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

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Montreal, 13-16 December 1994

PROJECT PROPOSAL: COLOMBIA

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

Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment in the following three enterprises:

(a) Inducol
(b) Indufrial
(c) Wonder

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Colombia	
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment (Three Companies)	
BUDGET:	Capital Costs:	US $789,000
	Operating Costs:	US $286,507
INCREMENTAL COSTS:	US $1,075,507	
ODS PHASE-OUT:	52.4 MT CFCs 11 and 12	
COST EFFECTIVENESS:	US $20.52 per kg ODP saved	
PROJECT DURATION:	18 months	
IMPLEMENTING AGENCY:	UNDP	
NATIONAL COORDINATING AGENCY:	Ministerio del Medio Ambiente	
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _	

SECRETARIAT'S COMMENTS

1. This project covers the conversion of both the refrigeration and foaming systems in three commercial refrigeration enterprises (Inducol, Indufrial and Wonder) to HFC-134a and HCFC-141b respectively. There remains three other enterprises and a score of much smaller producers in this sub-sector in Colombia. The amounts of CFCs to be phased out by this project is estimated at 52.4 metric tonnes per year.

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

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

4. The project includes incremental operating costs (for six months duration) which will be incurred in both the refrigeration and foaming systems.

5. The cost effectiveness of the project is relatively low.

SECRETARIAT'S RECOMMENDATION

6. The Fund Secretariat recommends final approval of the project and the approval of US $1,075,507 in incremental costs as itemised in the following table.

Company	Production Units/year	CFC Consumption MT/year	Capital Cost US $	Operating Costs US $	Total Costs US $
Inducol	14,898	17	299,000	82,548	381,548
Indufrial	28,020	32	268,000	174,644	442,644
Wonder	7,900	7.4	222,000	29,315	251,315
Total	50,820	56.4	789,000	286,507	1,075,507

PROJECT COVER SHEET

COUNTRY:	**COLOMBIA**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment (Three Companies)
SECTORS COVERED:	COMMERCIAL REFRIGERATION
ODS USE IN SECTOR:	81 tons ODS (July '93 - June '94)
PROJECT IMPACT (ODP):	52.4 ODP tons
TOTAL PROJECT COST:	USD 1,075,507
INCREMENTAL CAPITAL COST:	USD 789,000
INCREMENTAL OPERATING COST:	USD 286,507
PROPOSED MLF GRANT:	USD 1,075,507
UNIT ABATEMENT COST:	7.92 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Ministerio del Medio Ambiente
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	August 1994

PROJECT SUMMARY:

The three companies concerned (Inducol, Indufrial and Wonder) are 100% Colombian owned enterprises manufacturing unitary commercial refrigeration equipment solely for the Colombian market. The companies currently uses CFC 11 as a blowing agent in the production of rigid polyurethane insulation foam for the refrigeration 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. The project will eliminate 52.4 ODP tons/year (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 are requested for a period of SIX months.

Prepared by: Stuart Kelly and Bert Veenendaal, in collaboration with the Ministerio del Medio Ambienete.

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

PROJECT OF THE GOVERNMENT OF COLOMBIA

ELIMINATION OF CFCs IN THE MANUFACTURE OF UNITARY COMMERCIAL REFRIGERATION EQUIPMENT

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFCs used by three manufacturers of unitary commercial refrigeration equipment (Inducol, Indufrial and Wonder). 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 a range of commercial refrigerators and freezers.

2. SECTOR BACKGROUND.

Colombia's Country Programme (CP) for the Phase-out of Ozone Depleting Substances (ODS) under the Montreal Protocol was approved at the 12th meeting of the Executive Committee of the Multilateral Fund (MLF) in March 1994.

From the CP, it is estimated that total CFC 11 consumption in Colombia in 1993 amounted to approximately 400 tons, of which 205 tons were used for the production of thermal insulating foams in domestic and commercial refrigeration equipment. Projects to eliminate the 169 tons of CFC 11 consumed in the domestic refrigeration sector were approved at the 13th meeting of the MLF in July 1994. This suggests that the commercial refrigeration sector consumes an estimated 36 tons of CFC 11.

Similarly from the CP, total CFC 12 consumption in Colombia in 1993 is estimated as being approximately 1,500 tons, of which 110 tons were used as refrigerant in the manufacture of domestic and commercial refrigerators and freezers. Projects to eliminate the 76 tons of CFC 12 consumed in domestic refrigerator manufacture were also approved at the 13th meeting of the MLF in July 1994. The estimated consumption of CFC 12 in the commercial refrigeration sector would then be of the order of 34 tons.

It is estimated that approximately 80,000 items of unitary commercial refrigeration equipment were manufactured in Colombia in the past 12 months (July 1993 to June 1994). The products include commercial refrigerators and freezers, bottle coolers, refrigerated and frozen food display cases, drinking water fountains, etc.

It is believed that there are as many as 50 enterprises engaged in the manufacture of such equipment although the majority of these are very small enterprises. Data on production volume and ODS consumption for these enterprises during the period July 1993 to June 1994 is provided in the following table:

Enterprise	Production Volume	CFC 11 Consumption (Tons)	CFC 12 Consumption (Tons)
Indufrial	28,020	21.4	10.7
Inducol	14,898	10.3	6.5
Wonder	7,900	4.4	3.0
Westell *	2,800	2.3	1.3
Friomix	12,000	4.8	3.1
Super Nordico *	2,400	0.7	2.9
Others (estimate)	12,000	6.5	3.1
Totals	80,018	50.4	30.6

Note: * The data for Westell and Super Nordico is for unitary equipment only. Both these enterprises are also engaged in the installation of commercial refrigeration equipment using larger semi-hermetic and open drive compressors.

This then suggests that the total current annual consumption of CFCs in the manufacture of unitary commercial refrigeration equipment in Colombia is approximately 50 tons of CFC 11 and 31 tons of CFC 12, i.e. the consumption of CFC 11 is considerably higher than estimated in the Colombian CP. **TOTAL SECTOR ODS USE IS THEN 81 ODP TONS.**

The **SIX** companies identified in the above table,

Industrias de Refrigeracion Comercial S.A. (Indufrial)
Industrias Colombia S.A. (Inducol)
Industrias Wonder S.A. (Wonder)
Friomix S.A.
Super Nordico S.A.
Westell Refrigeracion Comercial S.A.

account for approximately **85%** of production, and almost **90%** of ODS consumption, in the unitary commercial refrigeration equipment manufacturing sector.

