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

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PROJECT PROPOSAL: GUATEMALA

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 at two companies:

(a) IMCA
(b) Refrigua

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Guatemala
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Two Companies
BUDGET:	Capital cost: US $251,548 Operational cost: US $ 98,335
INCREMENTAL COST:	US $349,883
ODS PHASEOUT:	28.7 mt CFCs 11 and 12 per year
COST EFFECTIVENESS:	US $12.19 per Kg. ODP saved
PROJECT DURATION:	18 months
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	Commisión Nacional del Medio Ambiente
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. The proposal consists of two projects covering two commercial refrigeration equipment producers. The two producers constitute all the known production capacity in this sub-sector in Guatemala. The combined amount of CFCs to be eliminated is estimated at 28.7 mt/yr.

2. One enterprise (IMCA) will convert both refrigeration and foam systems to HFC-134a and HCFC-141b, respectively.

3. IMCA will use a small pressurized foam dispenser system at a much lower cost than that of full size high pressure machines. The other company, Refrigua, will use very low cost "solventless dispensing guns" instead of the large size foam machine.

4. The conversion of the refrigeration system in both companies will require changes in the production line, re-design, testing, trials and training.

5. Incremental operating costs requested for the two companies are calculated for a six-month period and covering both systems.

6. The cost effectiveness of the project is good.

SECRETARIAT'S RECOMMENDATIONS

7. The Secretariat recommends final approval of the project and approval of the following amounts:

(a)	IMCA:	US $141,000 (capital costs) US $ 14,017 (operating costs)
(b)	Refrigua:	US $110,548 (capital costs) US $ 84,318 (operating costs)

8. The Secretariat further recommends that foam dispensing systems to be used by the two Guatemalan companies should be used in similar low consuming enterprises in other Article 5 countries.

PROJECT COVER SHEET

COUNTRY:	GUATEMALA
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Two Companies.
SECTOR COVERED:	COMMERCIAL REFRIGERATION
ODS USE IN SECTOR:	31.1 tons ODS (Sept '93 - Aug '94)
PROJECT IMPACT (ODP):	28.7 ODP tons
TOTAL PROJECT COST:	USD 349,883
INCREMENTAL CAPITAL COST:	USD 251,548
INCREMENTAL OPERATING COST:	USD 98,335
PROPOSED MLF GRANT:	USD 349,883
UNIT ABATEMENT COST:	4.85 U$/kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Comision Nacional del Medio Ambiente
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	September 1994

PROJECT SUMMARY:

The two companies (IMCA and REFRIGUA) are 100% Guatemalan owned enterprise engaged in the manufacture of unitary commercial refrigeration equipment. The companies sell their products both in the local market as well as a number of other Central American countries. IMCA 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. REFRIGUA is already using HCFC 141b as a blowing agent in the production of rigid polyurethane insulation foam for the refrigeration cabinets and doors, having replaced the previously used CFC 11 in July 1993. 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 28.7 ODP tons/yr (based on September 1993 - August 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 & Bert Veenendaal, in collaboration with the Comision Nacional del Medio Ambiente (CONAMA).

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

PROJECT OF THE GOVERNMENT OF GUATEMALA

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 the two companies concerned (IMCA and REFRIGUA) which are the only two known manufacturers of a range of unitary commercial refrigeration equipment in Guatemala.

The CFCs which will be eliminated are CFC 11, used as a blowing agent for producing thermal insulating foams, and CFC 12, used as the refrigerant.

2. SECTOR BACKGROUND.

Guatemala's Country Programme (CP) for the Phase-out of Ozone Depleting Substances (ODS) under the Montreal Protocol was approved at the 9th meeting of the Executive Committee of the Multilateral Fund (MLF) in (April 1993).

The data on ODS consumption in the CP relates to the year 1991 when it was estimated that total ODS consumption was 286 ODP tons. 269 tons (94%) of this is attributable to CFCs 11 and 12 which are almost exclusively used in the refrigeration and air-conditioning sector, both for the manufacture and charging of new equipment, and for maintenance and servicing of existing equipment.

The total consumption of CFC 11 is estimated as 45.0 tons, of which 41.0 tons were used for the production of rigid insulating foam in the refrigeration sector.

The total consumption of CFC 12 is estimated as being 224.3 tons, of which 15.0 tons were attributed to the domestic refrigeration sector, and 22.0 tons to the commercial refrigeration sector.

At the present time there is no production of domestic refrigerators in Guatemala. Only two enterprises, Refrigeradores De Guatemala S.A. (REFRIGUA) and Industria de Metalurgica Centroamericana S.A. (IMCA), have been identified as being actively engaged in the manufacture of a range of unitary commercial refrigeration equipment which includes bottle coolers, commercial refrigerators and freezers, refrigerated food display cases, etc. IMCA used to manufacture domestic refrigerators on a small scale but ceased this activity several years ago due to non-profitability.

