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

Seventeenth Meeting
Montreal, 26-28 July 1995

PROJECT PROPOSALS: COLOMBIA

This document includes the Comments and Recommendations from the Fund Secretariat on the following projects:

- Elimination of CFCs 11 and 12 in the manufacture of unitary commercial refrigeration equipment at Friomix S.A. — UNDP
- Elimination of CFCs 11 and 12 in the manufacture of commercial refrigeration equipment at Industrias Westell Ltda. — UNDP

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Colombia	
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the commercial refrigeration plants at: a) FRIOMIX S.A. b) Industrias Westell	
BUDGET:	a) Capital Costs:	US $144,033[1]
	Operating Costs:	US $ 49,033
	b) Capital Costs:	US $236,200
	Operating Costs:	US $45,638
INCREMENTAL COSTS:	a)	US $16,852[2]
	b)	US $281,838
ODS PHASE-OUT:	a)	9.67 MT
	b)	20.37 MT
COST EFFECTIVENESS[3]:	a)	US $14.89 per kg. ODP saved
	b)	US $13.84 per kg. ODP saved
PROJECT DURATION:	1.5 years	
IMPLEMENTING AGENCY:	UNDP	
NATIONAL COORDINATING AGENCY:	Ministerio del Medio Ambiente	
TECHNICAL REVIEW COMPLETED:	YES __X__ NO _____	

SECRETARIAT'S COMMENTS

1. This project evaluation sheet covers two projects on the conversion of both the refrigeration and foaming systems in two commercial refrigeration enterprises, FRIOMIX S.A. and Industrias Westell to HFC-134a and HCFC-141b.

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1 Including a 10 per cent contingency fee.

2 Calculated on the basis of 11.7 per cent local ownership.

3 Determined as the ratio of project cost to the estimated annual savings of ODP ($/ODP/Kg. phased out). For CFC-11 and CFC-12, ODS=ODP.

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

3. Conversion to HCFC-141b foaming technology was chosen by companies where cyclopentane technology could not be applied. It will require high pressure foam machines, test runs and training. HCFC-141b is a transitional chemical, however, the high pressure foam machines should be easily modified to be compatible with future zero-ODP blowing agents at a very moderate cost.

4. The Secretariat reviewed the project proposals to assess the eligibility and costs of requested equipment and other project components in the light of similar projects approved by the Executive Committee. The Secretariat discussed with UNDP the incrementality of all costs components and their amounts.

5. It was agreed that replacement of capital equipment will be eliminated where retrofitting was possible. Cost of some items has been reduced on the basis of lower prices for the equipment available on the market. Some costs have been recognized as not eligible incremental costs.

6. Westell and Friomix companies do not currently have a polyurethane foaming machine. The foam chemicals are mixed manually and poured into moulds. Polyol and CFC-11 are purchased as a pre-mix. Westell recognizes the need to purchase a foam chemicals dispensing machine to be able to use a non-CFC technology. In the absence of an existing machine, it is proposed that the difference between a low pressure and a high pressure foaming machine of US $30,000 will be incremental costs. Friomix will fund the purchase of a high pressure machine themselves.

7. Requested incremental costs have been reduced according to 11.7 per cent national ownership for FRIOMIX company.

8. Consequently it was agreed that new project budget should be recommended for approval.

9. Operating costs have been reviewed. Costs associated with HFC-134a compressors supplied by the compressor manufacturing company Andinos (Colombia) have been deducted from incremental operating costs for FRIOMIX and Industrial Westell companies since a project for conversion of Andinos company was approved at the 13th Meeting of the Executive Committee.

10. The cost effectiveness was calculated on the basis of 100 per cent national ownership. Cost-effectiveness of each project is below the threshold established by the Executive Committee for the commercial refrigerator subsector.

SECRETARIAT'S RECOMMENDATION

11. The Fund Secretariat recommends approval of the two projects and the approval of US $238,748 in incremental costs as itemized in the following table and recommends US $31,037 in support cost for UNDP.

Company	Conversion technology	Recommended incremental costs (US $)	Cost-Effectiveness US $/kg. ODP phased out
FRIOMIX S.A.	HFC-134a HCFC-141b	11,146	9.85
Industria Westell	HFC-134a HCFC-141b	227,602	11.17
TOTAL		238,748	

PROJECT COVER SHEET

COUNTRY:	COLOMBIA
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment at FRIOMIX S.A.
SECTOR COVERED:	Commercial Refrigeration (Mfg)
ODS USE IN SECTOR:	109.00 tons ODS
PROJECT IMPACT (ODP):	9.67 ODP tons
TOTAL PROJECT COST:	US$ 144,033
INCREMENTAL CAPITAL COST:	US$ 95,000
INCREMENTAL OPERATING COST:	US$ 49,033
PROPOSED MLF GRANT:	US$ 16,852
UNIT ABATEMENT COST:	0.78 US$/Kg
COST EFFECTIVENESS:	14.89 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Ministerio del Medio Ambiente
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	December 1994

PROJECT SUMMARY:

FRIOMIX S.A. is an 11.70% Colombian-owned company manufacturing bottle coolers for Coca-Cola for the Colombian domestic market. Currently, CFC 11 is used as the blowing agent in the production of the rigid polyurethane insulation foam for the equipment cabinets and doors, and CFC 12 is used as the refrigerant. Based on 1994 figures, this project will eliminate 9.67 ODP tons/yr of CFCs 11 and 12 by conversion to HCFC 141b as the foam blowing agent and HFC 134a as the refrigerant respectively. Funds requested will be used to change the existing production lines, and for technology transfer, technical assistance, 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 Colombian Ministerio del Medio Ambiente.

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

PROJECT OF THE GOVERNMENT OF COLOMBIA

ELIMINATION OF CFCs IN THE MANUFACTURE OF UNITARY COMMERCIAL REFRIGERATION EQUIPMENT

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFCs used by Friomix S.A., a manufacturer of unitary commercial refrigeration equipment. The CFCs which will be eliminated include CFC 11, used as a blowing agent for producing thermal insulating foams, and CFC 12 used as refrigerant.

2. SECTOR BACKGROUND.

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

From the CP, it is estimated that total CFC 11 consumption in Colombia in 1993 amounted to approximately 400 tons, of which 205 tons were used for the production of thermal insulating foams in domestic and commercial refrigeration equipment. Projects to eliminate 169 tons of CFC 11 consumed in the domestic refrigeration sector, and 36 tons consumed in the unitary commercial refrigeration sector, were approved at the 13th and 15th meetings of the MLF.

Similarly from the CP, total CFC 12 consumption in Colombia in 1993 is estimated as being approximately 1,500 tons, of which 110 tons were used as refrigerant in the manufacture of domestic and commercial refrigerators and freezers. The same projects referred to above will eliminate 76 tons of CFC 12 consumed in domestic refrigerator manufacture, and 20 tons consumed in the manufacture of unitary commercial refrigeration equipment.

The CP estimates R502 consumption in 1993 for charging new equipment as being 11.0 tons.

Revision of the market data now suggests that approximately 78,000 units of unitary commercial refrigeration equipment were manufactured in Colombia in 1994. The products include commercial refrigerators and freezers, bottle coolers, refrigerated and frozen supermarket food display cases, drinking water fountains, etc.