With increasing social stability and confidence in the domestic economy, significant growth in production volume in this sector has ocurred in 1994 versus 1993, and continued growth of circa 7% pa is anticipated for the next several years. Uninhibited growth would lead to an estimated consumption in the year 2000 of 75 tons per year of CFC 11 and 45 tons per year of CFC 12.

The industry imports most raw materials and parts. Compressors are sourced locally from Compresores Andinos, and also from Embraco and Sicom of Brazil, L'Unite Hermetique of France, and Tecumseh (USA).

The Ministerio del Medio Ambiente, 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 this project by the MLF in December 1994 will result in the elimination of a significant part of the CFCs used in the manufacture of unitary commercial refrigeration equipment in Colombia during 1996. Additional projects in the commercial refrigeration sector will be prepared for submission to the MLF in early 1995. The possibility of a Technical Assistance Programme to reduce and subsequently eliminate CFC use at the smaller enterprises manufacturing unitary commercial refrigeration equipment will be considered in due course.

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 machines for the rigid insulation foam 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 each company.

The companies will also require test-runs before being able to start industrial production with the new technology. These activities will include training of staff in the safe handling of HCFC 141b.

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

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 given in para 5.2.3.

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

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 may be 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 unitary commercial refrigeration equipment applications. It combines an attractive price with zero ODP properties. Cyclopentane is not, however, presently available in Colombia.

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

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

- proven technology in both processing and product performance
- environmentally acceptable (as a transitional replacement for CFC 11)
- readily available in the Colombian market

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

4.1.3. IMPACT ON THE PRODUCTION PROCESS

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

The refrigerator/freezer cabinet liner material must be resistant to HCFC 141b. The three companies currently exclusively use metal cabinet 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 and commercial refrigeration equipment using hermetic compressors. 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 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 at the present time.

HFC 152a might be considered as another candidate for CFC 12 replacement in unitary commercial refrigeration equipment. 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 presently commercially available.

4.2.2 SELECTION

The selected technology is HFC 134a. The CFC 12 based technology used by the companies was developed "in house". The new HFC 134a based technology will also be developed by the companies with assistance from compressor and refrigerant suppliers. The companies 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 THE PRODUCTION PROCESS

HFC 134a, like CFC 12, is non-flammable. HFC 134a has also been the subject of extensive toxicological testing and is considered safe in use in industrial applications provided the suppliers recommended occupational exposure limits are not exceeded. At the present time this means ensuring that exposure levels do not exceed 1,000 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 incremental operational cost calculation (see Annex A, Part 2.).

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

Because system cleanliness and moisture content are paramount to the successful manufacture of hermetic compressor based HFC 134a refrigeration systems, the companies 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 the companies will be producing both CFC 12 and HFC 134a based commercial refrigeration equipment during the implementation phase of this project. This is feasible given the configuration of the company's production facilities. This means that there is a requirement for new system evacuation equipment and refrigerant charging equipment at the three companies.

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 three companies request reimbursement to the amount of the project costs of US$ 1,075,507

6. PROJECT IMPLEMENTATION

6.1 MANAGEMENT

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

6.2 SCHEDULE

The time schedule for each companies will be as follows:

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. Commissioning						
Machine Start-up			x			
Trials & Training			xxx	xxx	xx	
Mass Production Change					x	xx
Certification						x

7. PROJECT IMPACT

This project will eliminate the use of 52.4 tons of CFC's per year. This is based on figures for the 12 months, July 1993 - June 1994.

ANNEX 1 -- INDUCOL

COUNTRY:	**COLOMBIA**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industrias Colombia S.A. (Inducol)
SECTORS COVERED:	COMMERCIAL REFRIGERATION
ODS USE IN SECTOR:	81 tons ODS (July '93 - June '94)
PROJECT IMPACT (ODP):	15.7 ODP tons
TOTAL PROJECT COST:	USD 381,548
INCREMENTAL CAPITAL COST:	USD 299,000
INCREMENTAL OPERATING COST:	USD 82,548
PROPOSED MLF GRANT:	USD 381,548
UNIT ABATEMENT COST:	8.32 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Ministerio del Medio Ambiente
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	August 1994

PROJECT SUMMARY:

Inducol S.A. is a 100% Colombian owned enterprise manufacturing unitary commercial refrigeration equipment solely for the Colombian market. Inducol S.A. currently uses CFC 11 as a blowing agent in the production of rigid polyurethane insulation foam for the refrigeration 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. The project will eliminate 15.7 ODP tons/year (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 are requested for a period of SIX months.

Prepared by: Stuart Kelly and Bert Veenendaal, in collaboration with the Ministerio del Medio Ambienete.

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

PROJECT OF THE GOVERNMENT OF COLOMBIA

ELIMINATION OF CFCs IN THE MANUFACTURE OF UNITARY COMMERCIAL REFRIGERATION EQUIPMENT

1. PROJECT OBJECTIVE AND BACKGROUND.

See General Section.

2. ENTERPRISE BACKGROUND

Industrias Colombia S.A. (Inducol) accounted for an estimated **18%** of the total production of unitary commercial refrigeration equipment in Colombia in the 12 month period July 1993 to June 1994. More details on Inducol are given below:

CFC USE IN LAST 12 MONTHS: (July 1993 - June 1994)	10.3 tons CFC 11 6.5 tons CFC 12
PLANT LOCATION:	Autopista al Aeropuerto Km 6, E.Soledad, Baranquilla, Colombia
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Colombian)
No. OF MODELS:	22
PRODUCTION IN LAST 12 MONTHS: July 1993 - June 1994	14,898 units
No. OF PRODUCTION LINES:	3
COMPRESSOR SUPPLIERS:	EMBRACO, Brazil (80%) UNITE HERMETIQUE, France (20%)
CONTACT PERSONS:	Cesar Giraldo - Technical V.P. Fabian Llinas - Plant Manager Jairo Olier - Ref. Dept. Manager
TEL / FAX:	Tel: (57 58) 421866, 421956 Fax: (57 58) 421876

Inducol was founded in 1948 and is one of several companies in the SREDNI Investment Group. The Group includes a steel mill, a zinc plating company, and Inducol, which in addition to the production of a wide range of unitary commercial refrigeration equipment also manufactures steel furniture and piping. The Inducol refrigeration equipment includes bottle coolers, chest freezers, "reach-in" freezers, show case refrigerators and freezers, and drinking water

chillers. All production is sold in Colombia. Inducol presently employs 600 persons, of which 400 are involved the refrigeration business. Inducol moved to a new factory site in July 1994. This project encompasses all ODS consumption used in manufacturing operations at Inducol.

