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Implementation of the Montreal Protocol

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PROJECT PROPOSAL: MAURITIUS

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 domestic refrigerators in the following two enterprises:

  (a) A.H. Bahemia
  (b) Blyfridge Ltd.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Mauritius
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Two Enterprises (A.H. Bahemia, Blyfridge Ltd.)
BUDGET:	US $410,708
INCREMENTAL COSTS:	US $440,000 Incremental capital cost US $ 22,500 Incremental operational cost
COST EFFECTIVENESS[1]:	US $18.45/Kg. ODP
PROJECT DURATION:	1.5 years
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	Ministry of Environment & Quality of Life, Department of Environment
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. This project covers the conversion of both the refrigeration and foaming systems in two commercial enterprises to HFC-134a and HCFC-141b respectively. The two enterprises are the only manufacturers of domestic refrigerators and freezers in Mauritius. The quantity of CFCs to be phased out by this project is estimated to be 4.7 tonnes per year.

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

3. Conversion of the foam systems to HCFC-141b will require new, high pressure foam machines and pilot scale testing. HCFC-141b is a transitional chemical, however, current

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

indications are that high pressure foam machines will be able to be easily modified to be compatible with future non-ODS blowing agents. While cyclopentane has a lower unit cost, conversion costs are significantly higher. Cyclopentane is not presently available in Mauritius.

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

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

6. A.H. Bahemia is 100% locally owned. Blyfridge Ltd. is 79.2 per cent locally owned. The incremental cost sought for the project has been reduced in proportion to the percentage overseas ownership of Blyfridge Ltd.

SECRETARIAT'S RECOMMENDATION

7. The Fund Secretariat recommends final approval of the project and approval of US $410,708 in incremental costs as itemized in the following table.

Company	Production Units/yr	CFC Consumption MT/yr	Capital Cost US $	Incremental Operating Cost US $	Total US $	Local Owner-ship	Grant US $
A.H. Bahemia	2644	2.7	203,000	10,500	213,500	100%	213,500
Blyfridge Ltd.	3312	2.0	237,000	12,000	249,000	79.2%	197,208
TOTAL:	5956	4.7	440,000	22,500	462,500		410,708

PROJECT COVER SHEET

COUNTRY:	**MAURITIUS**
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Two Enterprises
SECTOR COVERED:	Domestic Refrigeration
ODS USE IN SECTOR:	4.7 tons ODS (August 93 - July 94)
PROJECT IMPACT (ODP):	Elimination of 4.29 tons ODP
TOTAL PROJECT COST:	US$ 462,500
INCREMENTAL CAPITAL COST:	US$ 440,000
INCREMENTAL OPERATING COST:	US$ 22,500
PROPOSED MLF GRANT:	US$ 410,708
UNIT ABATEMENT COST:	18.45 US$/Kg
PROJECT DURATION:	1.5 years
ECONOMIC LIFE:	10 years
NATIONAL COORDINATING BODY:	Ministry of Environment & Quality of Life, Department of Environment
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	September 1994

PROJECT SUMMARY:

The project will eliminate the use of 4.70 tons of CFC-11 and CFC-12 in the manufacture of domestic refrigerators in Mauritius. Under the project, alternative technologies using HCFC-141b and HFC-134a respectively will be adopted by the two manufacturing companies - A.H. Bahemia, and Blyfridge Ltd. Funds requested will be used to change the existing production lines, and for re-design, testing, pre-production trials, and training. Incremental operational costs resulting from the conversion to the new technology (6 months only) are also included.

Prepared by: Stuart Kelly, in collaboration with the Mauritius Department of Environment.

Reviewed by: Dr L.J.M. Kuijpers (Refrigeration) and Dr H. Creyf (Foam), UNDP Project Reviewers.

PROJECT OF THE GOVERNMENT OF MAURITIUS

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS AT TWO ENTERPRISES

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate the use of CFC-11 as blowing agent in the production of rigid insulation foam, and CFC-12 as refrigerant at two existing manufacturers of domestic refrigerators and freezers in Mauritius.

2. SECTOR AND ENTERPRISE BACKGROUND.

The Mauritius Country Programme (CP) for the Phase-out of Ozone Depleting Substances (ODS) under the Montreal Protocol was approved at the 10th Meeting of the Executive Committee of the Multilateral Fund for the Montreal Protocol in June 1993.

Data on ODS consumption in the CP is provided for the year 1991 when total consumption was estimated as 70.2 ODP tons with CFC 11 and CFC 12 accounting for 15.4 ODP tons (21.9%) and 37.7 ODP tons (53.7%) respectively. Since then, CFC use in aerosols has been eliminated, and this, with other market changes, has reduced total ODS consumption to an estimated present annual level of circa 40.0 ODP tons.

Consumption of ODS by sector in 1991 indicated that the refrigeration and air-conditioning sector was the largest consumer, accounting for a total of 30.2 ODP tons (43%).

The CP reports local production of domestic refrigerators and freezers as totalling 8,750 units with an average charge of 0.140 Kgs of CFC 12 and 0.700 Kgs of CFC 11 per unit. These figures translate into consumption of 1.23 metric tons of CFC 12, and 6.13 metric tons of CFC 11. A further 5.8 metric tons of CFC 12 was estimated as having been consumed in the repair and servicing of domestic refrigerators and freezers, mostly by private service agencies in the unorganised sector.

In preparing this project proposal, the following data for the 12 months August 1993 to July 1994, inclusive, was established as the best estimate of current CFC consumption for the manufacture of domestic refrigerators and freezers. ODS elimination project proposals are being presented to the Montreal Protocol Multilateral Fund for both the enterprises indicated, the only manufacturers of domestic refrigerators and freezers in Mauritius.

