarbon vapors,
  - o Extra fire extinguishers.

- o Production/Aging
  - o Separated from other working areas,
  - o Sprinklered or otherwise protected against fire hazards.

Production and maintenance personnel has to be trained in the safe handling of hydrocarbons, in addition to production training.

The use of CO_2 will require, according to the manufacturer, replacement of the extruder, related to insufficient temperature control on the existing equipment. CO_2 cylinders are usually leased from the supplier company. Detailed description of the required equipment changes are part of the license package and disclosed after signature of a pre-license agreement. Start-up trials will be made under supervision of DOW engineers.

5. PROJECT COSTS

5.1 CAPITAL COST

Following is a summary of the expected incremental cost of investment and related activities to introduce ODS-free technology. These costs, as well as other project cost, are specified and explained in Annex-A (Ajover) and Annex-B (Inaldes).

DESCRIPTION	SUBTOTAL	TOTAL
AJOVER		
o Storage Tanks	80,000	
o Equipment Modifications	270,000	
o Production Safety	245,000	
o Storage Safety	150,000	
o Recycling Safety	150,000	
o Personal Safety	20,000	
o Technology Transfer	20,000	
TOTAL AJOVER		935,000
INALDES		
o Tandem Extruder with CO_2 feeding	800,000	
o Resale Value Existing Extruder	(250,000)	
o Process Trials/Training	45,000	
o Technology Transfer	50,000	
TOTAL INALDES		645,000
o Pre/post Assessment		30,000
o Contingency/Rounding		160,000
TOTAL CAPITAL COST		1,770,000

5.2 OPERATING COSTS

A net incremental operating benefit is expected in both Ajover and Inaldes after the conversion. The net benefit results largely from reduced materials cost, which is greater than increases resulting form higher maintenance, safety and materials handling precaution requirements and additional training. As mentioned above, detailed calculations of the incremental benefits can be found in Annex-A and Annex-B.

The net present value of the incremental operating benefit calculated following the MLF's instruction is about <u>USD 698,000</u>.

5.3 UNIT ABATEMENT COST

a)	ODS Reduction Project Costs	USD 1,770,000
b)	Annual Incremental Benefits	220,000
c)	Capital Recovery Factor (10y/10%)	0.16275
d)	ODS reduction/y (base: 1995)	kg 450,000

Unit Abatement Costs [{a(c)+b}/d] 0.15 USD/kg/yr

7. FINANCING PLAN

The company request the financing of in the amount of:

USD 1,072,000

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP will oversee the implementation of this project and provide technical assistance.

8.2 SCHEDULE

Implementation schedule will start with MLF approval of the project and will end after satisfactory post monitoring.

TASK	TIME FOR COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
MLF Approval	x					
Visit Process Expert	x					
Procurement Preparation	xx					
2. Installation						
Arrival, Customs			x			
Installations				x		
Modifications		xxx	xxx	x		
3. Start-up, Training						
Start-up, training				x		
Commissioning				x		

8.3 PROCUREMENT

UNDP will oversee the procurement of this project, following Agency policies guidelines . UNDP has currently several XPE/PS projects in implementation, resulting in procedural and cost efficiencies.

9. REQUIRED REGULATORY ACTION

The companies have received appropriate building permits for construction related to this project. No regulatory requirement exist related to the use of butane and carbon dioxide.

10. PROJECT IMPACT

This project will eliminate the use of an expected 320t CFC-12 in the first year of implementation. Market growth indicates that this may increase by 10-20% annually in subsequent years. The project employs commercially viable and environmentally acceptable technology.

11. ANNEXES

Annex-A: Detailed Project Information AJOVER
Annex-B: Detailed Project Information INALDES
Annex-C: Technical Assessment

COLOMBIA/XPS.PRD
94-03-05/03

ANNEX-A

SUB-PROJECT AJOVER

1. COMPANY PROFILE

AJOVER is a major manufacturer of disposable and other plastic products in Colombia Its products are sold throughout the Andean Pact. The company is family owned, with shares holdings in Colombia and Panama. The company produces part of its feedstock--i.c. polystyrene--in-house.

Products includes plastic containers, cups, hoses, table ware, and packaging products for the food ware industry such as egg cartons, plates, fast food clams, etc.

The production of plastic products is currently concentrated in a factory in Bogota, consisting of essentially one large production and storage floor.

CFCs are used in the extrusion of polystyrene foam sheet. In 1992 about 160 CFC-12 was consumed. In 1993 this was increased to 190t and future increases of about 15% are expected.

Related to the project to replace CFCs by butane, the company expects to relocate the foam production outside Bogota.