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 Inducol has no formal technology transfer agreements with internationally recognised unitary commercial refrigeration equipment manufacturers.

The following tables provide a summary of refrigeration equipment production by Inducol during the 12 month period July 1993 to June 1994 inclusive, as well as other relevant project data.

Model No.	Description	Production Volume Jul93-Jun94	CFC 12 Charge Kgs	CFC 12 Consumption Kgs	PU Foam per Unit Kgs
EIC-280	Bot. Cooler	2,349	0.272	638.9	7.500
EIC-380	Bot. Cooler	2,906	0.363	1,054.9	7.625
EIC-500	Bot. Cooler	2,131	0.408	869.5	8.750
EIC-700	Bot. Cooler	476	0.526	250.4	11.250
EIC-1000	Bot. Cooler	398	0.821	326.8	13.125
CIC-07	Chest Frz	446	0.408	182.0	8.875
CIC-10	Chest Frz	534	0.425	227.0	7.500
CIC-12	Chest Frz	665	0.500	332.5	8.125
CIC-21	Chest Frz	576	0.822	473.5	11.875
VIC-03	Display Ref	2,020	0.363	733.3	9.375
VIC-04	Display Frz	372	0.500	186.0	10.000
VIC-05	Display Ref	302	0.397	119.9	8.750
VIC-06	Display Frz	748	0.862	644.8	12.500
VIC-07	Display Ref	76	0.595	45.2	13.750
VIC-08	Display Frz	80	0.454	36.3	15.625
VIC-09	Display Ref	91	0.482	43.9	17.500
VIC-CURV	Display Ref	100	0.595	59.5	3.125
PIC-10	Rch in Frz	26	0.425	11.1	7.500
PIC-12	Rch in Frz	68	0.500	34.0	8.125
BOTELLON	Water Chlr	116	0.340	39.4	-
GRIFO	Water Chlr	407	0.340	138.4	-
NEVERA	Water Chlr	11	0.397	4.4	-
Total or Weighted Average		14,898	0.433	6,451.7	8.646

Model No.	R12 Compressor Capacity & Cost HP & US$		R134a Compressor Capacity & Cost HP & US$	
EIC-280	1/4H	35.00	1/4H	38.90
EIC-380	1/4H	35.00	1/4H	38.90
EIC-500	1/4H	35.00	1/4H	38.90
EIC-700	1/3H	36.20	1/3H	40.00
EIC-1000	1/2H	97.00	1/2H	107.70
CIC 07	1/4L	46.70	1/4L	47.00
CIC-10	1/4L	46.70	1/4L	47.00
CIC-12	1/3L	49.80	1/3L	55.10
CIC-21	1/2L	99.70	1/2L	110.40
VIC-03	1/4H	35.00	1/4H	38.90
VIC-04	1/4H	35.00	1/4H	38.90
VIC-05	1/4H	35.00	1/4H	38.90
VIC-06	1/3H	36.20	1/3H	40.00
VIC-07	1/3H	36.20	1/3H	40.00
VIC-08	1/2H	97.00	1/2H	107.70
VIC-09	1/4L	46.70	1/4L	47.00
VIC-CURV	1/4H	35.00	1/4H	38.90
PIC-10	1/4L	46.70	1/4L	47.00
PIC-12	1/3L	49.80	1/3L	55.10
BOTELLON	1/8H	26.00	1/8H	29.20
GRIFO	1/4H	35.00	1/4H	38.90
NEVERA	1/8H	26.00	1/8H	29.20
Weighted Average	41.104		45.273	

Key: The number after the bottle cooler (EIC) designation indicates the capacity in number of bottles. The number in the chest freezer designation (CIC) and the reach in freezer designation (PIC) indicates the capacity in cubic feet. The number in the display refrigerators and freezers designation (VIC) indicates the number of display trays.

3. PROJECT DESCRIPTION

Inducol presently uses CFC 11 for the production of rigid insulating foams needed for the refrigeration equipment 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
Inducol	10.3	9.2	6.5	15.7

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

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

- 1 x OMS IMPIANTI high pressure foam injection machine. Throughput 1.25 Kgs/sec. Vintage 1993.
- 1 x Viking 012.80 low pressure foam injection machine. Throughput 1.25 Kgs/sec. Vintage 1986.
- 1 x Gusmer portable low pressure foam injection machine. Throughput 0.08 - 0.10 Kgs/sec. Vintage 1990.

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

- 3 x Airseco A-4053TLB-6-1/L R12 charging units
- 2 x Kinney Model KTC-21 Vacuum Pumps (21 cfm capacity)
- 2 x Edwards Model E2H30 Vacuum Pumps (30 cfm capacity)
- 1 x Marvac Model 1895B Vacuum Pump (23 cfm capacity)
- 1 x CPS "Leak Seeker 770" hand-held R12 Leak Detector
- 1 x Superior Rex "SR-300" hand-held R12 Leak Detector
- 1 x Robinair "14970B Leak Sensor" hand-held R12 Leak Detector

Notes:

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 5 vacuum pumps requested, two will be purchased new to allow for continuous production while retrofitting is being carried out. Three vacuum pumps will be retrofitted.

Given the modest production volume of approximately 15,000 units per annum, changes to the configurations of the existing three production lines were considered to establish whether more efficient use of replacement equipment could reduce the incremental project capital investment costs. Inducol have just (July 1994) relocated their production facilities to a new factory. Changes to the current production layout would be considerably more expensive than the provision of three refrigerant charging units!

4. PROJECT COSTS

4.1. Incremental Capital Costs (US$)

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAM MACHINE (1.25 Kgs/sec)	112,500
RETROFIT OF FOAM MACHINE (0.08 - 0.10 Kgs/sec)	10,000
TRAINING, TEST TRIALS, TECHNOLOGY TRANSFER	10,000
CONTINGENCIES (10%)	14,000
Subtotal (US$)	**146,500**

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (3 units)	75,000
NEW VACUUM PUMPS (2 units)	6,000
VACUUM PUMPS RETROFITTED (3 units)	1,500
LEAK DETECTION EQUIPMENT (3 units)	4,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION, & RELIABILITY TEST TRIALS (8 models)	32,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	14,000
Subtotal (US$)	**152,500**

TOTAL INCREMENTAL CAPITAL COST (US$) **299,000**

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 operating costs were obtained. The costs are sumarised below:

PHASE-OUT OF CFC 11

Cost for materials (see para 5.1): **29,736**

PHASE-OUT OF CFC 12

Cost for materials (see para 5.2): **52,812**

TOTAL INCREMENTAL OPERATING COST (US$) **82,548**

4.3 TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operating)	**381,548**
% Article 5.1 Country Ownership	**100%**
FUNDING REQUESTED FROM THE MLF (US$)	**381,548**