Data on the production volume and ODS consumption for these two

enterprises during the period September 1993 to August 1994 is provided in the following table:

Enterprise	Production Volume	CFC 11 Consumption (Tons)	CFC 12 Consumption (Tons)
REFRIGUA	18,180	(see note)	7.9
IMCA	5,000	3.5	1.2
Totals	23,180	3.5	9.1

Note: Influenced by the requirements of one of their major customers, REFRIGUA eliminated their consumption of CFC 11 in July 1993 by replacement with HCFC 141b. Their equivalent current consumption of CFC 11 would be 18.5 tons.

The total current annual consumption of CFCs in the manufacture of unitary commercial refrigeration equipment in Guatemala is then only of the order of 3.5 tons of CFC 11 and 9.1 tons of CFC 12.

An estimated 45% of the production of this unitary commercial refrigeration equipment is exported to Central American and Caribbean countries and both enterprises report strong growth in export sales.

Uninhibited growth in the absence of the Montreal Protocol would have resulted in an estimated consumption in the year 2000 of 35 tons per year of CFC 11 and 15 tons per year of CFC 12.

The industry imports most raw materials and parts. Compressors are variously sourced according to price from Embraco and Sicom of Brazil, L'Unite Hermetique of France, Matsushita of Singapore, and Tecumseh of the USA.

The Comision Nacional del Medio Ambiente (CONAMA), with the assistance of UNDP, has designed a strategy for the elimination of CFC 11 and CFC 12 in this sector beginning in early 1995. Approval of this project by the MLF in December 1994 will result in the elimination of the CFCs used in the manufacture of unitary commercial refrigeration equipment in Guatemala during 1996.

3. PROJECT DESCRIPTION

3.1. Replacement of CFC 11 with HCFC 141b.

IMCA 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 IMCA. A more detailed description of the existing foam injection equipment is given in annex 1. In view of the existing condition of the equipment, a 50% contribution by the company to the cost of the replacement equipment is included in the project cost calculations. IMCA 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.

In 1993, REFRIGUA purchased new "DELTA-THERM" HCFC 141b based PU thermal insulation foam technology and equipment from Flexible Products Company, Marietta, GA, USA, as an interim step to an ODS-free insulation foam system. This was was successfully commissioned in July 1993, eliminating REFRIGUA's CFC 11 consumption. The purchased equipment consisted primarily of two "DELTA-THERM" "Eliminator" solventless dispensing guns and foam chemicals feed pumps. The very modest incremental capital costs are provided in annex 2 and retroactive funding of these costs is requested from the MLF. The new equipment for use with HCFC 141b replaced a Decker Industries Inc., DB 30 low pressure foam injection machine with a throughput of 16 Kgs/min. This equipment was purchased in 1990. Although REFRIGUA incurred installation, commissioning, trialling and training costs, as well as the cost of additional ventilation, they did not keep records of these costs and they are, therefore, not being requested by the enterprise.

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

3.2. Replacement of CFC 12 with HFC 134a.

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

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

Operational Costs 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 Guatemala.

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

The use of HCFC 141b is recognised by IMCA and REFRIGUA as a CFC 11 replacement that represents:

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

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

4.1.3. IMPACT ON THE PRODUCTION PROCESS

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

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

Foam density may have to be adjusted to obtain proper insulation values.

The refrigeration cabinet liner material must be resistant to HCFC 141b. IMCA and REFRIGUA 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 Guatemala 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 IMCA was obtained under a technology agreement with Tappan, USA. As this technology agreement is no longer in existence, and the enterprise has no other formal technology agreements, the new HFC 134a based technology is being developed by IMCA with assistance from compressor and refrigerant suppliers.

Concerning REFRIGUA, the CFC 12 based technology used by REFRIGUA was obtained under a technology agreement with Fogel Jordan Commercial Refrigerator Company, Philadelphia, USA. The new HFC 134a based technology has also been developed by REFRIGUA with assistance from Fogel Jordan under the ongoing technical assistance agreement.

Provision is made within the project budget for formal technology assistance from these suppliers, as well as the relevant UNDP consultants, in order to ensure successful implementation of this project.

5.2.3. IMPACT ON THE PRODUCTION PROCESS

HFC 134a, like CFC 12, is non-flammable. HFC 134a has also been the subject of extensive toxicological testing and is considered safe in use in industrial applications provided the suppliers recommended occupational exposure 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, IMCA 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 IMCA 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 IMCA.

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

IMCA and REFRIGUA request reimbursement to the amount of US$ 28.7 ODP tons per year.