This consumption of 4.7 ODP tons represents approximately 10% of present day ODS consumption in Mauritius.

ENTERPRISE	PRODUCTION VOLUME	ODS CONSUMPTION (tes)	
		CFC 11	CFC 12
Blyfridge Ltd	3,312	1.5	0.5
A. H. Bahemia	2,644	2.3	0.4
TOTAL:	5,956	3.8	0.9

Additional information on the two enterprises are provided in the respective sub-project contained in the annexes.

It should be noted that whilst PU foam blown with CFC 11 is used as the refrigerator insulation material, both the enterprises, **Blyfridge Ltd** and **A. H. Bahemia**, also import some pre-foamed/pre-assembled cabinets and doors which are completed and charged with refrigerant in Mauritius. This is taken into account in all cost calculations in this project.

Blyfridge and Bahemia presently account for an estimated 40% of sales of such products in the local market. The remaining sales are made up of imports from a number of countries including Korea, Australia, and ASEAN countries. Almost all local production is sold within Mauritius with only minimal levels of exports to Madagascar, Seychelles, and some African countries.

Local production of refrigerators has declined by an estimated 30% over the past three years due to price competition from imports. Both the local producers have taken cost cutting measures and anticipate growth of around 5% per annum for the next several years, although overall the market is considered near to saturation with an annual demand of around 15,000 refrigerators and freezers as replacements for the ageing existing population of around 200,000 units.

The industry imports all raw materials and parts, including some refrigerators in CKD and SKD kit form. Compressors are sourced from a variety of suppliers including Aspera, Goldstar, Whirlpool, Necchi, Mitsubishi, Tecumseh, and L'Unite Hermetique.

Uninhibited growth in the manufacture of domestic refrigerators and freezers would lead to an estimated consumption in the year 2000 of 5 tons per year of CFC 11 and of 1.2 tons per year of CFC 12.

The Department of Environment, 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 would bring the implementation of this strategy well in line with the target. A complete phase-out of the use of CFCs in the manufacture of domestic refrigerators and freezers in Mauritius can be achieved in 1996.

3. PROJECT DESCRIPTION

Under the project, the use of CFC-11 will be eliminated through conversion to HCFC-141b technology as an interim step to an ODS-free system. For CFC-12, it will be replaced by HFC-134a. The conversion will involve replacement of existing machine for the rigid insulation foam by a high pressure machine that will be able to process the higher viscosities and mixing requirements of the low ODS systems, and also any of the developing ODS-free systems. For the refrigerant replacement, the project will finance the costs of HFC-134a compressors and the associated new synthetic lubricants, new system evacuation, refrigerant charging unit, leak detection equipment, re-design of the refrigeration systems, prototyping, testing and optimization of each refrigerator model, 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. Operational Costs for six months are requested, to be paid following approval of the project.

4. TECHNOLOGY

4.1. Replacement of CFC 11 with HCFC 141b.

4.1.1. OVERVIEW

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

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

In addition, compounds such as perfluoroalkanes, HCFC 123, fluorinated ethers and 2-chloropropane have been suggested, but the technology is not mature. Furthermore, the products are only available in limited quantities, and toxicological testing is not complete and, therefore, safety in use cannot be evaluated.

The first option, the "liquid" solution, is the one which will be applied in this project, and it employs technology that is closely related to the existing one. The final step to non-ODS technology in this process is not yet decided. One potential solution is HFC 356, but full water blown foam with improved cell structure remains

an option, 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, 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 safety review prior to, and after, installation.

4.1.2. SELECTION

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

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

The use of HCFC 141b is recognised by both enterprises - Bahemia and Blyfridge Ltd. - as a CFC-11 replacement that is:

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

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

4.2. Replacement of CFC 12 with HFC 134a.

4.2.1. OVERVIEW

HFC 134a is universally accepted as a replacement for CFC 12 in the manufacture of domestic refrigerators. HFC 134a is widely available and the technology is mature, having already been introduced commercially in many of the Developed Countries.

While hydrocarbon refrigerants are being used on a limited basis in at least one Developed Country, the technology is not considered as

sufficiently developed to consider transfer to Mauritius at the present time. Safety issues associated with the use of flammable hydrocarbon refrigerants, and the absence of suitable compressors on a commercial scale further mitigate against the adoption of this technology at the present time.

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

4.2.2. SELECTION

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

5. PROJECT COSTS

5.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAMING MACHINE	US$	200,000
TRAINING, TESTING & TRIALS		20,000
CONTINGENCIES (10%)		22,000
Subtotal	**US$**	**242,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT	US$	46,000
VACUUM PUMP		10,000
LEAK DETECTION EQUIPMENT (1 off)		3,000
TRAINING		10,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE, PRODUCTION & RELIABILITY TEST TRIALS (5 models)		70,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE		40,000
CONTINGENCIES (10%)		19,000
Subtotal	**US$**	**198,000**
TOTAL INCREMENTAL CAPITAL COST	**US$**	**440,000**

5.2 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. Annex A of the two sub-projects provide detailed explanations on how the incremental operational costs were obtained. The total incremental operating costs for these two sub-projects amount to **$22,500.**

5.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL PROJECT COST (Capital + Operational)	**US$ 462,500**
FUNDS REQUESTED FROM MLF (LOCAL OWNERSHIP)	**410,708**

5.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	410,708
b. Capital Recovery Factor (10% p.a.)	0.16275
c. Incremental Operating Costs	19,917
d. ODS Reduction (ODP Kgs August 93 - July 94)	4,700
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	18.45

THE PROJECT UNIT ABATEMENT COST IS 19.0 US$/Kg

6. FINANCING PLAN

The total incremental cost being requested for these two enterprises amounts to US$ 410,708.