4.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Cost (US$)	**299,000**
b. Capital Recovery Factor (10% p.a.)	**0.16275**
c. Incremental Operating Costs/Benefits	**82,548**
d. ODS Reduction (ODP Kgs July 93 - June 94)	**15,700**
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	**8.32**

THE PROJECT UNIT ABATEMENT COST IS 8.32 US$/Kg

5.1. INCREMENTAL OPERATIONAL COST CALCULATIONS

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

Inducol S.A.	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.380	0.388	0.008
b. MDI	0.540	0.540	-
c. Kg Blowing Agent	0.080	0.072	(0.008)
Prices in US$/Kg			
d. Polyol	2.50	2.65	0.15
e. MDI	2.00	2.00	-
f. Blowing Agent	1.80	4.00	2.20
g. Liner (Type: Metal)	N/A	N/A	-
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.950	1.028	0.078
i. = b. x e. MDI	1.080	1.080	-
j. = c. x f. Blowing Agent	0.144	0.288	0.144
k. = h+i+j Total Cost per Kg of Foam	2.174	2.396	0.222
Materials Used per Refrigerator			
l. Kg of Foam per Refrigerator (avg)	8.646	9.511	0.865
m. Kg of Liner material per refrigerator (avg)	-	-	-
Cost per Refrigerator			
n. = l. x k. for Foam	18.796	22.788	3.992
o. = m. x g. for Liner	-	-	-
p. = n. + o. Total per Refrigerator	18.796	22.788	3.992
q. = No. of Refrigerators (see Note 1.)	7,449		
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)	**29,736**		

(see also Note 1. and Note 2. below)

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

Inducol S.A.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.40	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.433	0.390	
c. No. of Refrigerators Produced (see Note 1.)	7,449	7,449	
1d. Cost for Refrigerant = a x b x c	7,741	26,146	18,405
2. Compressors			
a. Cost per Compressor (see Note 2.)	41.104	45.273	
b. No. of Compressors (see Note 1.)	7,449	7,449	
2c. Cost for Compressors = a x b	306,184	337,239	31,055
3. Condensers			
a. Cost per Condenser	N/C	N/C	
b. No. of Condensers (see Note 1.)	7,449	7,449	
3c. Cost for Condensers = a x b	-	-	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.810	0.970	
b. No. of Filter/Dryers (see Note 1.)	7,449	7,449	
4c. Cost for Filter/Dryers = a x b	6,034	7,226	1,192
5. Capillary Tubes			
a. Cost per Capillary Tube	1.530	1.820	
b. No. of Capillary Tubes (see Note 1.)	7,449	7,449	
5c. Cost for Capillary Tubes = a x b	11,397	13,557	2,160
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c		**52,812**	

Note 1. Figures in the above tables are based on actual production volume for the period July 1993 to June 1994 obtained from Inducol at the time of project preparation. In accordance with the decision of the 12th Meeting of the MLF Executive Committee regarding Incremental Operational Cost calculation, anticipated growth has not been included.

Note 2. All prices used in the above tables are either Colombian National prices, or weighted average 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: COLOMBIA

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industrias Colombia S.A. (Inducol)

Sector/sub-sector Commercial refrigeration

Relationship to country program (UNDP)

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

Inducol 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 commercial refrigeration, unitary equipment, 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 14.7 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: 20 October 1994

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1. **COUNTRY:** Colombia

2. **PROJECT TITLE:** Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industrias Colombia S.A. (Inducol)
Note: This review deals only with the foam blowing agent conversion.

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

4. **CP RELATIONSHIP:** The project refers to the CP in the background sector. During project formulation, much more detailed information on the commercial refrigeration sector was obtained which is included in the project.

5. **TECHNOLOGY:** The different technical possibilities to replace CFC 11 in the insulation foam in the refrigerator are well described, with their advantages and disadvantages. Replacement with HCFC 141b is, considering all circumstances, the best choice which could be made for the reasons explained in the project text. Furthermore, the use of HCFC 141b leads to only a minor increase of the lambda value for the PU-panel, whereas other solutions would have led to more important increases. This is an important factor in refrigeration which leads to lower electricity costs. Furthermore HCFC 141b is safe to work with.

6. **ENVIRONMENTAL IMPACT:**
HCFC 141b presents a relatively low ODP of O.11 and may have some GWP of 0.1 as compared to the GWP of CFC 11. No particular toxicological problems are faced when the treshold limit values (TLV) are respected (eg 500 ppm for HCFC 141b).

7.	**PROJECT COSTS:**	The project costs as presented are realistic and may be accepted. The price to eliminate 1 ton of ODP is 31,956 US$.
8.	**IMPLEMENTATION:**	The 1.5 year projected refers to the refrigeration part and not to the replacement of CFC 11 by HCFC 141b which can be performed more rapidly.
9.	**RECOMMENDATION:**	Approval as proposed.

ANNEX 2 : INDUFRIAL

COUNTRY:	**COLOMBIA**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industrias de Refrigeracion Comercial S.A. (Indufrial)
SECTOR COVERED:	COMMERCIAL REFRIGERATION
ODS USE IN SECTOR:	81 tons ODS (July '93 - June '94)
PROJECT IMPACT (ODP):	29.8 ODP tons
TOTAL PROJECT COST:	USD 442,644
INCREMENTAL CAPITAL COST:	USD 268,000
INCREMENTAL OPERATING COST:	USD 174,644
PROPOSED MLF GRANT:	USD 442,644
UNIT ABATEMENT COST:	7.3 U$/kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Ministerio del Medio Ambiente
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	August 1994

PROJECT SUMMARY:

Indusfrial S.A. is a 100% Colombian owned enterprise manufacturing unitary commercial refrigeration equipment both for the Colombian and other Pacto Andinos countries. Indufrial S.A. currently uses CFC 11 as a blowing agent in the production of rigid polyurethane insulation foam for the refrigeration 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 27.5 tons-ODP/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 are requested for a period of SIX months.

Prepared by: Stuart Kelly and Bert Veenendaal, in collaboration with the Ministerio del Medio Ambiente.