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

Enterprise	Production Volume	CFC 11 Consumption (Tons)	CFC 12 Consumption (Tons)
Indufrial	28,020	21.4	10.7
Inducol	14,898	10.3	6.5
Wonder	7,900	4.4	3.0
Westell *	3,454	4.8	2.2
Friomix	10,452	7.5	3.0
Super Nordico	2,033	2.2	1.7
Others (estimate)	11,243	6.5	3.1
Totals	78,000	57.1	30.2

Note: * The data for Westell is for unitary equipment only. Westell are also engaged in the manufacture and installation of supermarket refrigerated display cases etc., again insulated with PU foam and using larger semi-hermetic compressors. Westell consume an additional 10.5 tons of CFC 11, 1.4 tons of CFC 12, and 9.7 tons of R502 in this activity. This additional consumption is included in the "ODS Use in Sector" in the Project Summary.

The total current annual consumption of CFCs for the manufacture and installation of domestic and commercial refrigeration equipment in Colombia is, therefore, approximately:

237 tons of CFC 11 (cf CP 1993 estimate 205 tons)
108 tons of CFC 12 (cf CP 1993 estimate 110 tons)
10 tons of R502 (cf CP 1993 estimate 11 tons)

With increasing social stability and confidence in the domestic economy, significant growth in production volume in this sector has ocurred in 1994 versus 1993, and continued growth of circa 7% pa is anticipated for the next several years. Uninhibited growth would lead to an estimated consumption in the year 2000 of 100 tons per year of CFC 11 and 47 tons per year of CFC 12.

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

The **SIX** companies identified in the above table, **Industrias de Refrigeracion Comercial S.A. (Indufrial), Industrias Colombia S.A. (Inducol), Industrias Wonder S.A. (Wonder), Friomix S.A., Industrias de Refrigeracion Super Nordico (Super Nordico), and Industrias Westell Ltda. (Westell)** account for approximately **85%** of production, and almost **90%** of ODS consumption, in the unitary commercial refrigeration equipment manufacturing sector.

Projects to eliminate ODS consumption at Indufrial, Inducol, and Wonder were approved at the 15th meeting of the Executive Committee of the MLF in December 1994. This project proposal, relating to ODS elimination at **Friomix S.A.**, is the planned follow-up in the commercial refrigeration sector as described in those earlier projects.

The Ministerio del Medio Ambiente, with the assistance of UNDP, has designed a strategy for the elimination of CFC 11 and CFC 12 in this sector beginning early 1995. Approval of this project by the MLF in July 1995, together with projects for Super Nordico and Westell, will result in the elimination of around 90% of the CFCs used in the manufacture of unitary commercial refrigeration equipment in Colombia during 1996.

The possibility of a Technical Assistance Programme to reduce and subsequently eliminate CFC use at the smaller enterprises manufacturing unitary commercial refrigeration equipment will be considered in due course.

3. ENTERPRISE BACKGROUND

FRIOMIX S.A. manufactures a range of unitary commercial bottle coolers for The Coca-Cola Company for use in the Colombian market. FRIOMIX S.A. is an 11.70% Colombian owned enterprise.

TOTAL CFC USE IN 1994:	7.52 tons CFC 11 2.98 tons CFC 12
FULL NAME:	FRIOMIX S.A.
ADDRESS:	Carrera 90A No. 62-06, Alamos Norte, Santafe de Bogota, Colombia.
% ARTICLE 5 COUNTRY OWNERSHIP:	11.70% (Colombia)
No. OF MODELS:	5
PRODUCTION IN 1994:	10,452 units
No. OF PRODUCTION LINES:	1
COMPRESSOR SUPPLIERS:	Compresores Andinos (Colombia) Embraco, and Sicom (Brazil)
CONTACT PERSONS:	Juan Carlos Amador O. - Technical Mgr Arturo Calderon - Development Mgr Jairo Reyes - Purchasing Mgr
TEL / FAX:	Tel: (57 1) 430 2497 Fax: (57 1) 224 6316

Friomix S.A. was founded in 1987 and is engaged in the manufacture of dispensers, bottle coolers, etc. for Industrias de Gaseosas (INDEGA), which is the Coca-Cola bottling company in Colombia. INDEGA in turn, is part of PANAMCO, the Panamanian registered corporation handling Pan-american Coca-Cola bottling operations which also includes SPAHL in Brazil, and AZTECA in Mexico.

The 11.70% Article 5.1 country ownership is Colombian. The balance is predominantly USA (Coca Cola), but it also includes some European capital. A statement on Corporate Ownership is attached.

The current product range comprises 3 horizontal bottle coolers and 2 upright, glass door, bottle coolers. Production volumes are dictated by specific orders from INDEGA. All production is for the Colombian market.

The bottle cooler and freezer designs and technology were developed "in-house". Friomix has no technology transfer or licensing agreements with any internationally recognised commercial refrigeration equipment manufacturers.

Friomix presently employs 130 persons, all of whom are engaged in refrigeration related activities.

This project encompasses all ODS consumption used in the manufacture of bottle coolers at Friomix S.A.

The following tables provide a summary of bottle cooler production by Friomix S.A. during the 12 month period January to December 1994 inclusive.

Model No.	Capacity No. of Bottles	Description	Production Volume	R 12 Charge Kgs	R12 Consumption Kgs
B 200 F	200	Chest BC	3,500	0.240	840
B 400	400	Chest BC	200	0.255	51
B 400 F	400	Chest BC	3,200	0.300	960
N 15 AF	15 ft3	Vert BC GD	1,552	0.300	466
N 18 AF	18 ft3	Vert BC GD	2,000	0.330	660
Totals or Weighted Average			10,452	0.285	2,977

Model No.	PU Foam per Unit Kgs	Cabinet & Door Liner per Unit	R12 Compressor HP & Price US$	R134a Compressor HP & Price US$
B 200 F	3.560	Metal	1/5 34.68	1/5 38.66
B 400	5.880	Metal	1/4 35.74	1/4 40.38
B 400 F	5.880	Metal	1/4 35.74	1/4 40.38
N 15 AF	6.400	Metal	1/5 34.68	1/5 38.66
N 18 AF	7.720	Metal	1/4 35.74	1/4 40.38
Weighted Average	5.532		33.24	37.84

4. PROJECT DESCRIPTION

Friomix presently uses CFC 11 for the production of the rigid insulating foam needed for the bottle cooler cabinets and doors. CFC 12 is used as refrigerant. The total consumption in the 12 months January - December 1994, and the ODP tons that will be eliminated by this project are shown in the following table:

CFC 11 consumed (tons)	ODP tons eliminated * see Note	CFC 12 consumed (tons)	ODP tons eliminated	Total ODP tons eliminated
7.52	6.69	2.98	2.98	9.67

Note: *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.

Friomix will replace the CFC 11 used as a blowing agent in the production of the insulation foam with HCFC 141b as an interim step to an ODS-free system. (See attached Annex C.)

Friomix does not currently have a PU foam dispensing machine. The foam chemicals are mixed manually and poured into the molds. Polyol and CFC 11 are purchased as a pre-mix. Friomix recognise the need to purchase a foam chemicals dispensing machine to be able to use non-CFC technology, and the enterprise will fund the purchase of a 45 Kgs/minute capacity high pressure machine themselves.

The conversion to HCFC 141b will incur some costs related to technology transfer, production test trials and training at Friomix. These activities will include training of staff in worker-safety related to HCFC 141b.

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

4.2. REPLACEMENT OF CFC 12 WITH HFC 134a.

HFC 134a is universally accepted as a Zero-ODP replacement for CFC 12 in the manufacture of unitary commercial refrigeration equipment and the technology is mature. This is the CFC 12 replacement technology selected by Friomix.

The conversion to HFC 134a requires the use of HFC 134a specific 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.

Details of the existing equipment on which the technology change will impact are provided in Section 5.2.3.