7. PROJECT IMPLEMENTATION

7.1 MANAGEMENT

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

7.2 SCHEDULE

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

8. PROJECT IMPACT

This project will eliminate the use of 4.7 tons of CFC's per year. This is based on figures for the 12 months, August 1993 - July 1994.

9. ANNEXES

ANNEX-1: Sub-project: BAHEMIA
ANNEX-2: Sub-project: BLYFRIDGE LTD.

ANNEX 1 - SUB-PROJECT: BAHEMIA

PROJECT COVER SHEET

COUNTRY:	**MAURITIUS**
PROJECT TITLE:	A.H. BAHEMIA - Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators
SECTOR COVERED:	Domestic Refrigeration
ODS USE IN SECTOR:	4.7 tons ODS (August 93 - July 94)
PROJECT IMPACT (ODP):	2.45 ODP tons
TOTAL PROJECT COST:	US$ 213,500
INCREMENTAL CAPITAL COST:	US$ 203,000
INCREMENTAL OPERATING COST:	US$ 10,500
PROPOSED MLF GRANT:	US$ 213,500
UNIT ABATEMENT COST:	16.74 US$/Kg
PROJECT DURATION:	1.5 years
ECONOMIC LIFE:	10 years
NATIONAL COORDINATING BODY:	Ministry of Environment & Quality of Life, Department of Environment
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	September 1994

PROJECT SUMMARY

A. H. Bahemia is a 100% Mauritius-owned company manufacturing a range of domestic appliances including refrigerators and freezers for sale in Mauritius. Bahemia currently uses CFC 11 as a blowing agent in the production of rigid polyurethane insulation foam for the refrigerator cabinets and doors, and CFC 12 is used as the refrigerant. This project will eliminate the use of CFC 11 and CFC 12 by conversion to the use of HCFC 141b as the insulation foam blowing agent and HFC 134a as the refrigerant respectively. The project will eliminate 2.45 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 (6 months only) are also included.

Prepared by: Stuart Kelly, in collaboration with the Mauritius Department of Environment.

Reviewed by: Dr L.J.M.Kuijpers (Refrig.) and Dr H. Creyf (Foam).

PROJECT OF THE GOVERNMENT OF MAURITIUS

BAHEMIA - ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. ENTERPRISE BACKGROUND

A.H. Bahemia is one of only **TWO** enterprises presently manufacturing domestic refrigerators and freezers in Mauritius and they account for approximately **44%** of the total local production of such products. Bahemia is a 100 per cent Mauritius, family owned, enterprise. More details on A. H. Bahemia are given below:

CFC use in last 12 months:	2.3 tons CFC 11
(August 1993 - July 1994)	0.4 tons CFC 12
Full name of enterprise:	A. H. Bahemia
Plant location:	Guibes Road, Pailles, Mauritius
% Article 5 country ownership	100% (Mauritius)
No. of models:	8
Production in last 12 months: (August 1993 - July 1994)	2,644 units
No. of production lines:	1
Compressor suppliers:	Necchi, Italy Mitsubishi, Japan Tecumseh, Spain L'Unite Hermetique, France
Contact persons:	Ajum Bahemia - General Manager Afzel Bahemia - Asst. Manager
Telephone/Fax:	Tel: (320) 212 5404 Fax: (320) 212 5398

Other information:

A. H. Bahemia was founded in 1970 and is engaged in the manufacture and assembly of domestic refrigerators and freezers as well as the import of washing machines, gas cookers, rice cookers, and ceramic tiles. It markets it's refrigerator/freezer products under a variety of brand names including Iceberg, Zerowatt, Kelon, and Artic. The current product range comprises 6 refrigerators and two chest freezers. The original CFC refrigerator technology was purchased from Magic Chef, Torino, Italy in 1970. The arrangement included a ten year period of technical assistance but this expired in 1980, since when, Bahemia has developed it's own new models or purchased CKD/SKD models from other countries. There are currently no formal technical or technology transfer agreements with internationally recognised refrigerator manufacturers. All production is sold in Mauritius. The company presently employs 19 persons, 17 of whom are engaged in activities related to refrigerator assembly operations. This project encompasses all ODS consumption used in manufacturing operations at A. H. Bahemia.

It should be noted that the company only manufactures the PU foam

insulation for a part (2,514 out of 2,644 units in the period August 1993 to July 1994) of it's refrigerator production, for the rest, pre-foamed, pre-assembled cabinets and doors are imported. Some models of refrigerators and the chest freezers have metal liners and only 2,224 refrigerator units out of 2,644 have plastic liners which are purchased as part of the CKD package. These facts are taken into account in the incremental operational cost calculations.

The following table provides a summary of refrigerator and freezer production by Bahemia during the 12 month period August 1993 to July 1994 inclusive.

Model No.	Capacity Litres	Description	Production Volume	CFC 12 Charge Kgs	PU Foam per Unit Kgs
KR 178	178	DD Ref CKD	1,400	0.160	6.2
KR 118	103	DD Ref CKD	424	0.135	4.7
BCD 183	183	DD Ref CKD	400	0.160	6.5
A 22	230	SD Ref	100	0.080	4.9
A 35	310	SD Ref	75	0.115	6.6
BCD 218	218	DD Ref SKD	130	0.180	N/A
CF 48	480	Chest Frz CKD	75	0.225	8.25
CF 18	180	Chest Frz CKD	40	0.160	4.73
			2,644		

Key:
SD = Single Door
DD = Double Door
CKD = Complete Knock Down
SKD = Semi Knock Down
Ref = Refrigerator
Frz = Reezer

2. PROJECT DESCRIPTION

Bahemia presently uses CFC 11 as blowing agent for the production of rigid insulating foams needed for the refrigerator and freezer cabinets and doors, and uses CFC 12 as refrigerant. The total consumption in the 12 months 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
Bahemia	2.3	2.05	0.4	2.45

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

2.1. Replacement of CFC 11 with HCFC 141b.

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

This will require equipment replacement and training at A. H. Bahemia. A more detailed description of the existing foam injection equipment is given in para 5.1.3. Bahemia will also require test-runs before being able to start industrial production with the new technology. These activities will include training of staff in worker-safety related to HCFC 141b. Operational Costs for six months are requested, to be paid following approval of the project.