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

PROJECT OF THE GOVERNMENT OF COLOMBIA

ELIMINATION OF CFCs IN THE MANUFACTURE OF UNITARY COMMERCIAL REFRIGERATION EQUIPMENT

1. PROJECT OBJECTIVE AND BACKGROUND.

See General Section

2. ENTERPRISE BACKGROUND

Industrias de Refrigeracion Comercial S.A. (Indufrial) accounted for an estimated **35%** of the total production of unitary commercial refrigeration equipment in Colombia in the 12 month period July 1993 to June 1994. More details on Indufrial are given below:

CFC USE IN LAST 12 MONTHS: (July 1993 - June 1994)	21.4 tons CFC 11 10.7 tons CFC 12
PLANT LOCATION:	Calle 21 No. 49-39 Bosque, Cartagena de Indias, Colombia
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Colombian)
No. OF MODELS:	10
PRODUCTION IN LAST 12 MONTHS: July 1993 - June 1994	28,020 units
No. OF PRODUCTION LINES:	4
COMPRESSOR SUPPLIERS:	EMBRACO, Brazil (70%) SICOM, Brazil (20%) COMANDINOS, Colombia (10%)
CONTACT PERSONS:	Alejandro Cardenas O - Production Mgr Enrique F. Zurek - Systems Mgr Javier Torres Posada - Eng. Dept.
TEL / FAX:	Tel: (57 56) 625161/625096 Fax: (57 56) 625929

Indufrial was founded in 1956 and is solely engaged in the manufacture of a wide range of unitary commercial refrigeration equipment, including bottle coolers, chest freezers, "reach-in" freezers and show case freezers. 97% of production is sold in Colombia, with the rest exported to Pacto Andino markets. The

company presently employs 400 persons. This project encompasses all ODS consumption used in manufacturing operations at Indufrial.

The existing CFC technology was developed "in house" with the assistence of compressor and refrigerant suppliers. The CFC replacement technology will be developed by the same process. Currently Indufrial has no formal technology transfer agreements with internationally recognised commercial refrigeration equipment manufacturers.

The following tables provide a summary of unitary refrigeration equipment production by Indufrial during the 12 month period July 1993 to June 1994 inclusive, as well as other relevant project data.

Model No.	Description	Production Volume Jul93-Jun94	CFC 12 Charge Kgs	CFC 12 Consumption Kgs	PU Foam per Unit Kgs
BGL-550	Bot. Cooler	7,940	0.435	3,435.9	5.60
BGL-350	Bot. Cooler	9,060	0.295	2,672.7	4.60
ICH-22	Chest Frz	2,760	0.570	1,573.2	7.60
ICH-15	Chest Frz	790	0.500	395.0	6.20
ICH-8	Chest Frz	2,160	0.360	776.6	4.60
IC-5	Chest Frz	1,460	0.170	248.2	2.80
INPV-12	Reach-in Frz	1,190	0.230	273.7	4.30
IVD-23-3	Display Frz	2,130	0.420	894.6	4.10
IVD-30-4	Display Frz	410	0.825	338.3	5.10
IVD-45-6	Display Frz	120	0.920	110.4	6.40
Total or Weighted Average		28,020	0.383	10,737.6	5.10

Key: The number after the bottle cooler (BGC) designation indicates the capacity in numbers of bottles. For the remaining equipment the number in the model designation refers to the capacity in cubic feet. The letter "V" in the model designation denotes glass doors. Frz = Freezer.

Model No.	R12 Compressor Capacity & Cost (HP & US$)	R134a Compressor Capacity & Cost (HP & US$)	R12 Condenser & Fan Cost US$	R134a Condenser & Fan Cost US$
BGL-550	1/4 39.77	1/4 42.57	21.0	21.0
BGL-380	1/5 34.90	1/5 37.70	10.0	10.0
ICH-22	1/3 44.34	1/2 51.22	21.0	28.0
ICH-15	1/3 44.34	1/2 51.22	21.0	28.0
ICH-8	1/5 35.80	1/4 43.08	10.0	21.0
IC-5	1/8 31.48	1/6 35.99	9.5	11.4
INPV-12	1/5 34.90	1/5 37.70	10.0	10.0
IVD-23-3	1/5 35.80	1/4 43.08	10.0	21.0
IVD-30-4	1/4 40.28	1/3 47.14	21.0	21.0
IVD-45-6	1/3 44.34	1/2 51.22	21.0	28.0
Weighted Average	37.47	41.72	14.69	17.39

Key: The number after the bottle cooler (BGC) designation indicates the capacity in numbers of bottles. For the remaining equipment the number in the model designation refers to the capacity in cubic feet. The letter "V" in the model designation denotes glass doors. Frz = Freezer.

Note: In SEVEN out of the TEN refrigerator/freezer models the existing compressor capacity is close to the limit in respect of achieving design cooling performance. With a reduction in cooling capacity resulting from the different thermodynamic properties of HFC 134a, in changing to the new technology it is necessary to increase the compressor capacity to achieve the design cooling performance. These changes have an impact on the incremental operating costs of this project proposal as indicated in the average incremental compressor price increase which is higher than normal.

3. PROJECT DESCRIPTION

Indufrial presently uses CFC 11 for the production of rigid insulating foams needed for the refrigeration equipment 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
Indufrial	21.4	19.1	10.7	29.8

Note *: 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 Indufrial on which the technology change to HCFC 141b will impact is as follows:

- 1 x Elastogram Puromat high pressure foam injection machine. Throughput 0.2 to 2.0 Kgs/sec. Vintage 1987.
- 1 x Elastogram Puromat high pressure foam injection machine. Throughput 0.2 to 2.0 Kgs/sec. Vintage 1993.

- 1 x Decker low pressure foam injection machine. Throughput 0.08 to 0.10 Kgs/sec. Vintage not known.

3.2. Replacement of CFC 12 with HFC 134a.

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

- 4 x Danfoss 118-500100 R12 refrigerant charging units
- 2 x Kinney Model KTC-21 Vacuum Pumps (21 cfm capacity)
- 1 x Kinney Model KTC-35 Vacuum Pump (35 cfm capacity)
- 2 x Kinney Model KS-13 Vacuum Pumps (13 cfm capcity)
- 1 x Kinney Model KC-8 Vacuum Pump (8 cfm capacity)
- 1 x GE H-25 R12 Electronic Leak Detector
- 1 x GE H-10B hand-held R12 Electronic Leak Detector

Notes:
All the vacuum pumps are in service. 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.

Given the modest production volume, changes to the configurations of the 4 existing production lines were considered to establish whether more efficient use of replacement equipment could reduce the incremental project capital investment costs. With over 40 different designs, the range of refrigerator/freezer cabinet sizes, and the constraints imposed by the building design and other production operations, it was concluded that it was more cost effective to maintain the existing layout.