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

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

ANNEX 1: IMCA

COUNTRY:	GUATEMALA
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industria Metalurgica Centroamericana S.A. (IMCA)
SECTOR COVERED:	COMMERCIAL REFRIGERATION
ODS USE IN SECTOR:	31.1 tons ODS (Sept '93 - Aug '94)
PROJECT IMPACT (ODP):	4.3 ODP tons
TOTAL PROJECT COST:	USD 155,017
INCREMENTAL CAPITAL COST:	USD 141,000
INCREMENTAL OPERATING COST:	USD 14,017
PROPOSED MLF GRANT:	USD 155,017
UNIT ABATEMENT COST:	8.6 U$/kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Comision Nacional del Medio Ambiente
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	September 1994

PROJECT SUMMARY:

Industria Metalurgica Centroamericana S.A. (IMCA) is a 100% Guatemalan owned enterprise engaged in the manufacture of a range of electrical household appliances and unitary commercial refrigeration equipment. The company sells it's products both in the local market as well as a number of other Central American countries. IMCA 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 4.3 ODP tons/yr (based on September 1993 - August 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 & Bert Veenendaal, in collaboration with the Comision Nacional del Medio Ambiente (CONAMA).
Reviewed by:	L.J.M. Kuijpers/M.J.P. Janssen (Refrigeration) and H. Creyf (Foam). Their comments are attached.

PROJECT OF THE GOVERNMENT OF GUATEMALA

ELIMINATION OF CFCs IN THE MANUFACTURE OF UNITARY COMMERCIAL REFRIGERATION EQUIPMENT

1. PROJECT OBJECTIVE AND BACKGROUND.

See General Information Section.

2. ENTERPRISE BACKGROUND

Industria Metalugica Centroamericana S.A. (IMCA) accounted for 22% of the total production of unitary commercial refrigeration equipment in Guatemala in the 12 month period September 1993 to August 1994. More details on IMCA are given below:

CFC USE IN LAST 12 MONTHS: (Sept 1993 - Aug 1994)	3.5 tons CFC 11 1.2 tons CFC 12
PLANT LOCATION:	Km 28.5 Autopista al Pacifico Amatitlan, AP 292, Guatemala, C.A.
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Guatemalan)
No. OF MODELS:	5
PRODUCTION IN LAST 12 MONTHS: (Sept 1993 - Aug 1994)	5,000 units
No. OF PRODUCTION LINES:	1
COMPRESSOR SUPPLIERS:	Sicom Matsushita
CONTACT PERSONS:	Benny Tenenbaum - Presidente Mario Orrego - General Manager Oscar E. Oliva Gonzalez - Plant Mgr
TEL / FAX:	Tel: (502 2) 0330 470 Fax: (502 2) 0330 555

IMCA was founded in 1968 and the enterprise is engaged in the manufacture of a diverse range of household appliances as well as a small range of unitary commercial refrigeration equipment which includes bottle coolers, freezers, and hieleras (cool boxes). 70% of sales are in Guatemala with exports to El Salvador, Nicaragua, and Honduras. IMCA presently employs 462 persons, of which some 150

are involved in the refrigeration business. This project encompasses all the current ODS consumption used in manufacturing operations at IMCA.

The existing CFC technology was obtained under a technology agreement with Tappan, USA, who previously had an equity share in IMCA. This was bought out in 1989 and IMCA is now 100% Guatemalan owned. There is an ongoing arrangement to use the Tappan brand name for which IMCA pay a royalty on sales but there is currently no technology agreement or provision for technical assistance. The CFC replacement technology is, therefore, being developed "in house" with the assistance of compressor and refrigerant suppliers. The following tables provide a summary of refrigeration equipment production by IMCA during the 12 month period September 1993 to August 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
EBT-H15	1,050	0.341	358.05	7.329
EBT-H11	800	0.341	272.80	6.782
EBT-V15	1,300	0.341	443.30	6.106
CT-H11	212	0.425	90.10	5.649
HIELERA	1,638	-	-	1.667
Total or Weighted Average	5,000	0.346	1,164.25	4.997

Model No.	Description	R12 Compressor HP & Price (US$)		R134a Compressor HP & Price (US$)	
EBT-H15	Bottle Cooler	1/4	40.65	1/4	42.22
EBT-H11	Bottle Cooler	1/4	40.65	1/4	42.22
EBT-V15	Bottle Cooler	1/4	40.65	1/4	42.22
CT-H11	Chest Freezer	1/3	44.40	1/3	46.38
HIELERA	Cool Box	-			
Weighted Average		40.89		42.48	

Key: The number after the Bottle Cooler (EBT) and Freezer (CT) designation indicates the capacity in cubic feet. The "H" and "V" designations refer to horizontal and vertical designs.