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

5. TECHNOLOGY

5.1. REPLACEMENT OF CFC 11.

5.1.1. OVERVIEW

Currently, the three principal technology options for the replacement of CFC 11 in thermoset insulation foams are:

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, perfluoroalkanes, hydrofluoroalkanes such as HFcs 245, 356, etc., fluorinated ethers, 2-chloropropane, and vacuum panels have been suggested for specific applications, but the technologies are not mature. Furthermore, some of these 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, employs technology that is closely related to the existing CFC 11 technology. The final step

to non-ODS technology in this process is not yet decided. One potential solution may be the use of liquid HFCs such as HFC 356, or HFC 245, but full water blown foam with improved cell structure remains another option.

The second one, the "gas" solution, utilizes physical blowing agents which are liquefied gases. This technology always requires new foam dispensing equipment and extensive adjustments. The final step to a zero-ODP technology in this process could be the use of a gaseous HFC such as HFC 134a.

The third option, pentane technology, is commercially proven and is now extensively used in many rigid PU insulation foam applications in Europe. It is currently the most cost effective of the non-ODS technologies for CFC replacement. However, pentanes are flammable and this means a careful review of manufacturing operations with respect to the safe handling of a flammable foam blowing agent. Pentane technology is often not a practical or cost effective option in the existing workplace environments at many smaller scale enterprises due to the safety modifications required.

Several companies currently offer pentane technology packages, including equipment. However, UNDP requires an independent safety review prior to, and after, installation.

5.1.2. SELECTION

Based on economic and environmental considerations, cyclopentane appears to be the best choice for small unitary commercial refrigeration equipment. It combines an attractive price with zero ODP, and near zero-GWP properties, as well as acceptable foam insulation qualities. Friomix considered cyclopentane technology, but whilst recognising both the environmental and economic benefits of cyclo-pentane, HCFC 141b was chosen as a first stage, interim, replacement for CFC 11 because of concerns that cyclo-pentane technology could not be safely introduced in the existing workplace environment.

HCFC 141b is recognised by Friomix as a CFC 11 replacement that is:

- proven technology in both processing and product performance
- environmentally acceptable
- available in the Colombian market
- a technology that can be implemented safely and cost effectively within their existing factory configurations

The purchase of high pressure foam dispensing equipment by Friomix will facilitate the subsequent step to a final zero-ODP insulating foam system and the enterprise accepts that any additional capital costs associated with such a change is for its own account.

5.1.3. IMPACT ON THE PRODUCTION PROCESS

The use of HCFC 141b technology will be facilitated through the purchase of high pressure foam production equipment.

HCFC 141b is a non-flammable liquid (no flash point), but moderately flammable in the gaseous state. The flammability limits are 7.6 - 17.1% by volume in air. The usually recommended PEL (Permissable Exposure Limit) is 500 ppm on an eight-hour time-weighted average. In the intended application, the use of HCFC 141b should not pose a significant risk, but UNDP will, as part of its safety audit programme, perform a monitoring check at commissioning to ensure the adherence to safe worker exposure levels. Ventilation will be installed if the results idicate the need.

Friomix uses only metal cabinet and lid liners, or glass doors. The technology change to HCFC 141b does not require any change in liner materials.

Foam density adjustments will be necessary to obtain equivalent insulation values.

5.2. REPLACEMENT OF CFC 12.

5.2.1. OVERVIEW

HFC 134a is universally accepted as a replacement for CFC 12 in unitary commercial refrigeration equipment. HFC 134a is widely available and the technology is mature. Replacement of CFC 12 with HFC 134a requires relatively modest changes to existing production facilities.

Whilst hydrocarbon refrigerant (iso-butane) is being increasingly used in the manufacture of domestic refrigerators in several Developed Countries, the transfer of this technology to Developing Countries is not always cost effective. It also raises questions about safety issues and remains conditional on the support of a technology partner experienced in the production of comparable refrigerators and freezers on a commercial scale. It is further dependent on the technology partner providing assurances in writing on safety issues, and, of course, the availability of adequate supplies of both compressors and hydrocarbon refrigerant of the required quality.

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 commercially available.

5.2.2. SELECTION

The selected technology is HFC 134a. The CFC 12 based technology used by Friomix was developed "in-house" with assistance from compressor, component, and refrigerant suppliers. Friomix has no formal technology transfer agreements with internationally recognised commercial refrigeration equipment manufacturers or compressor suppliers.

The new HFC 134a based technology will be developed by the enterprise with assistance from compressor and refrigerant suppliers. The project budget makes provision for formal technology assistance from compressor and refrigerant suppliers, as well as the relevant UNDP consultants, in order to ensure successful implementation of the 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 levels are not exceeded. At the present time this means ensuring that exposure levels do not exceed 1000 parts per million on an 8-hour time-weighted average basis. This is the same as the Occupational Exposure Limit (OEL)/Threshold Limit Value (TLV) for CFC 12 and thus no changes from current practices are required.

There will be an approximately 10% reduction in the mass charge of HFC 134a compared with CFC 12 for a refrigerator system of the same capacity. This is taken into account in the calculation of the incremental operational costs.

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

Because system cleanliness and moisture content are paramount to the successful manufacture of unitary HFC 134a refrigeration equipment, Friomix will need to carefully re-assess production procedures and re-train production personnel as appropriate. Provision for this is also made within the proposed project budget.

The conversion from CFC 12 to HFC 134a will take place on a model by model basis, so that Friomix will be producing both CFC 12 and HFC 134a refrigeration units 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.

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.

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

- 1 x Danfoss based R12 charging machine
- 5 x Ritchie Model 93200 vacuum pumps, 12 M3/hr
- 1 x GE H10B hand-held electronic R12 leak detector

Four of the vacuum pumps are in service, with one on stand-by duty. The project proposal includes provision for a new R134a charging machine and one new vacuum pump. Provision is also made for retrofit of the remaining vacuum pumps where considered feasible, or the funding provided for retrofitting will be used towards the purchase of new vacuum pumps, at the discretion of the enterprise.

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

TRAINING, TEST TRIALS & TECHNOLOGY TRANSFER	10,000
CONTINGENCIES (10%)	1,000
Subtotal (US$)	**11,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

R134A CHARGING EQUIPMENT (1 off)	25,000
NEW VACUUM PUMP (1 off)	3,000
RETROFITTING VACUUM PUMPS (5 off)	2,500
R134a LEAK DETECTION EQUIPMENT (1 off)	500
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION & RELIABILITY TEST TRIALS (5 models)	25,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	8,000
Subtotal (US$)	**84,000**

TOTAL INCREMENTAL CAPITAL COST (US$)	**95,000**

6.2 INCREMENTAL OPERATING COSTS

The calculation of the incremental operating costs is based on a six month period using 50% of the actual production for January to December 1994 inclusive. Annex A. provides detailed explanations on how the incremental operational costs were obtained, the costs are summarized below:

PHASE-OUT OF CFC 11

Costs for Materials (see Annex A. Part 1.) :	15,903

PHASE-OUT OF CFC 12

Costs for Materials (see Annex A. Part 2.) :	33,130
TOTAL INCREMENTAL OPERATING COST (US$)	**49,033**

6.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational) (US$)	**144,033**
% Article 5.1 Country Ownership	**11.70%**
FUNDING REQUESTED FROM MLF (US$)	**16,852**

6.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs (11.70% of US$ 95,000)	**11,115**
b. Capital Recovery Factor (10% p.a.)	**0.16275**
c. Incremental Operating Costs (11.70% of US$ 49,033)	**5,737**
d. ODS Reduction (ODP Kgs Jan - Dec 1994)	**9,670**
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	**0.78**

THE PROJECT UNIT ABATEMENT COST IS 0.78 US$/Kg

6.5 PROJECT COST EFFECTIVENESS (US$/Kg)

Total Project Cost	=	**144,033**	**US$**
ODS Eliminated	=	**9,670**	**ODP Kgs**
Project Cost Effectiveness	=	**14.89**	**US$/Kg**

THE PROJECT COST EFFECTIVENESS IS 14.89 US$/Kg

7. FINANCING PLAN

FRIOMIX S.A. requests reimbursement of US$ 16,852 representing 11.70% of the incremental Capital and Operating Costs of this project in line with the Article 5.1 country ownership of the enterprise.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

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

8.2 SCHEDULE

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

9. PROJECT IMPACT

Based on 1994 consumption data, this project will eliminate the use of 9.67 ODP tons per year.