4. PROJECT COSTS

4.1. INCREMENTAL CAPITAL COSTS (US$)

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAM MACHINE (4.8 - 6.0 Kgs/min)	55,000
TRAINING, TEST TRIALS, TECHNOLOGY TRANSFER	10,000
CONTINGENCIES (10%)	10,000
Subtotal (US$)	**75,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (4 units)	100,000
NEW VACUUM PUMPS (2 units)	6,000
VACUUM PUMPS RETROFITTED (4 units)	2,000
LEAK DETECTION EQUIPMENT (2 units)	7,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION, & RELIABILITY TEST TRIALS (10 models)	40,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	18,000
Subtotal (US$)	**193,000**

TOTAL INCREMENTAL CAPITAL COST (US$)	**268,000**

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 operationing costs were obtained. The costs are summarised below:

PHASE-OUT OF CFC 11	
Cost for Materials (see Para 5.1)	**43,767**
PHASE-OUT OF CFC 12	
Cost for Materials (see Para 5.2)	**130,877**
TOTAL INCREMENTAL OPERATING COST (US$)	**174,644**

4.3 TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operating)	**442,644**
% Article 5.1 Country Ownership	**100%**
FUNDING REQUESTED FROM THE MLF (US$)	**442,644**

4.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Cost (US$)		268,000
b. Capital Recovery Factor (10% p.a.)		0.16275
c. Incremental Operating Costs/Benefits		174,644
d. ODS Reduction (ODP Kgs July 93 - June 94)		29,800
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	7.3	

THE PROJECT UNIT ABATEMENT COST IS 8.32 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$)

Indufrial S.A.	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.350	0.365	0.150
b. MDI	0.500	0.500	-
c. Kg Blowing Agent	0.150	0.135	(0.150)
Prices in US$/Kg			
d. Polyol	2.50	2.65	0.15
e. MDI	2.00	2.00	-
f. Blowing Agent	1.80	4.00	2.20
g. Liner (Type: Metal)	N/A	N/A	
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.875	0.967	0.092
i. = b. x e. MDI	1.000	1.000	-
j. = c. x f. Blowing Agent	0.270	0.540	0.270
k. = h+i+j Total Cost per Kg of Foam	2.145	2.507	0.362
Materials Used per Refrigerator			
l. Kg of Foam per Refrigerator (avg)	5.10	5.61	0.45
m. Kg of Liner material per refrigerator (avg)	N/A	N/A	-
Cost per Refrigerator			
n. = l. x k. for Foam	10.940	14.064	3.124
o. = m. x g. for Liner	-	-	-
p. = n. + o. Total per Refrigerator	10.940	14,064	3.124
q. = No. of Refrigerators (see Note 1.)	14,010		
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)	**43,767**		

(see also Note 1. and Note 2. below)

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

Indufrial S.A.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.40	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.383	0.345	
c. No. of Refrigerators Produced (see Note 1.)	14,010	14,010	
1d. Cost for Refrigerant = a x b x c	12,878	43,501	30,623
2. Compressors			
a. Cost per Compressor (see Note 2.)	37.47	41.72	
b. No. of Compressors (see Note 1.)	14,010	14,010	
2c. Cost for Compressors = a x b	524,955	584,497	59,542
3. Condensers			
a. Cost per Condenser & Fan	14.69	17.39	
b. No. of Condensers (see Note 1.)	14,010	14,010	
3c. Cost for Condensers = a x b	205,807	243,634	37,827
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.48	0.60	
b. No. of Filter/Dryers (see Note 1.)	14,010	14,010	
4c. Cost for Filter/Dryers = a x b	6,725	8,406	1,681
5. Capillary Tubes			
a. Cost per Capillary Tube	0.548	0.634	
b. No. of Capillary Tubes (see Note 1.)	14,010	14,010	
5c. Cost for Capillary Tubes = a x b	7,678	8,882	1,204
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c	**130,877**		

Note 1. Figures in the above tables are based on actual production volume for the period July 1993 to June 1994 obtained from Indufrial at the time of project preparation. In accordance with the decision of the 12th Meeting of the MLF Executive Committee regarding Incremental Operational Cost calculation, anticipated growth has not been included.

Note 2. All prices used in the above tables are either Colombian National prices, or weighted average 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: COLOMBIA

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industrias de Refrigeracion Comercial S.A. (Indufrial)

Sector/sub-sector Commercial refrigeration
Relationship to country program (UNDP)

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

Indufrial 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 commercial refrigeration, unitary equipment, a GWP of this magnitude is negligible.

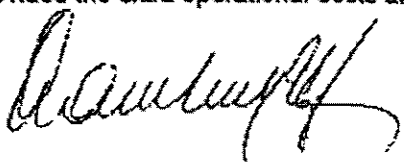
Project costs
The equipment requested by the manufacturer is essential for the conversion process. Costs of equipment, training, testing and external support are reasonable.
Operational costs are relatively high due to the fact that for 7 out for the 10 models the CFC-12 compressor is changed to a higher capacity HFC-134a compressor. As a consequence also a larger and more expensive condenser is requested for those models. Strictly speaking, this larger compressor should not be necessary. It should be demonstrated why these models do need a larger compressor.
If the UAC value is calculated for the refrigerant part separately a value of 17.3 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, provided the extra operational costs are motivated

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: 20 October 1994

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1. **COUNTRY:** Colombia

2. **PROJECT TITLE:** Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industrias de Refrigeracion Comercial S.A. (Indufrial)
Note: This review deals only with the foam blowing agent conversion.

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

4. **CP RELATIONSHIP:** The project refers to the CP in the background sector. During project formulation, much more detailed information on the commercial refrigeration sector was obtained which is included in the project.

5. **TECHNOLOGY:** The different technical possibilities to replace CFC 11 in the insulation foam in the refrigerator are well described, with their advantages and disadvantages. Replacement with HCFC 141b is, considering all circumstances, the best choice which could be made for the reasons explained in the project text. Furthermore, the use of HCFC 141b leads to only a minor increase of the lambda value for the PU-panel, whereas other solutions would have led to more important increases. This is an important factor in refrigeration which leads to lower electricity costs. Furthermore HCFC 141b is safe to work with.

6. **ENVIRONMENTAL IMPACT:** HCFC 141b presents a relatively low ODP of O.11 and may have some GWP of 0.1 as compared to the GWP of CFC 11. No particular toxicological problems are faced when the treshold limit values (TLV) are respected (eg 500 ppm for HCFC 141b).