3. PROJECT DESCRIPTION

IMCA 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 September 1993 to August 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
IMCA	3.5	3.1	1.2	4.3

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 IMCA on which the technology change to HCFC 141b will impact is as follows:

- 1 x Admiral 90-2 foam injection machine (Vintage 1978) with a throughput of 41 Kgs/min

This equipment is in need of replacement regardless of the type of blowing agent. The company could replace the unit by a low pressure dispenser, costing about US$ 45,000. This is, therefore, seen as a non-incremental cost part in the capital cost and subject to payment by the IMCA.

3.2. Replacement of CFC 12 with HFC 134a.

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

- 1 x Airseco Combo Station Model a-4053TLB-6-1 semi-automatic R12 charging unit (1970)
- 1 x Kinney KTC Compound Vacuum Pump, 21 M3/hr capacity
- 1 x Yokogawa model H-25C electronic R12 leak detector
- 1 x Yokogawa model H-10G hand-held R12 leak detector

Note:
The single existing vacuum pump precludes the possibility of retrofit given the phased nature of the change from the CFC 12 to HFC 134a technology.

4. PROJECT COSTS

4.1. INCREMENTAL CAPITAL COSTS (US$)

CAPITAL COST FOR CFC 11 PHASE-OUT

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

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

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

CAPITAL COST FOR CFC 12 PHASE-OUT

REFRIGERANT CHARGING EQUIPMENT (1 unit)	24,000
NEW VACUUM PUMP (1 unit)	3,000
LEAK DETECTION EQUIPMENT (2 units)	6,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION, & RELIABILITY TEST TRIALS (3 models)	15,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	7,000
Subtotal (US$)	75,000

TOTAL INCREMENTAL CAPITAL COST (US$)	141,000

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 September 1993 to August 1994 inclusive and ignoring growth. Paragraph 5 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):	7,325
PHASE-OUT OF CFC 12 for Materials (see Para 5.2):	6,692
TOTAL INCREMENTAL OPERATING COST (US$)	14,017

4.3 TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operating)	155,017
% Article 5.1 Country Ownership	100%
FUNDING REQUESTED FROM THE MLF (US$)	155,017

4.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Cost (US$)	141,000
b. Capital Recovery Factor (10% p.a.)	0.16275
c. Incremental Operating Costs/Benefits	14,017
d. ODS Reduction (ODP Kgs August 93 - July 94)	4,300
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	8.59

THE PROJECT UIT ABATEMENT COST IS 8.59 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$)

IMCA	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.343	0.357	0.014
b. MDI	0.518	0.518	-
c. Kg Blowing Agent	0.139	0.125	(0.014)
Prices in US$/Kg			
d. Polyol	2.50	2.65	0.15
e. MDI	2.00	2.00	-
f. Blowing Agent	1.80	4.00	2.20
g. Liner (Type: Metal)	N/A	N/A	-
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.858	0.946	0.088
i. = b. x e. MDI	1.036	1.036	-
j. = c. x f. Blowing Agent	0.250	0.500	0.250
k. = h+i+j Total Cost per Kg of Foam	2.144	2.482	0.338
Materials Used per Refrigerator			
l. Kg of Foam per Refrigerator (avg)	4.997	5.497	0.50
m. Kg of Liner material per refrigerator (avg)	N/A	N/A	-
Cost per Refrigerator			
n. = l. x k. for Foam	10.714	13.644	2.930
o. = m. x g. for Liner	-	-	-
p. = n. + o. Total per Refrigerator	10.714	13.644	2.930
q. = No. of Refrigerators (see Note 1.)	2,500		
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)	7,325		

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

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

IMCA	CFC 12	HFC 134a	Diff
1. Refrigerant	[redacted]	[redacted]	[redacted]
a. Price per Kg of Refrigerant	2.40	9.00	
b. Kg of Refrigerant per Refrigerator (average)	0.346	0.311	
c. No. of Refrigerators Produced (see Note 1.)	1,681	1,681	
1d. Cost for Refrigerant = a x b x c	1,396	4,705	3,309
2. Compressors & Condensers	[redacted]	[redacted]	[redacted]
a. Cost per Compressor & Condenser (see Note 2)	40.89	42.48	
b. No. of Compressors & Condensers (see Note 1)	1,681	1,681	
2c. Cost for Compressors & Condensers = a x b	68,736	71,409	2,673
3. Condensers	[redacted]	[redacted]	[redacted]
a. Cost per Condenser (included above)	-	-	
b. No. of Condensers (see Note 1.)	-	-	
3c. Cost for Condensers = a x b	-	-	-
4. Filter/Dryer	[redacted]	[redacted]	[redacted]
a. Cost per Filter/Dryer (average)	0.770	1.064	
b. No. of Filter/Dryers (see Note 1.)	1,681	1,681	
4c. Cost for Filter/Dryers = a x b	1,294	1,789	495
5. Capillary Tubes	[redacted]	[redacted]	[redacted]
a. Cost per Capillary Tube	0.855	0.983	
b. No. of Capillary Tubes (see Note 1.)	1,681	1,681	
5c. Cost for Capillary Tubes = a x b	1,437	1,652	215
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c		6,692	

Note 1. Figures in the above tables are based on actual production volume for the period September 1993 to August 1994 inclusive obtained from IMCA 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.