10. ANNEXES

Annex A: Incremental Operational Cost Calculations.
Annex B: Project Technical Reviews.
Annex C: FRIOMIX letter relating to HCFC 141b technology selection.

Notes relating to the calculation of the Incremental Operational Costs

Note 1.
Figures in the following tables are based on the actual production volumes for unitary bottle coolers for the 12 month period January to December 1994 obtained from Friomix S.A. at the time of project preparation. As Incremental Operational Costs are claimed for 6 months only, 50% of this 12 months production volume has been used in the calculation.

Note 2.
Refrigerant, and chemical prices used in the following tables are current weighted average prices for the principal domestic and commercial refrigerator manufacturers in Colombia. Compressor prices are weighted average prices for the enterprise. With the large differences in compressor capacity, and hence price, between the three enterprises it is not appropriate to use "National" weighted average prices for compressors.

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.

ANNEX A. INCREMENTAL OPERATIONAL COST CALCULATIONS

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

FRIOMIX S.A.	CFC 11	HCFC 141b	Diff
Use per Kg of Foam produced			
a. Kg Polyol	0.370	0.383	0.013
b. MDI	0.500	0.500	-
c. Kg Blowing Agent	0.130	0.117	(0.013)
Prices in US$/Kg			
d. Polyol	2.61	2.74	0.13
e. MDI	2.15	2.15	-
f. Blowing Agent	2.00	4.00	2.00
g. Liner (Type: Metal - no change)	n/a	n/a	-
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.966	1.049	0.083
i. = b. x e. MDI	1.075	1.075	-
j. = c. x f. Blowing Agent	0.260	0.468	0.208
k. = h+i+j Total Cost per Kg of Foam	2.301	2.592	0.291
Materials Used per Bottle Cooler			
l. Kg of Foam per Bottle Cooler (average)	5.532	6.085	0.553
m. Kg of Liner material per Bottle Cooler (avg)	n/a	n/a	-
Cost per Bottle Cooler			
n. = l. x k. for Bottle Cooler Foam	12.729	15.772	3.043
o. = m. x g. for Bottle Cooler Liner	-	-	-
p. = n. + o. Total per Bottle Cooler	12.729	15.772	3.043
q. = No. of Bottle Coolers (see Note 1.)	5,226		
TOTAL INCREMENTAL OPERATIONAL COST (US$)	**15,903**		

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

FRIOMIX S.A.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.60	8.50	
b. Kg of Refrigerant per Bottle Cooler (avg.)	0.285	0.257	
c. No. of Bottle Coolers Produced (Note 1.)	5,226	5,226	
1d. Cost for Refrigerant = a x b x c	3,873	11,416	7,543
2. Compressors			
a. Cost for Compressor (see Note 2.)	33.24	37.84	
b. No. of Compressors (see Note 1.)	5,226	5,226	
2c. Cost for Compressors = a x b	173,712	197,752	24,040
3. Condensers			
a. Cost per Condenser	N/C	N/C	
b. No. of Condensers	5,226	5,226	
3c. Cost for Condensers = a x b	-	-	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	1.200	1.350	
b. No. of Filter/Dryers (see Note 1.)	5,226	5,226	
4c. Cost for Filter/Dryers = a x b	6,271	7,055	784
5. Capillary Tubes			
a. Cost per Capillary Tube (average)	0.583	0.729	
b. No. of Capillary Tubes (see Note 1.)	5,226	5,226	
5c. Cost for Capillary Tubes = a x b	3,047	3,810	763
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)		**33,130**	

Country of origin: COLOMBIA

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment (Three companies: Industrias de Refrigeracion Super Nordico, Industrias Westell Ltda and Friomix S.A.)

Sector/sub-sector Commercial refrigeration

Relationship to country program UNDP (CP in preparation)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

- All manufacturers in this project have chosen for a conversion of their production to the HFC-134a technology. Part of the products will be converted from R-502 to R-502 replacements (e.g. R-404A, no final decision seems to be made here yet).
- In commercial refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption. Also R-502 replacements like R-404A are acceptable technologies to reduce CFC consumption.
- The companies in this project do not have a formal technology transfer agreement. However, all of them plan to develop the HFC-134a technology with assistance from compressor and refrigerant suppliers. This holds for both the unitary equipment produced by all manufacturers and the non-unitary equipment of Westell. Furthermore provisions for external assistance are present. Due to these facts, a successful project implementation can be expected at all three companies.
- Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of safety issues related to the use of flammable refrigerants in commercial equipment (relatively large charges) and because of the lack of commercially available compressors. From the zero ODP technologies HFC-134a is a cost effective solution.

Environmental impact

HFC-134a has an ODP of zero and a GWP of 0.27.

Project costs

Unitary equipment (for all three companies)

- The equipment requested is essential for the conversion process of the unitary equipment. Costs of equipment, redesign, training, testing and technical assistance are reasonable.
- Incremental operational costs are reasonable and correctly applied (for six months).
- If the UAC value is calculated for the refrigerant conversion part of the project, values of 1.83 USD/kg/y (Friomix, a low value due to the high foreign ownership), 14.1 USD (Super Nordico) and 8.0 USD (Westell) are found, which are reasonable values for commercial refrigeration projects, unitary products.
- The foreign ownership of the Friomix company is correctly taken into account.

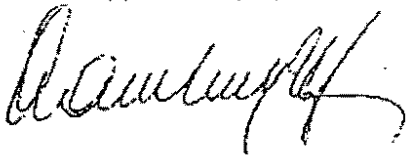
Non-unitary equipment (Westell):

- The refrigeration equipment requested for installing new equipment and for servicing existing equipment (including retrofits) is essential for a successful reduction of CFC-12 usage in the non-unitary sector. The costs claimed are reasonable. The investment in 4 recovery/recycling stations is not very cost effective due to the low CFC-12 reduction involved (only 80 kg ODP/year, however a not quantified additional amount could be recovered) but is still acceptable.

- The estimated value for the ODP reduction is reasonable.

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

Janssen M.J.P.,
Eindhoven, The Netherlands
30-January-1995



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

TECHNICAL REVIEW.

1.Country:

Colombia.

2.Project Title:

Elimination of CFCs in the Manufacture of Unitary Commercial Refrigeration equipment at three Firms(Friomix, Super Nordico and Westell).

3.(Sub)Sector:

(Commercial) Refrigeration.
This review covers only the foam part.

4.CP-Relationship:

The CP for Colombia for the phase-out of ODS under the Montreal Protocol was approved at the 12th Meeting of the Executive Committee of the MLF in March '94. Specific Programs for the elimination in the Refrigeration Sector, were approved at the 13th and 15th meetings of the MLF.At the latter meeting, the project of the three commercial refrigeration companies were approved. This project is the planned follow-up in the Commercial Refrigeration Sector to the projects approved at the 15th Executive Committee for Indufrial, Inducol and Wonder.