7.	**PROJECT COSTS:**	The project cost as presented is realistic and may be accepted. The price to eliminate 1 ton of ODP is 8,396 US$
8.	**IMPLEMENTATION:**	The 1.5 year projected refers to the refrigeration part and not to the replacement of CFC 11 by HCFC 141b which can be performed more rapidly.
9.	**RECOMMENDATION:**	Approval as proposed.

ANNEX 3 : WONDER

COUNTRY:	**COLOMBIA**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industrias Wonder S.A. (Wonder)
SECTOR COVERED:	COMMERCIAL REFRIGERATION
ODS USE IN SECTOR:	81 tons ODS (July '93 - June '94)
PROJECT IMPACT (ODP):	6.9 ODP tons
TOTAL PROJECT COST:	USD 251,315
INCREMENTAL CAPITAL COST:	USD 222,000
INCREMENTAL OPERATING COST:	USD 29,315
PROPOSED MLF GRANT:	USD 251,315
UNIT ABATEMENT COST:	9.5 U$/kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Ministerio del Medio Ambiente
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	August 1994

PROJECT SUMMARY:

Industrias Wonder S.A. is a 100% Colombian owned enterprise manufacturing unitary commercial refrigeration equipment solely for the Colombian market. Wonder currently uses CFC 11 as a blowing agent in the production of rigid polyurethane insulation foam for the refrigeration 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 6.9 ODP tons/yr (based on August 1993 - July 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 are requested for a period of SIX months.

Prepared by: Prepared by Stuart Kelly and Bert Veenendaal, in collaboration with the Ministerio del Medio Ambiente.

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

PROJECT OF THE GOVERNMENT OF COLOMBIA

ELIMINATION OF CFCs IN THE MANUFACTURE OF UNITARY COMMERCIAL REFRIGERATION EQUIPMENT

1. PROJECT OBJECTIVE AND BACKGROUND.

See General Section.

2. ENTERPRISE BACKGROUND

Industrias Wonder S.A. (Wonder) accounted for an estimated **10%** of the total production of unitary commercial refrigeration equipment in Colombia in the 12 month period July 1993 to June 1994. More details on Wonder are given below:

CFC USE IN LAST 12 MONTHS: (Aug 1993 - July 1994)	4.4 tons CFC 11 3.0 tons CFC 12
PLANT LOCATION:	Autopista A Giron Variante Chimita El Palengue, Bucaramanga, Colombia
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Colombian)
No. OF MODELS:	15
PRODUCTION IN LAST 12 MONTHS: (Aug 1993 - July 1994)	7,900 units
No. OF PRODUCTION LINES:	1
COMPRESSOR SUPPLIER:	TECUMSEH, USA (100%)
CONTACT PERSONS:	Orlando Chona V. - General Manager Armando Aragon - Plant Manager Luis Fernando Lizarazo- Mktg & TS Mgr
TEL / FAX:	Tel: (57 6) 468041, 468042 Fax: (57 6) 469230

Wonder was founded in July 1975 and the enterprise is engaged in manufacturing a diverse range of commercial goods and equipment. This includes unitary commercial refrigeration equipment such as refrigerators, freezers, display cabinets, and bottle chillers which Wonder began manufacturing in February 1989. All production is sold in Colombia. Wonder presently employs 175 persons, of which 65 are involved the refrigeration business. The company has plans to commence the production of domestic refrigerators in 1995.

This project encompasses all the current ODS consumption used in manufacturing operations at Wonder.

The existing CFC technology was developed "in house" with the assistance of compressor and refrigerant suppliers. The CFC replacement technology is being developed by the same process. Currently Industrias Wonder S.A. has no formal technology transfer agreements with internationally recognised unitary commercial refrigeration equipment manufacturers. However, it should be recognised that Wonder purchase "matched component kits", comprising compressor, condenser, and condenser fan etc. from Tecumseh, Michigan, USA.

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

Model No.	Production Volume	CFC 12 Charge Kgs	CFC 12 Consumption Kgs	PU Foam per Unit Kgs
BC-200	552	0.280	154.6	2.65
BC-400	2,812	0.336	944.8	4.10
BC-600	1,601	0.448	717.3	4.65
BC-800	412	0.504	207.7	6.00
CC-5	5	0.280	1.4	2.10
CC-9	588	0.292	171.7	2.65
CC-13	748	0.345	258.1	4.10
CC-17	438	0.463	202.8	4.65
CC-21	382	0.597	228.1	6.00
CD-9	28	0.292	8.2	3.65
CD-13	26	0.345	9.0	4.30
VPU-13	75	0.420	31.5	4.00
VPU-17	83	0.476	39.5	4.60
VPH-15	121	0.280	33.9	2.65
VPHD-15	29	0.448	13.0	3.65
Total or Weighted Average	7,900	0.383	3,021.6	4.21

Key: The number after the Bottle Cooler (BC) designation indicates the capacity in numbers of bottles. For the remaining equipment, the number in the model designation refers to the capacity in cubic feet. The letter "V" designates units with glass doors.

Model No.	Description	Compressor HP	R12 Compressor, Condenser, & Fan Kit Price US$	R134a Compressor, Condenser, & Fan Kit Price US$
BC-200	Bottle Cooler	1/4	106.20	108.73
BC-400	Bottle Cooler	1/4	106.20	108.73
BC-600	Bottle Cooler	1/3	113.30	116.04
BC-800	Bottle Cooler	1/2	139.80	142.14
CC-5	Chest Freezer	1/4	106.20	108.73
CC-9	Chest Freezer	1/4	106.20	108.73
CC-13	Chest Freezer	1/4	106.20	108.73
CC-17	Chest Freezer	1/3	113.30	116.04
CC-21	Chest Freezer	1/2	139.80	142.14
CD-9	Chest Freezer	1/4	106.20	108.73
CD-13	Chest Freezer	1/4	106.20	108.73
VPU-13	Vertical Ref	1/4	106.20	108.73
VPU-17	Vertical Ref	1/4	106.20	108.73
VPH-15	Horizont Ref	1/4	106.20	108.73
VPHD-15	Horizont Ref	1/4	106.20	108.73
Weighted Average			111.41	113.98

Key: The number after the Bottle Cooler (BC) designation indicates the capacity in numbers of bottles. For the remaining equipment, the number in the model designation refers to the capacity in cubic feet. The letter "V" designates units with glass doors.