It should be noted that the Incremental Operational Cost calculations for the CFC 11 replacement takes account of the fact that IMCA's production for the period considered includes some 1,638 Hieleras (PU foam insulated "Cool Boxes"). The calculation of the Incremental Operational Cost for the CFC 12 replacement excludes these Hieleras

Note 2. All prices used in the above tables are either Guatemalan 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: GUATEMALA

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industria Metalurgica Centroamericana S.A. (IMCA)

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.

The company IMCA does not have a real "technology transfer partner" to implement HFC-134a technology. The company produces and will produce products with the brand name Tappan (USA). No agreements for technical assistance with Tappan exist but it is supposed that a certain quality standard must be maintained. 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. Altogether, a successful project implementation can be anticipated.

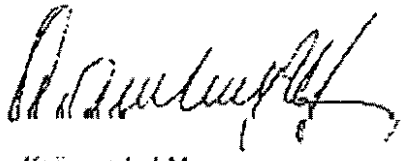
Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

Environmental impact
HFC-134a has an ODP of zero and a GWP of 0.27. For 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 are reasonable as well as costs for training, testing and external support.
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 reasonable especially when the very small scale of the company is taken into account.

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

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



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

TECHNICAL REVIEW

PREPARED BY: Dr Hubert Creyf
UNDP Foam Sector Project Reviewer

DATE: 20 October 1994

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1. **COUNTRY:** Guatemala

2. **PROJECT TITLE:** Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Industria Metalurgica Centroamericana S.A. (IMCA)
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 especially since the data of the CP dates from 1991.

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 39,460 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: REFRIGUA

COUNTRY:	GUATEMALA
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Refrigeradores De Guatemala S.A. (REFRIGUA)
SECTOR COVERED:	COMMERCIAL REFRIGERATION
ODS USE IN SECTOR:	31.1 tons ODS (Sept '93 - Aug '94)
PROJECT IMPACT (ODP):	24.4 ODP tons
TOTAL PROJECT COST:	USD 194,866
INCREMENTAL CAPITAL COST:	USD 110,548
INCREMENTAL OPERATING COST:	USD 84,318
PROPOSED MLF GRANT:	USD 194,866
UNIT ABATEMENT COST:	4.19 U$/kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Comision Nacional del Medio Ambiente
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	September 1994

PROJECT SUMMARY:

Refrigeradores De Guatemala S.A. (REFRIGUA) is a 100% Guatemalan owned enterprise manufacturing unitary commercial refrigeration equipment for the local market as well as export to other Central American/Caribbean countries. REFRIGUA is already using HCFC 141b as a blowing agent in the production of rigid polyurethane insulation foam for the refrigeration cabinets and doors, having replaced the previously used CFC 11 in July 1993. CFC 12 is used as the refrigerant. This project seeks partial retroactive funding for the replacement of the CFC 11 by HCFC 141b, and it will eliminate CFC 12 consumption by conversion to the use of HFC 134a as the refrigerant. The project effectively eliminates 24.4 ODP tons/yr (based on September 1993 - August 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 Comision Nacional del Medio Ambiente (CONAMA).

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

PROJECT OF THE GOVERNMENT OF GUATEMALA

ELIMINATION OF CFCs IN THE MANUFACTURE OF UNITARY COMMERCIAL REFRIGERATION EQUIPMENT

1. PROJECT OBJECTIVE AND BACKGROUND.

See General Information Section.

3. ENTERPRISE BACKGROUND

Refrigeradores De Guatemala S.A. (REFRIGUA) accounted for 78% of the total production of unitary commercial refrigeration equipment in Guatemala in the 12 month period September 1993 to August 1994. More details on REFRIGUA are given below:

CFC USE IN LAST 12 MONTHS: (Sept 1993 - Aug 1994)	- tons CFC 11 7.9 tons CFC 12
PLANT LOCATION:	48 Avenida y 3a. Calle, Zona 7, Guatemala
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Guatemalan)
No. OF MODELS:	39
PRODUCTION IN LAST 12 MONTHS: (Sept 1993 - Aug 1994)	18,180 units
No. OF PRODUCTION LINES:	3
COMPRESSOR SUPPLIERS:	Embraco (93%) L'Unite Hermetique (6%) Tecumseh (1%)
CONTACT PERSONS:	Jacobo Tefel Pasos - Presidente Jacobo G. Tefel - General Manager Federico Tefel Farrer - Prodn. Mgr
TEL / FAX:	Tel: (502 2) 910133, 942296, 940670 Fax: (502 2) 910106

REFRIGUA was founded in 1981 and the enterprise is solely engaged in the manufacture of a range of unitary commercial refrigeration equipment. This includes bottle coolers, commercial refrigerators and freezers, refrigerated display cabinets, etc. encompassing some 39 different models. Sales are split approximately evenly between the Guatemalan market and exports to other Central American and Caribbean countries including El Salvador, Costa Rica, Panama, and Puerto Rico. REFRIGUA presently employs 220 persons. This project encompasses all the current ODS consumption used in manufacturing operations at REFRIGUA.