5.Technology:

All three firms have chosen to substitute CFC11 with HCFC 141b, the main reason being that the HCFC 141b technology is proven, locally available, cost effective and presenting no major safety problems.This reasoning is correct.
Since the Maximum Allowed Concentration in the workplace is 500 ppm (instead of 1000 ppm for CFC 11) extra ventilation must be foreseen.The reviewer realises that this issue is perhaps only critical in the case of Westell, where high weights of polyurethane are used in

the cabinets.It is also noted that this matter will be addressed during the project commissioning.
In the case of the four models of Super Nordico, foreseen with plastic liners, the question of deterioration prevention is well taken care of.

6.Environmental Impact:

It must be stressed that the change to an HCFC as an auxiliary blowing agent is to be considered as an intermediate step to a zero ODS solution.It seems that all three firms have agreed upon that.The reviewer is aware that UNEP and UNDP inform the companies and the Government Counterpart in an adequate way, when an ODS free, safe technological solution is commercially available.
The ODP of HCFC 141b is .1, vs 1. for CFC 11. the GWP is .1 for 141b and 1. for CFC 11.The relative Smog Potential for CFC 11 is .1, for HCFC 141b it is 1., but it is 500 for pentane.

7.Project Costs:

It is understood that polyol:HCFC 141b mixtures is available in Colombia. This may lower raw matertial prices and operating costs.
7.1. FRIOMIX.
The incremental capital costs for Friomix are correctly represented.
The foam chemicals are presently mixed manually and poured into the molds.Since it is recognised that it is necessary to purchase a foam chemicals dispensing machine to be able to use non-CFC technology, the company agrees to contribute to the cost as if they would buy a low pressure machine today, and have the MLF pay for the difference between a high pressure and a low pressure machine. Local prices will be determined during project implementation, as per usual UNDP/UNOPS procedures.
The incremental operating costs are correct as stated.
The cost to eliminate 1 kg of ODS is USD 81,903/6,690 or USD 12.24.

7.2.SUPER NORDICO.

Both incremental capital and operating costs are correctly presented.
The cost for elimination of 1 kg of ODS is USD 81,823/1,950 or USD 41.96.

7.3.WESTELL.

As well the incremental capital, as the incremental operating costs are correctly presented.
The elimination cost of 1 kg of ODS in the foam part becomes: USD (66,000 + 29,990)/13,630 or USD 7.04.

8.Implementation:

The proposed time schedule can be accepted.

9.Recommendation:

Although substantial differences in unit elimination prices of ODS for the three firms are observed, it is recognised that, because only six compagnies produce commercial refrigeration in Colombia, it would be unfair to penalise some just because they are smaller. It is therefore recommended to accept the three projects.

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date:07 March 1995.

PROJECT COVER SHEET

COUNTRY:	COLOMBIA
PROJECT TITLE:	Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at INDUSTRIAS WESTELL Ltda.
SECTOR COVERED:	Commercial Refrigeration (Mfg)
ODS USE IN SECTOR:	109.00 tons ODS
PROJECT IMPACT (ODP):	20.37 ODP tons
TOTAL PROJECT COST:	US$ 281,838
INCREMENTAL CAPITAL COST:	US$ 236,200
INCREMENTAL OPERATING COST:	US$ 45,638
PROPOSED MLF GRANT:	US$ 281,838
UNIT ABATEMENT COST:	4.13 US$/Kg
COST EFFECTIVENESS:	13.84 US$/Kg
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Ministerio del Medio Ambiente
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	December 1994

PROJECT SUMMARY:

INDUSTRIAS WESTELL Ltda. is a 100% Colombian-owned company manufacturing unitary and non-unitary commercial refrigeration equipment. They install the non-unitary equipment and operate a nationwide service network. Currently, CFC 11 is used as the blowing agent for the production of the rigid PU insulation foam for the equipment cabinets. Both CFC 12 and R502 are used as refrigerants. Based on 1994 figures, this project will eliminate 20.37 ODP tons/yr of CFCs by conversion to HCFC 141b as the foam blowing agent and HFC 134a/R404A/R407A etc. as the refrigerants respectively. Funds requested will be used to change the existing production lines, to facilitate retrofit and recovery & recycle, and for technology transfer, technical assistance, 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 Colombian Ministerio del Medio Ambiente.

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

PROJECT OF THE GOVERNMENT OF COLOMBIA

ELIMINATION OF CFCs IN THE MANUFACTURE OF UNITARY COMMERCIAL REFRIGERATION EQUIPMENT

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFCs used by Industrias Westell Ltda, a manufacturer of both unitary and non-unitary commercial refrigeration equipment. The CFCs which will be eliminated include CFC 11, used as a blowing agent for producing thermal insulating foams, and CFC 12 and R502 used as refrigerants.

2. SECTOR BACKGROUND.

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

From the CP, it is estimated that total CFC 11 consumption in Colombia in 1993 amounted to approximately 400 tons, of which 205 tons were used for the production of thermal insulating foams in domestic and commercial refrigeration equipment. Projects to eliminate 169 tons of CFC 11 consumed in the domestic refrigeration sector, and 36 tons consumed in the unitary commercial refrigeration sector, were approved at the 13th and 15th meetings of the MLF.

Similarly from the CP, total CFC 12 consumption in Colombia in 1993 is estimated as being approximately 1,500 tons, of which 110 tons were used as refrigerant in the manufacture of domestic and commercial refrigerators and freezers. The same projects referred to above will eliminate 76 tons of CFC 12 consumed in domestic refrigerator manufacture, and 20 tons consumed in the manufacture of unitary commercial refrigeration equipment.

The CP estimates R502 consumption in 1993 for charging new equipment as being 11.0 tons.

Revision of the market data now suggests that approximately 78,000 units of unitary commercial refrigeration equipment were manufactured in Colombia in 1994. The products include commercial refrigerators and freezers, bottle coolers, refrigerated and frozen supermarket food display cases, drinking water fountains, etc.

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

Enterprise	Production Volume	CFC 11 Consumption (Tons)	CFC 12 Consumption (Tons)
Indufrial	28,020	21.4	10.7
Inducol	14,898	10.3	6.5
Wonder	7,900	4.4	3.0
Westell *	3,454	4.8	2.2
Friomix	10,452	7.5	3.0
Super Nordico	2,033	2.2	1.7
Others (estimate)	11,243	6.5	3.1
Totals	78,000	57.1	30.2

Note: * The data for Westell is for unitary equipment only. Westell are also engaged in the manufacture and installation of supermarket refrigerated display cases etc., again insulated with PU foam and using larger semi-hermetic compressors. Westell consume an additional 10.5 tons of CFC 11, 1.4 tons of CFC 12, and 9.7 tons of R502 in this activity. This additional consumption is included in the "ODS Use in Sector" in the Project Summary.

The total current annual consumption of CFCs for the manufacture and installation of domestic and commercial refrigeration equipment in Colombia is, therefore, approximately:

237 tons of CFC 11 (cf CP 1993 estimate 205 tons)
108 tons of CFC 12 (cf CP 1993 estimate 110 tons)
10 tons of R502 (cf CP 1993 estimate 11 tons)

With increasing social stability and confidence in the domestic economy, significant growth in production volume in this sector has ocurred in 1994 versus 1993, and continued growth of circa 7% pa is anticipated for the next several years. Uninhibited growth would lead to an estimated consumption in the year 2000 of 100 tons per year of CFC 11 and 47 tons per year of CFC 12.

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

The **SIX** companies identified in the above table, **Industrias de Refrigeracion Comercial S.A. (Indufrial), Industrias Colombia S.A. (Inducol), Industrias Wonder S.A. (Wonder), Friomix S.A., Industrias de Refrigeracion Super Nordico (Super Nordico), and Industrias Westell Ltda. (Westell)** account for approximately **85%** of production, and almost **90%** of ODS consumption, in the unitary commercial refrigeration equipment manufacturing sector.