2. PROJECT COSTS

The use of butane to replace CFC-12 in the production process requires encapsulation of the extruder and compartmentalisation of production, staging, thermoforming and recycling area's. these area's have to be monitored on butane gas concentration and protected against fire risk depending on the expected emissions in the different process stages (40% during extrusion, 20% during winding and relocation, 40% during staging or later over a period of 7-20 days).

This compartmentalisation will cause severe production flow problems in the plant for foam as well as other products. The company has therefore decided to relocate the foam production. The calculation of the incremental capital costs does not include such a relocation but is exclusively based on retrofit at current location.

The company will bear the cost of the new construction and related relocation. The incremental costs related to retrofitting without relocation can be applied against these costs.

2.1 CAPITAL COST

2.1.1 INCREMENTAL COST

Incremental cost related to retrofitting at current production site are as follows:

BUDGET ITEM	SUB-TOTAL	TOTAL
A. Butane Tank System		
2 Tanks @ 20,000............	USD 40,000	
Testing.....................	USD 5,000	
Booster Pump................	USD 5,000	
Deodorizing System..........	USD 10,000	
Connecting, Installation....	USD 20,000.........	USD 80,000
B. Fire Safety & Alarm		
Water Sprinkler System......	USD 200,000	
Butane Sensor System........	USD 30,000	
Ventilation Systems.........	USD 70,000.........	USD 300,000
C. Equipment Modifications		
High Pressure Pump..........	USD 60,000	
Extruder Modifications......	USD 90,000	
Automatic Shutdown System...	USD 10,000	
2 Explosion Proof Winders...	USD 110.000.........	USD 270,000
D. Modification of Production/Storage Space		
Fireproof Walls/Doors.......	USD 145,000	
Electrical System...........	USD 55,000	
Fireproof Recycling Silo....	USD 45,000.........	USD 245,000
E. Personal Safety		
Static Dissipating Clothing/Shoes..........	USD 7,000	
Handhold HC Monitor.........	USD 3,000	
Fire Safety Training........	USD 10,000.........	USD 20,000
F. Technology Transfer		
21 days @ 500...............	USD 10,500	
Travel......................	USD 7,500	
Local Expenses (Hotel etc)..	USD 2,000.........	USD 20,000
TOTAL INCREMENTAL CAPITAL COST......................		USD 935,000

2.1.2 PROJECT COST

The company expects the following costs related to relocation of production and retrofitting of equipment:

BUDGET ITEM	AMOUNT
Civil Construction	USD 1,600,000
Equipment	USD 550,000
Storage, Material Handling	USD 1,000,000
Safety Equipment	USD 1,250,000
Moving/reinstallation	USD 1,050,000
Technology Transfer	USD 50,000
TOTAL PROJECT COST	**USD 5,500,000**

It is proposed to apply the incremental cost based on retrofitting against the new construction.

2.2 OPERATING COST

ASSUMPTIONS

- 1 USD = 820 Pesos
- Prices:
  - CFC-12 USD 2.10/kg (CIF Venezuela plus freight to Bogota)
  - Butane USD 0.78/kg CIF Venezuela
0.90/kg incl. freight to Bogota
  - Additives USD 30/t Resin
- Consumption: 190t CFC-12 (equals use of butane)
2000t Polystyrene Resin

MATERIAL

190t CFC-12 @ 2,100..............................USD 399,000
Replaced by:
190t butane @ 900..............................USD 171,000
Additives 10t @ 3,000..........................USD 30,000

Savings/y......................................USD 198,000

OTHER COST

Maintenance 5% of 935,000......................USD 46,750
Insurance......................................USD 15,000
Recurrent safety training and monitoring.........USD 10,000
Additional material handling.....................USD 15,000

Total Other Cost/y..............................USD 86,750

TOTAL INCREMENTAL RECURRENT BENEFIT/Y..................USD 111,250

NET PRESENT VALUE OF INCREMENTAL BENEFIT 353,000

In conclusion, the material savings exceed the cost related to the utilization, shipping and handling of butane at the current site, resulting in a net operating benefit.

BIDDING SPECIFICATION
FOR
THE CONVERSION TO BUTANE IN THE MANUFACTURE OF
POLYSTYRENE FOAM SHEET AT AJOVER

SPECIFICATION A: INSTALLATION OF BUTANE TANK AND PIPING WORKS.

1. To supply and install _______ units of ________ K.L. Tank.
2. To construct footring and concrete slab for tanks.
3. To construct 9" thick x 2 meter height deflection wall approximately 60 ft.
4. To install 2 meter high PVC coated chain link fencing and two gates.
5. To fabricate and install 4 units of deodorizer.
6. To supply 1 unit of Butane pump (low pressure pump) with explosion motor, base plate and by-pass valve.
7. To install all piping system from tanks to low pressure to deodorizer including metering system, pressure switches and return valves.
8. Electrical connection to low pressure pump and high pressure pump.