The CFC technology was obtained under a technology agreement with Fogel Jordan Commercial Refrigerator Company, Philadelphia, USA. Fogel had an equity share in REFRIGUA until 1993 when this was bought out by the other shareholders, the Tefel family, and REFRIGUA is now 100% Guatemalan owned. REFRIGUA continue to market their products using the Fogel brand name for which they pay a 5% royalty on sales. This royalty fee also covers the provision of technical assistance from Fogel for product development and CFC replacement.

In response to concerns expressed by their customers, which include the major international soft drinks marketing companies, REFRIGUA began to examine options for CFC replacement in early 1993. They subsequently purchased new PU foam production technology based on HCFC 141b which was commissioned in July 1993, eliminating REFRIGUA's CFC 11 consumption.

REFRIGUA have also manufactured trial quantities of bottle coolers and refrigerators using HFC 134a refrigerant, samples of which have been provided to their major clients for evaluation.

The following tables provide a summary of refrigeration equipment production by REFRIGUA during the 12 month period September 1993 to August 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
Bottle Coolers				
BC-25	1,298	0.3742	485.72	8.4422
BC-50	1,358	0.4082	554.38	8.6168
BC-50-AF-2	1,084	0.4423	479.40	8.6168
BC-50-P	25	0.5273	13.18	8.8435
BC-65-AF-2	587	0.4423	259.60	10.8844
BC-65-P	62	0.5783	35.86	11.3379
BC-72	141	0.4933	69.55	11.3379
BC--95-AF-2	313	0.7144	223.61	15.1927
BC-95-P	66	1.1907	78.58	16.3265
EB-280	1,492	0.4082	609.08	7.4830
EB-280-AF	500	0.4423	221.13	8.3900
EB-280-FT-6-R	8	0.5103	4.08	8.3900
Horiz.Freezers				
CE-110	1,469	0.4423	649.67	7.7098
CE-170	222	0.5783	128.39	7.9365
FT-26	60	0.4082	24.49	5.4422
FT-50	275	0.5783	159.04	9.5238
FT-72	159	0.6124	97.36	11.1111
FT-96	51	1.1226	57.25	14.5125
Vert. Freezers				
CR-25	955	0.3742	357.37	11.1111
CR-25-AC	10	0.8505	8.50	12.5170
CR-25-C	109	0.9525	103.83	12.5170
CR-35-PC	227	0.5103	115.84	12.2449
CR-45-PC	149	0.6124	91.24	15.4195
CR-50	332	0.6124	203.30	18.5941
CR-50-AC	2	0.8505	1.70	26.7574
CR-50-C	33	0.9525	31.43	26.7574
CR-67-PC	81	0.6124	49.60	17.6871
CR-70	84	0.6124	51.44	20.8617
VR-17	6,382	0.3742	2,388.21	7.9365
VR-17-C	135	0.4763	64.30	7.9365
VR-30	206	0.3742	77.09	14.5125
WC-3-GE	30	0.4423	13.27	3.8549
WC-3-PT	5	0.4423	2.21	4.9887
Deli Cases etc				
Zephyr-4	24	0.5783	13.88	11.7914
Zephyr-6	82	1.0206	83.69	12.6984
DB-22	35	0.4763	16.67	11.3379
DB-12	36	0.4763	17.15	11.3379
DB-23	52	0.4763	24.77	11.5646
IC-B-1	41	0.3258	13.36	15.8730
Total or Weighted Average	18,180	0.4334	7,879.21	8.9397