2.2. Replacement of CFC 12 with HFC 134a.

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

The different properties of HFC 134a, the need to avoid cross-contamination with CFC 12, and the phased nature of the conversion of refrigerator production from CFC 12 to HFC 134a, means that new system evacuation, refrigerant charging, and leak detection equipment will be required. A more detailed description of the existing equipment on which the technology change will impact is provided in para 5.2.3. Operational Costs for six months are requested, to be paid following approval of the project.

3. PROJECT COSTS

3.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAMING MACHINE	US$	100,000
TRAINING, TESTING & TRIALS		10,000
CONTINGENCIES (10%)		11,000
Subtotal (US$)	**US$**	**121,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (1 off)	US$	10,000
VACUUM PUMP (1 off)		3,000
LEAK DETECTION EQUIPMENT (1 off)		1,000
TRAINING		5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE, PRODUCTION & RELIABILITY TEST TRIALS (5 models)		35,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE		20,000
CONTINGENCIES (10%)		8,000
Subtotal	**US$**	**82,000**
TOTAL INCREMENTAL CAPITAL COST	**US$**	**203,000**

3.2 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. Annex A provides detailed explanations on how the incremental operational costs were obtained, the costs are summarized below:

PHASE-OUT OF CFC 11

Cost for Materials (see Annex A Part 1.): **6,135**

PHASE-OUT OF CFC 12

Costs for Materials (see Annex A Part 2.): **4,317**

TOTAL INCREMENTAL OPERATING COST	**10,452**
	SAY US$ 10,500

3.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational)	US$	213,500
% Article 5.1 Country Ownership		100%
FUNDING REQUESTED FROM MLF	**US$**	**213,500**

3.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	**213,500**
b. Capital Recovery Factor (10% p.a.)	**0.16275**
c. Incremental Operating Costs	**10,452**
d. ODS Reduction (ODS Kgs August 93 - July 94)	**2,700**
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	**16.74**

THE PROJECT UNIT ABATEMENT COST IS 16.74 US$/Kg

4. FINANCING PLAN

A. H. Bahemia requests reimbursement of the full amount of the project costs of **US$ 213,500** in line with the 100% Article 5.1 country ownership of the enterprise.

5. PROJECT IMPACT

This project will eliminate the use of 2.7 tons of CFC's (2.45 ODP tons) per year. This is based on figures for the 12 months, August 1993 - July 1994.

6. ANNEXES

ANNEX A: INCREMENTAL OPERATIONAL COST CALCULATIONS
ANNEX B: TECHNICAL REVIEWS

ANNEX A: INCREMENTAL OPERATIONAL COST CALCULATIONS

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

A. H. Bahemia	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.350	0.365	0.015
b. MDI	0.500	0.500	-
c. Kg Blowing Agent	0.150	0.135	(0.015)
Prices in US$/Kg			
d. Polyol	3.33	3.46	0.13
e. MDI	3.58	3.58	-
f. Blowing Agent	2.02	4.00	1.98
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	1.166	1.263	0.097
i. = b. x e. MDI	1.790	1.790	-
j. = c. x f. Blowing Agent	0.303	0.540	0.237
k. = h+i+j Total Cost per Kg of Foam	3.259	3.593	0.334
Materials Used per Refrigerator			
l. Kg of Foam per Refrigerator (average)	5.993	6.592	0.599
Cost per Refrigerator			
n. = l. x k. for Foam	18.99	22.80	3.81
p. = No. of Refrigerators foamed by Bahemia		1,257	
INCREMENTAL OPERATIONAL COST FOR PU FOAM (US$) = p x n (Diff)		**4,789**	
q. = Average Cost per Refrigerator for Liners	12.05	13.26	1.21
r. = No. of Refrigerators with Plastic Liners		1,112	
INCREMENTAL OPERATIONAL COST FOR LINERS (US$) = r x q (Diff)		**1,346**	
TOTAL INCREMENTAL OPERATIONAL COST (US$)		**6,135**	

(see Notes 1., and 4. below)

ANNEX A: INCREMENTAL OPERATIONAL COST CALCULATIONS

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

A. H. Bahemia.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.94	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.155	0.140	
c. No. of Refrigerators Produced (see Note 1.)	1,322	1,322	
1d. Cost for Refrigerant = a x b x c	602	1,666	1,064
2. Compressors			
a. Cost per Compressor (see Note 2.)	43.51	45.72	
b. No. of Compressors (see Note 1.)	1,322	1,322	
2c. Cost for Compressors = a x b	57,520	60,442	2,922
3. Condensers			
a. Cost per Condenser	N/C	N/C	
b. No. of Condensers	-	-	
3c. Cost for Condensers = a x b	N/C	N/C	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.38	0.50	
b. No. of Filter/Dryers (see Note 1.)	1,322	1,322	
4c. Cost for Filter/Dryers = a x b	502	661	159
5. Capillary Tubes			
a. Cost per Capillary Tube (average)	0.81	0.94	
b. No. of Capillary Tubes (see Note 1.)	1,322	1,322	
5c. Cost for Capillary Tubes = a x b	1,071	1,243	172
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)		4,317	

Note 1. Figures in the above tables are based on the actual production volume for the 12 month period August 1993 to July 1994 obtained from A. H. Bahemia at the time of project preparation. As Incremental Operational costs are claimed for 6 months only, 50% of this 12 months production volume has been used in the calculation.