NOTE:

1) All equipment and work must conform with the local government rules and regulations on the use of hydrocarbon.

2) Submission of drawings to local authorities and insurance company for approval, thereafter testing and Certificate of Approval to be obtained.

SPECIFICATION B: FIRE SAFETY & ALARM SYSTEM

1. To supply, install, testing and commissioning of water sprinkler system at tank storage area together with drawings.

2. to supply and install heat detector c/w wiring in metal conduit and also o/w armored cable to alarm panel.

3. To supply, install, testing and commissioning of gas detection system.

4. To supply, install, testing and commissioning of ventilation systems.

5. To supply, install, testing and commissioning 24" blow-down fans complete with wiring switches (total 10 nos.).

6. To quote unit price for the following:
   a. Portable gas detector.
   b. 45kg trolley mounted Co2 fire extinguisher c/w license.
   c. 10 lbs. Co2 fire extinguisher c/w license.
   d. Static eliminator.

SPECIFICATION C: MODIFICATION & CONVERSION OF EXTRUDED LINE TO CFC-FREE EXTRUDED.

To modify and convert the existing polystyrene and polyethylene foam sheet extruded line to CFC-free extrusion plant. In this case, Butane is to be as blowing agent for the production process

I. High Pressure Pump

II. Auxiliary Equipment
1. 3 HP invertor
2. On/off switch to use in hydrocarbon up to pressure of 500kg/cm3.
3. Pressure gauge up to 500 kg/cm3.
4. 1/4" high pressure pipe per 6m length.
5. 1/4" stainless steel high pressure pipe cross-joint.

III. Drawings and piping diagram for the conversion.

IV. Technical information pertaining to the conversion and know how on the use of butane in the process.

SPECIFICATION D: MODIFICATION OF PRODUCTION/STORAGE SPACE

To modify the existing production hall and storage facilities to allow safe use of butane. Separate compartments required for extrusion, staging and recycling.

1. Installation of fireproof separation walls and doors, to create

    - Extrusion Room ($700m^2$)
    - Warehouse ($1,000m^2$)
    - Recycling Room ($400m^2$)

2. Installation of a recyling silo with internal fire extinguishing system.

3. Explosion proofing of electrical system.

NOTE:

1) All equipment and work must conform with the local government rules and regulations on the use of hydrocarbon as well as with any insurance requirements.

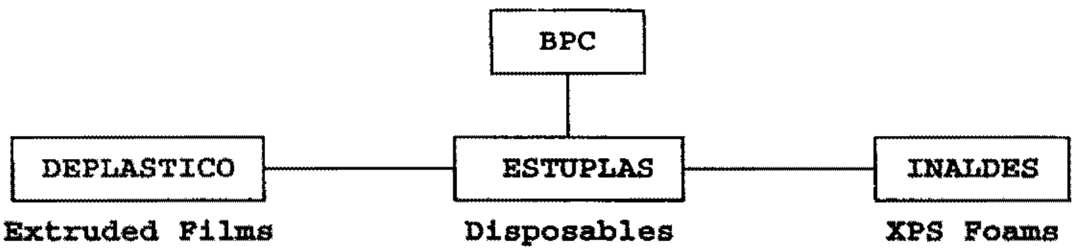
2) Submission of drawings to local authorities and insurance company for approval, thereafter testing and Certificate of Approval to be obtained.

ANNEX-B

SUB-PROJECT INALDES

1. COMPANY PROFILE

Inaldes is currently a subsidiary of Estuplas, a major manufacturer of disposables owned by the BPC Holding Company of the Colombian Bermal Family. The holding is planning a restructuring as follows:



Total employment is about 400.

The XPS foam sheet business was bought in 1991 from DOW Colombia. DOW's brand name "Celpac" is continued for Inaldes' products. The company targets the food industry with disposable plates, clam containers, egg cartons, etc. CFC-12 is used as a blowing agent. the following table shows the historical and predicted consumption of this agent:

YEAR	1990	1991	1992	1993	1994	1995	1996	1997
CFC-12 (t)	80	95	110	130	170	200	240	285

Related to the project to replace CFCs the company intends to relocate and the production and to expand the capacity.

2. PROJECT COST

Inaldes has opted for the use of carbon dioxide as the sole blowing agent. The technology will be provided by DOW Plastics under license. Management of Inaldes is familiar with the DOW technology from the time that DOW owned the facility and feels comfortable that it can work around perceived disadvantages of this technology i.c. a restricted density range and a rougher product surface through co-extrusion (currently under development) and focussing on the upscale market.

The current extruder cannot be retrofitted according to the manufacturer. This has been confirmed by an independent process specialist. Rather than just replacing the unit by the same capacity Inaldes intends to increase the extruder output. The company will pay for the cost related to the capacity increase. Likewise, Inaldes will pay for a relocation away from the current leased facility to new buildings to be constructed and owned by the company.