Model No.	Production Volume	R12 Compressor HP & Price (US$)		R134a Compressor HP & Price (US$)	
BC-25	1,298	1/5	38.27	1/5	40.20
BC-50	1,358	1/4	40.65	1/4	42.22
BC-50-AF-2	1,084	1/4	40.65	1/4	42.22
BC-50-P	25	1/3	44.40	1/3	46.38
BC-65-AF-2	587	1/3	44.40	1/3	46.38
BC-65-P	62	1/3	44.40	1/3	46.38
BC-72	141	1/3	44.40	1/3	46.38
BC--95-AF-2	313	1/2	103.34	1/2	104.48
BC-95-P	66	1/2	104.36	1/2	106.40
EB-280	1,492	1/5	38.27	1/5	40.20
EB-280-AF	500	1/5	38.27	1/5	40.20
EB-280-FT-6-R	8	1/3	44.40	1/3	46.38
CE-110	1,469	1/4	40.65	1/4	42.22
CE-170	222	1/3	44.40	1/3	46.38
FT-26	60	1/5	38.27	1/5	40.20
FT-50	275	1/3	44.40	1/3	46.38
FT-72	159	1/3	44.40	1/3	46.38
FT-96	51	1/2	104.35	1/2	106.40
CR-25	955	1/3	44.40	1/3	46.38
CR-25-AC	10	1/3	44.40	1/3	46.38
CR-25-C	109	1/2	104.36	1/2	106.40
CR-35-PC	227	1/3	44.40	1/3	46.38
CR-45-PC	149	1/2	103.34	1/2	104.48
CR-50	332	1/2	103.34	1/2	104.48
CR-50-AC	2	1/3	88.80	1/3	92.76
CR-50-C	33	1/2	208.72	1/2	212.80
CR-67-PC	81	1/2	103.34	1/2	104.48
CR-70	84	1/2	103.34	1/2	104.48
VR-17	6,382	1/4	40.65	1/4	42.22
VR-17-C	135	1/3	44.40	1/3	46.38
VR-30	206	1/3	44.40	1/3	46.38
WC-3-GE	30	1/3	44.40	1/3	46.38
WC-3-PT	5	1/3	44.40	1/3	46.38
Zephyr-4	24	1/4	40.65	1/4	42.22
Zephyr-6	82	1/3	44.40	1/3	46.38
DB-22	35	1/3	44.40	1/3	46.38
DB-12	36	1/3	44.40	1/3	46.38
DB-23	52	1/3	44.40	1/3	46.38
IC-B-1	41	1/4	40.65	1/4	42.22
Total or Weighted Average	18,180	45.29		46.99	

4. PROJECT DESCRIPTION

REFRIGUA is already using HCFC 141b for the production of rigid insulating foams needed for the refrigeration equipment cabinets and doors. CFC 12 is used as the refrigerant. The total "EQUIVALENT" CFC consumption in the 12 months September 1993 to August 1994, and the ODP tons that have/will be eliminated by this project are shown in the following table:

Enterprise	CFC 11 (tes) (see *)	ODP tons eliminated (see **)	CFC 12 (tes)	Total ODP tons eliminated
REFRIGUA	18.5	16.5	7.9	24.4

Notes:

* This is the equivalent CFC 11 tons that would have been consumed if REFRIGUA had not changed to the HCFC 141b technology. It is calculated using current production volumes, the historical average weight of foam per refrigeration unit, and the CFC 11 foam formulation.

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

4.1. Replacement of CFC 11 with HCFC 141b.

In 1993, REFRIGUA purchased new "DELTA-THERM" HCFC 141b based PU thermal insulation foam technology and equipment from Flexible Products Company, Marietta, GA, USA, as an interim step to an ODS-free insulation foam system. This was was successfully commissioned in July 1993, eliminating REFRIGUA's CFC 11 consumption.

The purchased equipment consisted primarily of two "DELTA-THERM" "Eliminator" solventless dispensing guns and foam chemicals feed pumps.

The new equipment for use with HCFC 141b replaced a Decker Industries Inc., DB 30 low pressure foam injection machine with a throughput of 16 Kgs/min. This equipment was purchased in 1990.

5.2. Replacement of CFC 12 with HFC 134a.

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

- 1 x Fogel (Proprietary Design) R12 charging unit (1988)
- 1 x Modified Robinair "Dial a Charge" R12 charging unit to REFRIGUA's own design
- 2 x Ritchie Yellow Jacket Model 93480 Vacuum Pumps (8 cfm)
- 4 x TIF Instruments Inc. Model 5500 hand-held R12 leak detectors

Note: Both the vacuum pumps are in service. Retrofit of the existing pumps is not considered feasible given the phased nature of the change from the CFC 12 to HFC 134a technology.