Projects to eliminate ODS consumption at Indufrial, Inducol, and Wonder were approved at the 15th meeting of the Executive Committee of the MLF in December 1994. This project proposal, relating to ODS elimination at **Westell**, is the planned follow-up in the commercial refrigeration sector as described in those earlier projects.

The Ministerio del Medio Ambiente, with the assistance of UNDP, has designed a strategy for the elimination of CFC 11 and CFC 12 in this sector beginning early 1995. Approval of this project by the MLF in July 1995, together with projects for Friomix and Super Nordico, will result in the elimination of around 90% of the CFCs used in the manufacture of unitary commercial refrigeration equipment in Colombia during 1996.

The possibility of a Technical Assistance Programme to reduce and subsequently eliminate CFC use at the smaller enterprises manufacturing unitary commercial refrigeration equipment will be considered in due course.

3. ENTERPRISE BACKGROUND

INDUSTRIAS WESTELL Ltda manufactures an extensive range of both unitary and non-unitary commercial refrigeration equipment, including refrigerators and freezers, bottle coolers, supermarket display cases, as well as "walk-in" cold rooms. They also install and service commercial refrigeration equipment throughout Colombia. Industrias Westell is a 100% Colombian family owned enterprise.

TOTAL CFC USE IN 1994:	15.31 tons CFC 11 } Factory 2.22 tons CFC 12 } Consumption 1.39 tons CFC 12 } On-site 9.67 tons R 502 } Charging 0.91 tons CFC 12 } Servicing 2.38 tons R 502 } & Repairs
FULL NAME:	INDUSTRIAS WESTELL Ltda.
ADDRESS:	Calle 12 # 44-70, Santafe de Bogota Colombia.
% ARTICLE 5 COUNTRY OWNERSHIP:	100% (Colombia)
No. OF MODELS:	43 (unitary equipment) 43 (non-unitary equipment)
PRODUCTION IN 1994:	3,454 units of unitary equipment 1,391 units of non-unitary equipment
No. OF PRODUCTION LINES:	2

COMPRESSOR SUPPLIERS:	Compresores Andinos, Colombia L'Unite Hermetique, France Copeland & Tecumseh, USA
CONTACT PERSONS:	Felipe Solano Gonzalez - Gen Mgr Maria Isabel Solano - Manager Felipe Solano Castaneda - Prodn Mgr
TEL / FAX:	Tel: (57 1) 268 5299 Fax: (57 1) 268 4625

Industrias Westell Ltda is a long established commercial refrigeration company in Colombia which was founded in 1964. In addition to their Bogota based manufacturing operations they have installation and service centres throughout Colombia, including Bogota, Medellin, Cali, Barranquilla, Pereira, Manizales, etc.

Approximately 42% of the 0.910 tons of CFC 12 consumption, and 50% of the 2.376 tons of R502 consumption for servicing is in Bogota and Medellin.

All Westell's production of commercial refrigeration equipment is sold within Colombia.

All the designs and technology for the extensive range of both unitary and non-unitary equipment which Westell manufacture were developed "in-house". Westell has no technology transfer or licensing agreements with any internationally recognised commercial refrigeration equipment manufacturers.

Industrias Westell presently employs 159 persons, 104 of whom are engaged in refrigeration related activities.

This project encompasses all ODS consumption used in the manufacture of unitary refrigeration equipment at Westell. It also includes provision to reduce ODS consumption in the non-unitary commercial refrigeration sector, through the supply of equipment to enable non-ODS refrigerants to be charged, although it is recognised that the choice of refrigerant cannot always be directly influenced by Westell.

The following tables provide a summary of production and ODS consumption for both unitary, and non-unitary equipment, by Industrias Westell Ltda. during the 12 month period January to December 1994 inclusive.

Model No.	Capacity Cu ft	Description	Production Volume	R12 Charge Kgs	R12 Consumption Kgs
TW3A1PL	11.0	Ref G	13	0.292	3.80
TW5A1PL	14.0	Ref G	360	0.486	174.96
TW6A2PL	17.0	Ref G	180	0.486	87.48
TW8A2PL	22.0	Ref G	15	0.551	8.27
TW10A2PL	27.0	Ref G	41	0.616	25.26
TKX4A1PL	9.0	Ref G	390	0.486	189.54
TKX8A3PL	19.0	Ref G	220	0.486	106.92
TWE3A1PL	11.0	Ref G	43	0.421	18.10
TWE5A1PL	14.0	Ref G	71	0.616	43.74
TWE6A2PL	17.0	Ref G	83	0.649	53.87
TX4A2CLC	9.0	Ref G	61	0.486	29.65
TX6A2CLC	6.0	Ref G	57	0.584	33.29
TXEA2CLC	4.0	Ref G	68	0.486	33.05
TXE6A2CLC	6.0	Ref G	22	0.584	12.85
TW5A1CLC	6.0	Ref G	186	0.616	114.58
TW6A2CLC	7.0	Ref G	141	0.649	91.51
TXE4CL	10.0	Ref G	20	0.389	7.78
SRD12A1	12.0	Ref	5	0.389	1.95
SRD12A1A	12.0	Ref	133	0.389	51.74
SRD24A2	24.0	Ref	240	0.422	101.28
SRD24A2G	24.0	Ref	45	0.422	18.99
SRD34A2	34.0	Ref	6	0.649	3.89
SRD34A2G	34.0	Ref	320	0.649	207.68
SRD40A3	40.0	Ref	1	0.811	0.81
SRD40A3G	40.0	Ref	1	0.811	0.81
SRD45A2	45.0	Ref	25	0.908	22.70
SRD45A2G	45.0	Ref	50	0.908	45.40
SRD45A4	45.0	Ref	2	0.908	1.82
SRD45A4G	45.0	Ref	2	0.908	1.82
CSRD34A2	17.0	Ref/Frz	75	1.427	107.03
CSRD34A2G	17.0	Ref/Frz	66	1.427	94.18
CSRD45A2	23.0	Ref/Frz	88	1.849	162.71
CSRD45A1X1G	23.0	Ref/Frz	15	1.849	27.74
CSRD45A2G	23.0	Ref/Frz	45	1.849	83.21
CR12A1	12.0	Frz	18	0.486	8.75
CR12A1G	12.0	Frz	175	0.486	85.05
CR24A1G	22.0	Frz	96	0.778	74.69
CR34A2	34.0	Frz	10	0.778	7.78
CR34A2G	34.0	Frz	13	0.778	10.11
CR40A2	40.0	Frz	13	1.103	14.34
CR40A2G	40.0	Frz	10	1.103	11.03
CR45A2	45.0	Frz	13	1.297	16.86
CR45A2G	45.0	Frz	16	1.297	20.75
Totals or Weighted Average			3,454	0.642	2,217.77