Note 2. Refrigerant and compressor prices used in the above tables are weighted average prices for the two refrigerator manufacturers in Mauritius.

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

Note 4. The calculation of incremental operational costs for the CFC 11 replacement takes account of the fact that not all of the Bahemia production of refrigerators and freezers uses PU insulation foam and liners manufactured by Bahemia. Presently some 5% of the refrigerator production comprises assembly and refrigerant charging of imported pre-foamed cabinets and doors already complete with liners. Also, some of the refrigerators and freezers have metal liners.

ANNEX-2: SUB-PROJECT - BLYFRIDGE
PROJECT COVER SHEET

COUNTRY:	**MAURITIUS**
PROJECT TITLE:	BLYFRIDGE LTD. - Elimination of CFC-11 and CFC-12 in the Manufacture of Domestic Refrigerators
SECTOR COVERED:	Domestic Refrigeration
ODS USE IN SECTOR:	4.7 tons ODS (August 93 - July 94)
PROJECT IMPACT (ODP):	Elimination of 1.84 ODP tons p.a
TOTAL PROJECT COST:	US$ 249,000
INCREMENTAL CAPITAL COST	US$ 237,000
INCREMENTAL OPERATING COST	US$ 12,000
PROPOSED MLF GRANT:	US$ 197,208 (79.20%)
UNIT ABATEMENT COST:	20.8 US$/Kg
PROJECT DURATION:	1.5 years
ECONOMIC LIFE:	10 years
NATIONAL COORDINATING BODY:	Ministry of Environment & Quality of Life, Department of Environment
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	September 1994

PROJECT SUMMARY:

Blyfridge is a 79.20% locally-owned company manufacturing domestic refrigerators and freezers principally for sale in Mauritius but with some small volume exports to neighbouring markets. Blyfridge currently uses CFC 11 as a blowing agent in the production of rigid polyurethane insulation foam for the refrigerator cabinets and doors, and CFC 12 is used as the refrigerant. This project will eliminate the use of CFC 11 and CFC 12 by conversion to the use of HCFC 141b as the insulation foam blowing agent and HFC 134a as the refrigerant respectively. The project will eliminate 1.84 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 (6 months only) are also included.

Prepared by: Stuart Kelly, in collaboration with the Mauritius Department of Environment.
Reviewed by: Dr L.J.M. Kuijpers (Refrigeration) and Dr H. Creyf (Foam).

PROJECT OF THE GOVERNMENT OF MAURITIUS

BLYFRIDGE LTD - ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS

1. ENTERPRISE BACKGROUND

Blyfridge Ltd is one of only TWO enterprises presently manufacturing domestic refrigerators and freezers in Mauritius and they account for approximately 56% of the total local production of such products. Blyfridge is 79.20 per cent locally owned, the ownership shares being 79.20% Mauritius, and 20.80% Switzerland. More details on Blyfridge Ltd are given below:

CFC use in last 12 months:	1.5 tons CFC 11
(August 1993 - July 1994)	0.5 tons CFC 12
Full name of enterprise:	Blyfridge Ltd
Plant location:	P.O. Box 741, Port Louis, Mauritius
% Article 5 country ownership	79.20% (Mauritius)
No. of models:	10
Production in last 12 months:	3,312 units
(August 1993 - July 1994)	
No. of production lines:	1
Compressor suppliers:	Aspera, Italy; Whirlpool; Goldstar, Korea
Contact persons:	Madoo Desha - Manager
	Hedley Yeung - Production Manager
Telephone/Fax:	Tel: (320) 208 3553
	Fax: (320) 208 7082

Other information:

Blyfridge was founded in 1982 and is part of the Retail Division of Ireland Blyth Ltd (IBL), the largest and very diversified business conglomerate in Mauritius. Blyfridge is engaged solely in the manufacture and sale of a range of domestic refrigerators and freezers which it markets under the Liebherr and Whirlpool brand names, as well as it's own IBELA brand. The product range includes designs from Liebherr (Switzerland), Whirlpool (Italy) and Goldstar (Korea). Whilst Liebherr has a 20.8% capital holding in Blyfridge, the enterprise effectively runs it's own operation. All three international companies with whom Blyfridge have commercial arrangements provide technical assistance on an "as-needed" basis as well as providing Standards and Norms for the production of their refrigerator designs which Blyfridge follow. However, there are currently no formal technical or technology transfer agreements with these companies. Over 95% of production is sold in the Mauritius market. The company presently employs 30 persons. This project encompasses all ODS consumption used in manufacturing operations at Blyfridge Ltd.

The original CFC technology for refrigerator manufacture was obtained from Liebherr International AG, Switzerland. This was subsequently developed by Blyfridge to meet local market needs in respect of refrigerator design. Currently, Blyfridge has no formal technology transfer agreements with internationally recognised refrigerator manufacturers. It should be noted that the company only manufactures the PU foam insulation for a part (1,918 out of 3,312 units) of it's refrigerator production, for the rest, pre-foamed, pre-assembled cabinets and doors are imported. This is taken into account in the incremental operational cost calculations.

The following table provides a summary of refrigerator and freezer production by Blyfridge during the 12 month period August 1993 to July 1994 inclusive.