4. PROJECT COSTS

4.1. INCREMENTAL CAPITAL COSTS (US$)

CAPITAL COST FOR CFC 11 PHASE-OUT	
HIGH PRESSURE FOAM DISPENSING GUN (18 Kgs/min)	4,000
HIGH PRESSURE FOAM DISPENSING GUN (7 Kgs/min)	4,875
FOAM CHEMICAL FEED PUMPS (2 units)	2,673
Subtotal (US$)	11,548
CAPITAL COST FOR CFC 12 PHASE-OUT	
REFRIGERANT CHARGING EQUIPMENT (1 unit)	30,000
REFRIGERANT CHARGING EQUIPMENT (1 - small unit)	10,000
NEW VACUUM PUMPS (2 units)	6,000
LEAK DETECTION EQUIPMENT (4 units)	4,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION, & RELIABILITY TEST TRIALS (8 models)	25,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	10,000
CONTINGENCIES (10%)	9,000
Subtotal (US$)	99,000
TOTAL INCREMENTAL CAPITAL COST (US$)	110,548

4.2 INCREMENTAL OPERATING COSTS & BENEFITS

The calculation of the incremental operating cost is based on a six month period using 50% of the actual production for the period September 1993 to August 1994 inclusive and ignoring growth. Paragraph 5 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):	41,523
PHASE-OUT OF CFC 12 for Materials (see Para 5.2):	42,795
TOTAL INCREMENTAL OPERATING COST (US$)	84,318

4.3 TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operating)	194,866
% Article 5.1 Country Ownership	100%
FUNDING REQUESTED FROM THE MLF (US$)	194,866

4.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Cost (US$)	110,548
b. Capital Recovery Factor (10% p.a.)	0.16275
c. Incremental Operating Costs/Benefits	84,318
d. ODS Reduction (ODP Kgs August 93 - July 94) *	24,400
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	4.19

* using the equivalent CFC 11 consumption as described in para 3

THE PROJECT UIT ABATEMENT COST IS 4.19 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$)

REFRIGUA	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.375	0.387	0.012
b. MDI	0.500	0.500	-
c. Kg Blowing Agent	0.125	0.113	(0.012)
Prices in US$/Kg			
d. Polyol	2.50	2.65	0.15
e. MDI	2.00	2.00	-
f. Blowing Agent	1.80	4.00	2.20
g. Liner (Type: Metal)	N/A	N/A	-
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.938	1.026	0.088
i. = b. x e. MDI	1.000	1.000	-
j. = c. x f. Blowing Agent	0.225	0.452	0.227
k. = h+i+j Total Cost per Kg of Foam	2.163	2.478	0.315
Materials Used per Refrigerator			
l. Kg of Foam per Refrigerator (avg)	8.13	8.94	0.81
m. Kg of Liner material per refrigerator (avg)	N/A	N/A	-
Cost per Refrigerator			
n. = l. x k. for Foam	17.585	22.153	4.568
o. = m. x g. for Liner	-	-	-
p. = n. + o. Total per Refrigerator	17.585	22.153	4.568
q. = No. of Refrigerators (see Note 1.)	9,090		
TOTAL INCREMENTAL OPERATIONAL COST (US$) = q x p (Diff)	41,523		

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

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

REFRIGUA	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.)	9,090	9,090	
1d. Cost for Refrigerant = a x b x c	9,446	31,906	22,460
2. Compressors & Condensers			
a. Cost per Compressor & Condenser (see Note 2)	45.29	46.99	
b. No. of Compressors & Condensers (see Note 1)	9,090	9,090	
2c. Cost for Compressors & Condensers = a x b	411,686	427,139	15,453
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)	0.770	1.063	
b. No. of Filter/Dryers (see Note 1.)	9,090	9,090	
4c. Cost for Filter/Dryers = a x b	6,999	9,663	2,664
5. Capillary Tubes			
a. Cost per Capillary Tube	1.356	1.600	
b. No. of Capillary Tubes (see Note 1.)	9,090	9,090	
5c. Cost for Capillary Tubes = a x b	12,326	14,544	2,218
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c		42,795	

Note 1. Figures in the above tables are based on actual production volume for the period September 1993 to August 1994 inclusive obtained from REFRIGUA 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 Guatemalan 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: GUATEMALA

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Refrigeradores De Guatemala S.A. (REFRIGUA)

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.

REFRIGUA has a technology agreement with Fogel Jordan Commercial Refrigerator Company, USA which covers the use of the brand name Fogel and covers the assistance in CFC-conversion via royalty fees on the products. The company already produced trial quantities of products for evaluating the performance with HFC-134a. 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 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 are reasonable as well as costs for training, testing and external support.
Operational costs are reasonable and correctly applied.
If the UAC value is calculated for the refrigerant part separately a value of 8.3 USD is obtained which is reasonable compared to other, similar, projects.

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

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22-October-1994

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TECHNICAL REVIEW

PREPARED BY: Dr Hubert Creyf
UNDP Foam Sector Project Reviewer

DATE: 20 October 1994

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1. **COUNTRY:** Guatemala

2. **PROJECT TITLE:** Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at Refrigeradores De Guatemala S.A. (REFRIGUA)
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 especially since the data of the CP dates from 1991.

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. Very cheap technology is used in the manufacturing of the foam panels. It is suggested to UNDP to check whether this technology can be used by other producers of commercial refrigerators.

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 3,216 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.