Model No.	PU Foam per Unit Kgs	Capillary Tube Price US$	R12 Compressor HP & Price US$		R 134a Compressor HP & Price US$	
TW3A1PL	6.60	1.20	1/4	46.70	1/4	50.93
TW5A1PL	7.20	1.20	1/4	46.70	1/4	50.93
TW6A2PL	8.40	1.90	1/4	46.70	1/4	50.93
TW8A2PL	9.20	2.30	1/3	49.80	1/3	54.15
TW10A2PL	9.20	2.90	1/2	99.70	1/2	110.40
TKX4A1PL	7.40	2.90	1/4	46.70	1/4	50.93
TKX8A3PL	11.20	2.90	1/3	49.80	1/3	54.15
TWE3A1PL	5.60	1.20	1/4	46.70	1/4	50.93
TWE5A1PL	6.10	1.20	1/4	46.70	1/4	50.93
TWE6A2PL	6.90	2.30	1/3	49.80	1/3	54.15
TX4A2CLC	6.60	1.00	1/4	46.70	1/4	50.93
TX6A2CLC	7.20	1.90	1/3	49.80	1/3	54.15
TXEA2CLC	5.50	1.90	1/4	46.70	1/4	50.93
TXE6A2CLC	5.90	1.90	1/3	49.80	1/3	54.15
TW5A1CLC	7.20	1.20	1/4	46.70	1/4	50.93
TW6A2CLC	7.80	1.90	1/3	49.80	1/3	54.15
TXE4CL	5.50	1.20	1/4	46.70	1/4	50.93
SRD12A1	8.20	1.90	1/4	46.70	1/4	50.93
SRD12A1A	6.70	1.90	1/4	46.70	1/4	50.93
SRD24A2	9.60	2.30	1/3	49.80	1/3	54.15
SRD24A2G	7.60	2.30	1/3	49.80	1/3	54.15
SRD34A2	16.90	2.30	1/3	49.80	1/3	54.15
SRD34A2G	14.40	2.30	1/3	49.80	1/3	54.15
SRD40A3	6.10	ExV	1/3	49.80	1/3	54.15
SRD40A3G	2.90	ExV	1/3	49.80	1/3	54.15
SRD45A2	6.10	ExV	1/2	99.70	1/2	110.40
SRD45A2G	2.90	ExV	1/2	99.70	1/2	110.40
SRD45A4	6.10	ExV	1/2	99.70	1/2	110.40
SRD45A4G	2.90	ExV	1/2	99.70	1/2	110.40
CSRD34A2	16.70	3.80	1/3+1/4	96.50	1/3+1/4	105.08
CSRD34A2G	14.30	3.80	1/3+1/4	96.50	1/3+1/4	105.08
CSRD45A2	19.40	ExV	1/2+1/3	149.50	1/2+1/3	164.55
CSRD45A1X1G	18.40	ExV	1/2+1/3	149.50	1/2+1/3	164.55
CSRD45A2G	17.40	ExV	1/2+1/3	149.50	1/2+1/3	164.55
CR12A1	11.40	2.30	1/3	49.80	1/3	54.15
CR12A1G	9.80	2.30	1/3	49.80	1/3	54.15
CR24A1G	8.20	3.50	1/2	99.70	1/2	110.40
CR34A2	6.60	2.90	1/2	99.70	1/2	110.40
CR34A2G	3.30	2.90	1/2	99.70	1/2	110.40
CR40A2	6.60	ExV	1.0	162.40	1.0	178.60
CR40A2G	3.30	ExV	1.0	162.40	1.0	178.60
CR45A2	6.60	ExV	1.0	162.40	1.0	178.60
CR45A2G	3.30	ExV	1.0	162.40	1.0	178.60
Weighted Average	9.211	2.189	55.14		60.26	

Display Cases: Non-Unitary Equipment Charged on-site

Model No.	Production Volume	R12 Charge Kgs	R12 Consumption Kgs	R502 Charge Kgs	R502 Consumption Kgs
CFX 1094	275	-	-	11.4	3,135.0
C2FFA1094	198	-	-	11.4	2,257.2
EWFX2P	141	-	-	8.1	1,142.1
CFR10	183	-	-	11.4	2,086.2
AP4	127	3.6	457.2	-	-
WKYT10	236	2.7	637.2	-	-
SWC-635-A1	10	-	-	8.1	81.0
FWC-624-A1	10	-	-	8.1	81.0
SWE-635-A1	10	-	-	8.1	81.0
FWC-344-A1	10	-	-	7.2	72.0
FWE-499-A1	10	4.1	41.0	-	-
FWE-519-A1	10	4.1	41.0	-	-
FWE-174-A1	10	0.9	9.0	-	-
SWE-462-A1	10	4.0	40.0	-	-
SWC-300-A1	5	-	-	7.2	36.0
SWE-186-A1	5	0.9	4.5	-	-
SWC-19-270	5	-	-	40.8	204.0
SWE-323	5	0.9	4.5	-	-
SWE-654	5	5.4	27.0	-	-
SWE-178	11	5.7	62.7	-	-
SWC-264	5	-	-	5.4	27.0
SWC-322	5	-	-	5.4	27.0
SWC-307	5	-	-	5.4	27.0
SWC-639	5	-	-	5.4	27.0
SWC-456	5	-	-	7.2	36.0
SWC-478	5	-	-	7.2	36.0
SWC-310	5	-	-	5.4	27.0
SWC-365	5	-	-	5.4	27.0
SWE-175	5	0.9	4.5	-	-
SWC-464	5	-	-	7.2	36.0
SWC-179X17	5	-	-	5.4	27.0
SWE-441	5	2.7	13.5	-	-
SWE-410	5	2.7	13.5	-	-
SWC-214	5	-	-	7.2	36.0
SWE-313	5	2.7	13.5	-	-
SWE-314	5	2.7	13.5	-	-
FWC-781	5	-	-	8.1	40.5
FWE-461-A	5	2.7	13.5	-	-
FWC-338	5	-	-	5.4	27.0
FWC	5	-	-	11.3	56.5
SWC	5	-	-	7.2	36.0
SWC	5	5.4	27.0	-	-
SWE	5	0.4	2.0	-	-
Totals	1,391		1,425		9,668.5

Model No.	Production Volume	Weight of PU Foam per unit - Kgs	Weight of PU Foam consumed - Kgs
CFX 1094	275	21.4	5,885.0
C2FFA1094	198	44.8	8,870.4
EWFX2P	141	28.0	3,948.0
CFR10	183	43.6	7,978.8
AP4	127	18.7	2,374.9
WKYT10	236	2.0	472.0
SWC-635-A1	10	170.1	1,701.0
FWC-624-A1	10	168.0	1,680.0
SWE-635-A1	10	170.1	1,701.0
FWC-344-A1	10	115.5	1,155.0
FWE-499-A1	10	144.0	1,440.0
FWE-519-A1	10	120.0	1,200.0
FWE-174-A1	10	61.6	616.0
SWE-462-A1	10	109.2	1,092.0
SWC-300-A1	5	108.5	542.5
SWE-186-A1	5	61.6	308.0
SWC-19-270	5	1,353.8	6,769.0
SWE-323	5	86.8	434.0
SWE-654	5	134.4	672.0
SWE-178	11	677.6	7,453.6
SWC-264	5	98.0	490.0
SWC-322	5	112.0	560.0
SWC-307	5	108.0	540.0
SWC-639	5	171.0	855.0
SWC-456	5	136.5	682.5
SWC-478	5	143.5	717.5
SWC-310	5	108.0	540.0
SWC-365	5	119.0	595.0
SWE-175	5	61.0	305.0
SWC-464	5	140.0	700.0
SWC-179X17	5	177.0	885.0
SWE-441	5	103.6	518.0
SWE-410	5	99.4	497.0
SWC-214	5	84.0	420.0
SWE-313	5	85.4	427.0
SWE-314	5	84.0	420.0
FWC-781	5	196.0	980.0
FWE-461-A	5	120.4	602.0
FWC-338	5	119.0	595.0
FWC	5	255.5	1,277.5
SWC	5	178.5	892.5
SWC	5	52.5	262.5
SWE	5	39.2	196.0
Totals/Wtd. Avg.	1,391	50.50	70,250.7

4. PROJECT DESCRIPTION

Industrias Westell presently uses CFC 11 for the production of rigid insulating foams needed for the commercial refrigeration show cases, cabinets, and "walk-in" cold rooms. Only CFC 12 is used as refrigerant for the unitary equipment, whilst both CFC 12 and R502 are both used in the non-unitary systems.