Model No.	Capacity Cubic Feet	Description	Production Volume	CFC 12 Charge Kgs	PU Foam per Unit Kgs
KS 2092	7.0	SD Ref	170	0.100	3.07
KS 2592	9.0	SD Ref	575	0.075	4.74
KSD 3294	11.5	DD Ref	411	0.150	7.89
KGS 4091	13.5	DD Ref	123	0.180	7.84
FKS 2592	9.0	SD Ref	105	0.100	3.55
GT 12.5	12.5	Chest Frz	10	0.550	7.77
DD 300L	10.0	DD Ref	524	0.160	6.07
NF 252	9.0	SKD NF	1,149	0.160	N/A
NF 312	11.0	SKD NF	125	0.180	N/A
NF 362	12.0	SKD NF	120	0.185	N/A
			3,312		

Key:
SD = Single Door
DD = Double Door
SKD = Semi Knock Down
Ref = Refrigerator
Frz = Freezer
NF = No Frost

2. PROJECT DESCRIPTION

Blyfridge presently uses CFC 11 for the production of rigid insulating foams needed for the refrigerator and freezer cabinets and doors, and uses CFC 12 as refrigerant. The total consumption in the 12 months 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
Blyfridge	1.5	1.34	0.5	1.84

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

2.1. Replacement of CFC 11 with HCFC 141b.

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

This will require equipment replacement and training at Blyfridge Ltd. A more detailed description of the existing foam injection equipment is given in para 5.1.3. Blyfridge will also require test-runs before being able to start industrial production with the new technology. These activities will include training of staff in worker-safety related to HCFC 141b. Operational Costs for six months are requested, to be paid following approval of the project.

2.2. Replacement of CFC 12 with HFC 134a.

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

The different properties of HFC 134a, the need to avoid cross-contamination with CFC 12, and the phased nature of the conversion of refrigerator production from CFC 12 to HFC 134a, means that new system evacuation, refrigerant charging, and leak detection equipment will be required. A more detailed description of the existing equipment on which the technology change will impact is provided in para 5.2.3. Operational Costs for six months are requested, to be paid following approval of the project.

3. PROJECT COSTS

3.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAMING MACHINE	US$	100,000
TRAINING, TESTING & TRIALS		10,000
CONTINGENCIES (10%)		11,000
Subtotal	**US$**	**121,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (1 off)	US$	36,000
VACUUM PUMPS (3 off)		7,000
LEAK DETECTION EQUIPMENT (2 off)		2,000
TRAINING		5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION & RELIABILITY TEST TRIALS (5 models)		35,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE		20,000
CONTINGENCIES (10%)		11,00
Subtotal	**US$**	**116,000**

TOTAL INCREMENTAL CAPITAL COST	**US$**	**237,000**

3.2 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. Annex A provides detailed explanations on how the incremental operational costs were obtained, the costs are summarized below:

PHASE-OUT OF CFC 11

Cost for Materials (see Annex A Part 1.):	**US$**	**5,466**

PHASE-OUT OF CFC 12

Costs for Materials (see Annex A Part 2.):	**US$**	**6,484**

TOTAL INCREMENTAL OPERATING COST (US$)		**11,950**
	SAY	**US$12,000**

3.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational)	**US$249,000**
Article 5.1 Country Ownership	**79.20%**
FUNDING REQUESTED FROM MLF	**US$197,208**

3.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs (79.20%)	197,208
b. Capital Recovery Factor (10% p.a.)	0.16275
c. Incremental Operating Costs (79.20%)	9,465
d. ODS Reduction (ODP Kgs August 93 - July 94)	2,000
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	20.8

THE PROJECT UNIT ABATEMENT COST IS 20.8 US$/Kg

4. FINANCING PLAN

Blyfridge Ltd. requests reimbursement to the amount of **US$ 197,208** representing 79.20% of the project costs of US$ 249,000 in line with the Article 5.1 capital ownership of the enterprise.

5. PROJECT IMPACT

This project will eliminate the use of 2.0 tons of CFC's (1.84 ODP tons) per year. This is based on figures for the 12 months, August 1993 - July 1994.

6. ANNEXES

ANNEX A: INCREMENTAL OPERATIONAL COST CALCULATIONS
ANNEX B: TECHNICAL REVIEWS

ANNEX A: INCREMENTAL OPERATIONAL COST CALCULATIONS

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

Blyfridge Ltd.	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.357	0.370	0.013
b. MDI	0.510	0.510	-
c. Kg Blowing Agent	0.133	0.120	(0.013)
Prices in US$/Kg			
d. Polyol	3.33	3.46	0.13
e. MDI	3.58	3.58	-
f. Blowing Agent	2.02	4.00	1.98
g. Liner (Type: HIPS with EVOH Protection)	2.60	2.86	0.26
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	1.189	1.280	0.091
i. = b. x e. MDI	1.826	1.826	-
j. = c. x f. Blowing Agent	0.269	0.480	0.211
k. = h+i+j Total Cost per Kg of Foam	3.284	3.586	0.302
Materials Used per Refrigerator			
l. Kg of Foam per Refrigerator (average)	5.781	6.359	0.578
m. Kg of Liner material per refrigerator (avg)	7.240	7.240	-
Cost per Refrigerator			
n. = l. x k. for Foam	18.99	22.80	3.81
o. = m. x g. for Liner	18.82	20.71	1.89
p. = n. + o. Total per Refrigerator	37.81	43.51	5.70
q. = No. of Refrigerators (see Note 4.)	959		
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)	**5,466**		

(see Notes 1., and 4. below)