3. PROJECT DESCRIPTION

Wonder presently uses CFC 11 for the production of rigid insulating foams needed for the refrigeration equipment cabinets and doors, and uses CFC 12 as refrigerant. The total consumption in the 12 months August 1993 - July 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
Wonder	4.4	3.9	3.0	6.9

Note *: 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 Wonder on which the technology change to HCFC 141b will impact is as follows:

- 1 x OMS 2001/C60 foam injection machine (Vintage 1989)

3.2. Replacement of CFC 12 with HFC 134a.

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

- 1 x Airseco 5405 R12 charging unit (1988)
- 1 x Leybold Model 701-002.G1 Vacuum Pump
- 1 x Kinney KTC Compound Vacuum Pump
- 2 x Ritchie Yellow Jacket Model 9300 Vacuum Pumps (5 cfm)
- 1 x Leybold Inficon HLD 3000 R12 Leak Detector
- 2 x Leybold hand-held R12 leak detectors

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 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 (US$)

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAM MACHINE	100,000
TRAINING, TEST TRIALS, 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
VACUUM PUMPS RETROFITTED (2 units)	1,000
LEAK DETECTION EQUIPMENT (3 units)	7,500
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION & RELIABILITY TEST TRIALS (8 models)	32,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	9,500
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 August 1993 to July 1994 inclusive and ignoring growth. Paragraph provides detailed explanations on how the incremental operating costs were obtained, the costs are summarised below:

PHASE-OUT OF CFC 11 for Materials (see para 5.1):	9,622
PHASE-OUT OF CFC 12 for Materials (see para 5.2):	19,693
TOTAL INCREMENTAL OPERATING COST (US$)	29,315

4.3 TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operating)	251,315
% Article 5.1 Country Ownership	100%
FUNDING REQUESTED FROM THE MLF (US$)	251,315

4.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Cost (US$)	222,000
b. Capital Recovery Factor (10% p.a.)	0.16275
c. Incremental Operating Costs/Benefits	29,315
d. ODS Reduction (ODP Kgs August 93 - July 94)	6,900
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	9.5

THE PROJECT UNIT ABATEMENT COST IS 9.5 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 Wonder S.A.	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.395	0.408	0.013
b. MDI	0.474	0.474	-
c. Kg Blowing Agent	0.131	0.118	(0.013)
Prices in US$/Kg			
d. Polyol	2.50	2.65	0.15
e. MDI	2.00	2.00	-
f. Blowing Agent	1.80	4.00	2.20
g. Liner (Type: Metal)	N/A	N/A	N/A
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.988	1.081	
i. = b. x e. MDI	0.948	0.948	
j. = c. x f. Blowing Agent	0.236	0.472	
k. = h+i+j Total Cost per Kg of Foam	2.172	2.501	0.329
Materials Used per Refrigerator			
l. Kg of Foam per Refrigerator (avg)	4.21	4.63	0.42
m. Kg of Liner material per refrigerator (avg)	N/A	N/A	
Cost per Refrigerator			
n. = l. x k. for Foam	9.144	11.580	2.436
o. = m. x g. for Liner	-	-	-
p. = n. + o. Total per Refrigerator	9.144	11.580	2.436
q. = No. of Refrigerators (see Note 1.)	3,950		
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)	9,622		

(see also Note 1. and Note 2. below)

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

Industrias Wonder S.A.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.40	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.383	0.345	
c. No. of Refrigerators Produced (see Note 1.)	3,950	3,950	
1d. Cost for Refrigerant = a x b x c	3,631	12,265	8,634
2. Compressors & Condensers			
a. Cost per Compressor & Condenser (see Note 2)	111.41	113.98	
b. No. of Compressors & Condensers (see Note 1)	3,950	3,950	
2c. Cost for Compressors & Condensers = a x b	440,070	450,221	10,151
3. Condensers			
a. Cost per Condenser (included above)	-	-	
b. No. of Condensers (see Note 1.)	-	-	
3c. Cost for Condensers = a x b	-	-	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.620	0.740	
b. No. of Filter/Dryers (see Note 1.)	3,950	3,950	
4c. Cost for Filter/Dryers = a x b	2,449	2,923	474
5. Capillary Tubes			
a. Cost per Capillary Tube	0.290	0.400	
b. No. of Capillary Tubes (see Note 1.)	3,950	3,950	
5c. Cost for Capillary Tubes = a x b	1,146	1,580	434
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c		19,693	

Note 1. Figures in the above tables are based on actual production volume for the period August 1993 to July 1994 inclusive obtained from Industrias Wonder S.A. at the time of project preparation. In accordance with the decision of the 12th Meeting of the MLF Executive Committee regarding Incremental Operational Cost calculation, anticipated growth has not been included.

Note 2. All prices used in the above tables are either Colombian National prices, or weighted average prices. Because compressors and condensers are purchased together as a "kit", the calculation of incremental operational costs for these items is based on the combined "kit" 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: COLOMBIA

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industrias Wonder S.A. (Wonder)

Sector/sub-sector Commercial refrigeration

Relationship to country program (UNDP)

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

Wonder 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 commercial refrigeration, unitary equipment, 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 16.1 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: 20 October 1994

1.	**COUNTRY:**	Colombia
2.	**PROJECT TITLE:**	**Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industrias Wonder S.A. (Wonder)** **Note: This review deals only with the foam blowing agent conversion.**
3.	**(SUB) SECTOR:**	Commercial Refrigeration -- Foamed Plastics
4.	**CP RELATIONSHIP:**	**The project refers to the CP in the background sector. During project formulation, much more detailed information on the commercial refrigeration sector was obtained which is included in the project.**
5.	**TECHNOLOGY:**	**The different technical possibilities to replace CFC 11 in the insulation foam in the refrigerator are well described, with their advantages and disadvantages. Replacement with HCFC 141b is, considering all circumstances, the best choice which could be made for the reasons explained in the project text. Furthermore, the use of HCFC 141b leads to only a minor increase of the lambda value for the PU-panel, whereas other solutions would have led to more important increases. This is an important factor in refrigeration which leads to lower electricity costs. Furthermore HCFC 141b is safe to work with.**

6. ENVIRONMENTAL IMPACT:

HCFC 141b presents a relatively low ODP of O.11 and may have some GWP of 0.1 as compared to the GWP of CFC 11. No particular toxicological problems are faced when the treshold limit values (TLV) are respected (eg 500 ppm for HCFC 141b).

7.	**PROJECT COSTS:**	The project cost as presented is realistic and may be accepted. The price to eliminate 1 ton of ODP is 42,083 US$.
8.	**IMPLEMENTATION:**	The 1.5 year projected refers to the refrigeration part and not to the replacement of CFC 11 by HCFC 141b which can be performed more rapidly.
9.	**RECOMMENDATION:**	Approval as proposed.