The existing extruder has a considerable rest value that will be subtracted from the incremental cost. The equipment will be sold under stipulations to be worked out with the Implementing Agency. This to assure that no CFCs will be processed.

2.1 CAPITAL COST

2.1.1 INCREMENTAL COST

The following cost are related to the introduction of carbon dioxide:

BUDGET ITEM	SUB-TOTAL	TOTAL
A. Tandem Extruder with CO_2 Feeding		
Blending System	USD 90,000	
Primary Extruder System	USD 150,000	
Metering System	USD 60,000	
Secondary Extruder System	USD 500,000	USD 800,000
B. Rest Value Existing Extruder		USD (250,000)
C. Technology Transfer		
Down Payment DOW	USD 50,000	
Training/Trials	USD 45,000[2]	USD 95,000
TOTAL INCREMENTAL CAPITAL COST		**USD 645,000**

[2] Based on one engineer/ technician for two months (24,000), Air transportation (10,000), accommodation, local transportation (7,200), misc. & rounding (4,800).

2.1.2 PROJECT COST

The company expects the following cost related to relocation and capacity expansion:

BUDGET ITEM	AMOUNT
Property Acquisition.......................USD	195,000
Civil Construction.........................USD	960,000
New Equipment..............................USD	1,400,000
Relocation/Reinstallation..................USD	100,000
Training/Trials............................USD	65,000
Miscellaneous Cost.........................USD	130,000
Write-off on Disbanded Equipment[3]..........USD	300,000
TOTAL PROJECT COST.........................USD	**3,150,000**

2.2 OPERATING COST

ASSUMPTIONS

- 1 USD = 820 Pesos
- Prices:
  - CFC-12 USD 2.10/kg (CIF Venezuela plus freight to Bogota)
  - CO_2 USD .50/kg
- One part CFC-12 to be replaced by one part CO_2
- Density to be increased by 6%

[3] Value of equipment/structures not to be relocated.......USD 550,000
Expected value of resale...............................USD 250,000

MATERIAL

130t CFC-12 @ 2,100	USD 273,000
130t CO_2 @ 500	USD 65,000
6% Density Increase (58,500kg @ 1.20)	USD 70,200
Additional Royality (975,000 kg @ 0.03)	USD 29,250
INCREMENTAL BENEFIT/Y	**USD 109,000**
NET PRESENT VALUE OF INCREMENTAL BENEFIT	**USD 345,000**

There are no other incremental recurrent cost such as insurance, maintenance, training etc. as CO_2 is safe in use and the equipment is basically the same.

A net recurrent incremental benefit is expected to be realized from the conversion.

TECHNICAL ASSESSMENT

PROJECT TITLE:	Elimination of the Use of ODS in the Polystyrene Foam Sector (Colombia)
CATEGORY:	Foamed Plastics; Thermoplastic Foams
RECOMMENDATION:	The project is supported
INFORMATION:	Adequate, but see "OTHER ISSUES"
TECHNOLOGY:	Acceptable. Despite emerging interest for the use of carbon dioxide, butane remains the most selected phaseout technology. The choice of Inaldes for carbon dioxide is based on experience from previous trials of the licensor in the Inaldes plant. The project should provide interesting information for future reference
REFERENCES:	Similar projects in Egypt, India, Indonesia, Malaysia, PRC, The Philippines, Thailand and Venezuela
ENVIRONMENTAL:	Butane is a VOC and photochemically active. Emerging regulations to be monitored. The carbon dioxide in the DOW process provides no net increase in global CO_2 and is so with an environmentally very attractive solution
SAFETY:	The risks related to the flammability of butane are adequately addressed. UNDP has developed a safety manual that is passed out to AJOVER
COST EFFECTIVENESS:	The costs are high in comparison to other projects but acceptable in view of the particular plant layout and equipment configuration. The cost effectiveness is very good, based on the relatively large size of the operations

OTHER ISSUES:

The project has been substantially modified after preview, leading to a substantially lower grant request

It is recommended that Inaldes provides a letter from DOW stating the willingness to provide Inaldes with the DOW technology and confirming the financial conditions

Inaldes as well as an independent process consultant (Attachment-1) did request a higher budget based on a statement from the machine manufacturer (attachment-2) stating that CO_2 requires a higher output machine. This argument is not accepted by the reviewer and not included in the project. It is the reviewer's standpoint that higher output is not needed, would constitute capacity increase and should therefore be paid by the recipient

Inaldes' project includes replacement of the extruder. This is based on recommendation of the equipment supplier and the process expert. It is recommended that Inaldes prior to implementation provides UNDP as written statement from DOW as technology provider supporting this recommendation

REVIEWER: Bert Veenendaal

DATE: April 16, 1994