ANNEX A: INCREMENTAL OPERATIONAL COST CALCULATIONS

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

Blyfridge Ltd.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.94	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.143	0.129	
c. No. of Refrigerators Produced (see Note 1.)	1,656	1,656	
1d. Cost for Refrigerant = a x b x c	696	1,923	1,227
2. Compressors			
a. Cost per Compressor (see Note 2.)	43.51	45.72	
b. No. of Compressors (see Note 5.)	1,718	1,718	
2c. Cost for Compressors = a x b	74,750	78,547	3,797
3. Condensers			
a. Cost per Condenser	7.93	9.02	
b. No. of Condensers (see Note 4.)	959	959	
3c. Cost for Condensers = a x b	7,605	8,650	1,045
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	0.55	0.67	
b. No. of Filter/Dryers (see Note 1.)	1,656	1,656	
4c. Cost for Filter/Dryers = a x b	911	1,110	199
5. Capillary Tubes			
a. Cost per Capillary Tube	0.79	0.92	
b. No. of Capillary Tubes (see Note 1.)	1,656	1,656	
5c. Cost for Capillary Tubes = a x b	1,308	1,524	216
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)		6,484	

Note 1. Figures in the above tables are based on the actual production volume for the 12 month period August 1993 to July 1994 obtained from Blyfridge Ltd. at the time of project preparation. As Incremental Operational costs are claimed for 6 months only, 50% of this 12 months production volume has been used in the calculation.

Note 2. Refrigerant and compressor prices used in above tables are weighted average prices for the two refrigerator manufacturers.

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

Note 4. The calculation of incremental operational costs for the CFC 11 replacement takes account of the fact that only a part (58%) of the Blyfridge production of refrigerators and freezers uses PU insulation foam and HIPS liners manufactured by Blyfridge Ltd. The remainder of the refrigerator production comprises assembly and refrigerant charging of imported pre-foamed cabinets and doors. These cabinets also have integral condensers and again this is taken into account in the incremental operational cost calculations for condensers for the new technology..

Note 5. One model of refrigerator/freezer has two compressors. This is taken into account in the calculation of incremental operational costs for the R134a compressors.

Mauritius

REVIEW OF A HFC-134a CONVERSION PROJECT

Manufacture of HFC-134a Appliances at A.H. Bahemia

Proposal by UNDP, October 1994

RTU-UNWB-LK-94541-lk

Scope

The project under review covers the conversion from CFC-12 to HFC-134a in circuits of refrigerators and the conversion from CFC-11 to HCFC-141b. Only the HFC-134a part is reviewed here.

Technology

The HFC-134a technology selected is environmentally sound and safe. It is the most cost effective non-ODS option that can be used at present. The proposal contains a "phased" approach for the introduction of HFC-134a, during one to two quarters, and includes a training component. The time schedule may be rather tight, taking into account that results from testing have to be implemented into the manufacturing process.

Although technology for CFCs has been imported, there is no clear partner available that can support testing and training. The proposal therefore adequately mentions the issue of technology transfer and technical assistance (also from the UNDP consultant !), and budgets an amount for which a refrigerant and compressor supplier could be involved in the process.

Compared to the production level in general, investment and other costs are considerable, however, thought to be necessary; the project therefore should be eligible for funding.

Environmental impact

The HFC-134a refrigerant proposed has no ODP. Health and safety impacts are minimised.

Project costs

All components mentioned are necessary for the conversion, i.e. the instalment of 4 charging stations, the leak detection and the vacuum pump is required.
It is acceptable that some new equipment is installed while producing both CFC-12 and HFC-134a equipment. It is, however, questionable whether this aspect should deserve much attention since the conversion will take place in a rather short timeframe.

- Charging, vacuum pump and leak detection
Costs are reasonable

- Production and reliability test trials
It is proposed to test 5 models in a rather short timeframe. Regarding the amount of testing, it would concern roughly 20 prototype tests and about 5-10 lifetime tests. Costs would be in the order of 15-20,000. Together with some costs for measuring equipment the proposed level of USD 35,000 could be acceptable.

- Training
The amount proposed for training (5000,-) is rather low, however, if it is considered combined with the issue "transfer and assistance", the amount is considered adequate.

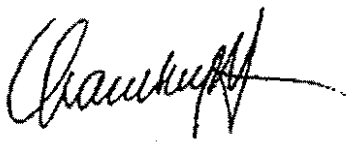
Operating costs

Incremental operating costs are acceptable, and are as observed in similar proposals.

Implementation timeframe
The implementation timeframe seems to be rather short. It is proposed to allow a somewhat longer period (during which consultancy on the results obtained can take place) so that a reliable manufacturing operation can be implemented.

Recommendations
The HFC-134a conversion, as proposed in the project, can be recommended.

Kuijpers, LJM
Eindhoven, 19 October 1994



TECHNICAL REVIEW

PREPARED BY: Dr Hubert Creyf
UNDP Foam Sector Project Reviewer

DATE: 20 October 1994

1.	**COUNTRY:**	Mauritius
2.	**PROJECT TITLE:**	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at A. H. Bahemia Note: This review deals only with the foam blowing agent conversion.
3.	**(SUB) SECTOR:**	Domestic Refrigeration -- Foamed Plastics
4.	**CP RELATIONSHIP:**	The project refers to the CP in the background section. During project formulation, much more detailed information on the commercial refrigeration sector was obtained especially since the data of the CP dates from 1991. The largest consumer of ODS in Mauritius is the airconditioning and refrigeration sector.
5.	**TECHNOLOGY:**	**The replacement of CFC 11 by HCFC 141b is the only correct choice which can be made considering the local situation. Although cyclopentane would present a more economical solution, it cannot be considered for safety reasons with the actual hardware (pictures available).** **The use of HCFC 141b is safer (less flammable) and leads to only a small increase in lambda value for the foam panels.**

6. **ENVIRONMENTAL IMPACT:**

HCFC 141b has an ODP value of only 11% of that of CFC 11. It is foreseen that the product can be used for over a decade. At this time another solution will have to be found. The GWP of HCFC 141b is 10 times smaller than the GWP of CFC 11.

7. **PROJECT COSTS:**

It must be stressed that monitoring gasses from the polyurethane panel production is a necessity, since a high pressure machine will be used. In case any chemical exceeds the TLV, a ventilation system has to be installed (US$ 10,000).

It is clear that the sector is in economic difficluties (saturated market, more expensive technology to be used). The price to eliminate 1 ton of ODP in the insulation panel is 81,041 US$. While this amount seems high, it is recommended to use alternative decision criteria for very small users such as this company. These criteria should include the small size of the country, the demonstrative effect on other refrigeration manufacturers in similar situations, social factors, etc.

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:**

Despite economic difficulties, this project fits into the spirit of the Montreal agreement, and should be approved taking into account the remarks made under (7).

Mauritius

REVIEW OF A HFC-134a CONVERSION PROJECT

Manufacture of HFC-134a Appliances at Blyfridge Ltd.

Proposal by UNDP, October 1994

RTU-UNWB-LK-94542-Ik

Scope

The project under review covers the conversion from CFC-12 to HFC-134a in circuits of refrigerators and the conversion from CFC-11 to HCFC-141b. Only the HFC-134a part is reviewed here.

Technology

The HFC-134a technology selected is environmentally sound and safe. It is the most cost effective non-ODS option that can be used at present. The proposal contains a "phased" approach for the introduction of HFC-134a, during one to two quarters, and includes a training component. The time schedule may be rather tight, taking into account that results from testing have to be implemented into the manufacturing process.

Although technology for CFCs has been imported from Liebherr, there is no established firm contact pattern, i.e. a clear partner available that can support testing and training. The proposal therefore adequately mentions the issue of technology transfer and technical assistance (also from the UNDP consultant !), and budgets an amount for which Liebherr, and additional refrigerant and compressor suppliers could be involved in the process.

Compared to the production level in general, investment and other costs are considerable, however, thought to be necessary; the project therefore should be eligible for funding.

Environmental impact

The HFC-134a refrigerant proposed has no ODP. Health and safety impacts are minimised.

Project costs

All components mentioned are necessary for the conversion, i.e. the instalment of a charging station, the leak detection and the vacuum pump is required.
It is acceptable that some new equipment is installed while producing both CFC-12 and HFC-134a equipment. It is, however, questionable whether this aspect should deserve much attention since the conversion will take place in a rather short timeframe.

- Charging, vacuum pump and leak detection

Charging equipment is considerably more expensive than in a similar proposal, however, this will be due to the manufacturing process and is therefore acceptable. Costs for 3 vacuum pumps are considerable, if no retrofit is possible to HFC-134a (depending on the age of the pumps and the available vacuum), costs are acceptable.

- Production and reliability test trials

It is proposed to test 5 models in a rather short timeframe. Regarding the amount of testing, it would concern roughly 20 prototype tests and about 5-10 lifetime tests. Costs would be in the order of 15-20,000. Together with some costs for measuring equipment the proposed level of USD 35,000 could be acceptable.

- Training

The amount proposed for training (5000,-) is rather low, however, if it is considered combined with the issue "transfer and assistance", the amount is considered adequate.

Operating costs
Incremental operating costs are acceptable, and are as observed in similar proposals.

Implementation timeframe
The implementation timeframe seems to be rather short. It is proposed to allow a somewhat longer period (during which consultancy on the results obtained can take place) so that a reliable manufacturing operation can be implemented.

Recommendations
The HFC-134a conversion, as proposed in the project, can be recommended.

Kuijpers, LJM
Eindhoven, 19 October 1994

TECHNICAL REVIEW

PREPARED BY: Dr Hubert Creyf
UNDP Foam Sector Project Reviewer

DATE: 20 October 1994

1.	**COUNTRY:**	Mauritius
2.	**PROJECT TITLE:**	Elimination of CFCs 11 and 12 in the Manufacture of Domestic Refrigerators at Blyfridge Ltd Note: This review deals only with the foam blowing agent conversion.
3.	**(SUB) SECTOR:**	Domestic Refrigeration -- Foamed Plastics
4.	**CP RELATIONSHIP:**	The project refers to the CP in the background section. During project formulation, much more detailed information on the commercial refrigeration sector was obtained especially since the data of the CP dates from 1991. The largest consumer of ODS in Mauritius is the airconditioning and refrigeration sector.
5.	**TECHNOLOGY:**	The replacement of CFC 11 by HCFC 141b is the only correct choice which can be made considering the local situation. Although cyclopentane would present a more economical solution, it cannot be considered for safety reasons. The use of HCFC 141b is safer (less flammable) and leads to only a small increase in lambda value for the foam panels.

6. **ENVIRONMENTAL IMPACT:**

HCFC 141b has an ODP value of only 11% of that of CFC 11. It is foreseen that the product can be used for over a decade. At this time another solution will have to be found. The GWP of HCFC 141b is 10 times smaller than the GWP of CFC 11.

7. **PROJECT COSTS:**

It must be stressed that monitoring gasses from the polyurethane panel production is a necessity, since a high pressure machine will be used. In case any chemical exceeds the TLV, a ventilation system has to be installed (US$ 10,000).

It is clear that the sector is in economic difficluties (saturated market, more expensive technology to be used). The price to eliminate 1 ton of ODP in the insulation panel is 100,162 US$. While this amount seems high, it is recommended to use alternative decision criteria for very small users such as this company. These criteria should include the small size of the country, the demonstrative effect on other refrigeration manufacturers in similar situations, social factors, etc.

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:**

Despite economic difficulties, this project fits into the spirit of the Montreal agreement, and should be approved taking into account the remarks made under (7).