Industrias Westell can inluence the choice of refrigerant for new non-unitary equipment and the ODS consumption of 1.43 tons of CFC 12 and 9.97 tons of R502 consumed for this purpose are included in the project. It is estimated that 12% of the 0.38 tons of CFC 12 and 1.19 tons of R502 consumed for servicing in Bogota and Medellin, a total of 0.08 ODP tons, can be eliminated by the provision of FOUR small "Recovery & Recycle" machines and this is, therefore, also included in the project.

The total consumption in the 12 months January - December 1994, and the ODP tons that will be eliminated by this project are shown in the following table:

CFC 11 consumed (tons)	ODP tons eliminated * see Note	CFC 12/R502 consumed (tons)	ODP tons eliminated * see Note	Total ODP tons eliminated
15.31	13.63	16.57	6.74	20.37

Note:

*The second column of figures for CFC 11 takes the ODP of HCFC 141b into account (ODP = 0.11), the second column of figures for CFC 12/R502 takes account of the ODP of R502 (ODP = 0.315)

4.1. REPLACEMENT OF CFC 11 WITH HCFC 141b.

Westell will replace the CFC 11 used as a blowing agent in the production of the insulation foam with HCFC 141b as an interim step to an ODS-free system. (See attached Annex C.)

Westell does not currently have a PU foam dispensing machine. The foam chemicals are mixed manually and poured into the molds. Polyol and CFC 11 are purchased as a pre-mix.

Westell recognise the need to purchase a foam chemicals dispensing machine to be able to use non-CFC technology. In the absence of an existing machine it is proposed that the MLF contributes the incremental cost difference between a low pressure and a high pressure machine with a maximum capacity of 45 Kgs/minute.

The conversion to HCFC 141b will incur some costs related to technology transfer, production test trials and training at

Friomix. These activities will include training of staff in worker-safety related to HCFC 141b.

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

4.2. REPLACEMENT OF CFC 12 & R502 WITH HFC 134a & R502 REPLACEMENTS (R404A, R407A, etc.)

4.2.1. UNITARY EQUIPMENT MANUFACTURE

HFC 134a is universally accepted as a Zero-ODP replacement for CFC 12 in the manufacture of unitary commercial refrigeration equipment and the technology is mature. This is the CFC 12 replacement technology selected by Westell.

The conversion to HFC 134a requires the use of HFC 134a specific 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.

Incremental Operational Costs associated with the technology change from CFC 12 to HFC 134a in the manufacture of the unitary equipment are requested for a period of SIX months.

4.2.2. NON-UNITARY EQUIPMENT INSTALLATION & SERVICE

Industrias Westell has a nationwide installation and service organisation with centres in all the major Colombian cities. Westell's engineers install, commission, repair and service the company's commercial refrigeration equipment. These engineers are equipped with the basics of manifold gauge charging sets, vacuum pumps, and hand held electronic leak detectors.

4.2.2.1. Replacement of CFC 12 & R502 with HFC 134a & R502 Replacements (R404A, R407A, etc.) in new equipment

In the case of the non-unitary equipment which Westell install themselves, they will simply source appropriately sized HFC 134a or

R404A/R407A etc. compressors from Tecumseh or Copeland according to the refrigeration capacity of the installation. Information on the recommended zero-ODP refrigerant, compatible lubricants and materials etc. will likewise be provided by the compressor supplier and refrigerant supplier and there will be no requirement for prototyping, etc. There will, however, be a training requirement for the refrigeration engineers before working on the installation and service of HFC 134a and R404A/R407A systems.

In order to eliminate the consumption of CFC 12 and R502, and to be able to convert their clients to zero-ODP R134a based technology, Industrias Westell requires the following new equipment to be able to install, commission, and service new R134a installations:

R134a manifold gauge charging sets
16 M3/hr vacuum pumps
Hand-held R134a electronic leak detectors

It is proposed that ONE set of such equipment be supplied for each of the SIX major service centres in Bogota, Medellin, Cali, Baranquilla, Pereira, and Manizales.

4.2.2.2. Retrofitting Existing CFC 12 & R502 Equipment to use HFC 134a & R502 Replacements (R404A, R407A, R407B, etc.)

There is a need to retrofit some existing commercial refrigeration systems to R134a, or R404A/R407A/R407B etc., duty in order to prolong their useful lifetime.

The refrigeration engineers existing R12 evacuation, charging and leak detection equipment, together with the new equipment proposed in 4.2.2.1. will enable Industrias Westell to offer a retrofit service to their customers (and others).

However, the R12 and R502 removed during retrofit needs to be recovered and recycled for future use in servicing equipment where retrofit is not a cost effective or practical option. Refrigerant charges typically range from 1.0 to 12 Kgs. In order to encourage retrofit activities it is proposed that FOUR "Recovery and Recycle" machines of the appropriate capacity be supplied, initially for use in Bogota and Medellin, in order to offer retrofit combined with CFC 12/R502 recovery and recycling. It is hoped that this will serve to publicise retrofit and encourage Westell to invest in additional "Recovery & Recycle" equipment as the future need arises. (It is not possible at this time to quantify the amount of CFC 12/R502 consumption which can be eliminated by retrofitting.).

4.2.2.3. Recovery and Recycling of CFC 12/R502 during Servicing

The same refrigeration engineers carry out "on-site" maintenance and service operations and it is estimated that the provision of these FOUR "Recovery and Recycle" machines, for use in Bogota and

Meddelin, can eliminate approximately 12% of the annual CFC 12 and R502 consumption for servicing in these centres. It will also, hopefully, publicise and encourage the practice of recovery and recycling generally in the commercial refrigeration sector.

5. TECHNOLOGY

5.1. REPLACEMENT OF CFC 11.

5.1.1. OVERVIEW

Currently, the three principal technology options for the replacement of CFC 11 in thermoset insulation foams are:

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, perfluoroalkanes, hydrofluoroalkanes such as HFcs 245, 356, etc., fluorinated ethers, 2-chloropropane, and vacuum panels have been suggested for specific applications, but the technologies are not mature. Furthermore, some of these 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, employs technology that is closely related to the existing CFC 11 technology. The final step to non-ODS technology in this process is not yet decided. One potential solution may be the use of liquid HFCs such as HFC 356, or HFC 245, but full water blown foam with improved cell structure remains another option.

The second one, the "gas" solution, utilizes physical blowing agents which are liquefied gases. This technology always requires new foam dispensing equipment and extensive adjustments. The final step to a zero-ODP technology in this process could be the use of a gaseous HFC such as HFC 134a.

The third option, pentane technology, is commercially proven and is now extensively used in many rigid PU insulation foam applications in Europe. It is currently the most cost effective of the non-ODS technologies for CFC replacement. However, pentanes are flammable and this means a careful review of manufacturing operations with respect to the safe handling of a flammable foam blowing agent. Pentane technology is often not a practical or cost effective option in the existing workplace environments at many smaller scale enterprises due to the safety modifications required.

Several companies currently offer pentane technology packages, including equipment. However, UNDP requires an independent safety review prior to, and after, installation.

5.1.2. SELECTION

Based on economic and environmental considerations, cyclopentane appears to be the best choice for small unitary commercial refrigeration equipment. It combines an attractive price with zero ODP, and near zero-GWP properties, as well as acceptable foam insulation qualities. Westell considered cyclopentane technology, but whilst recognising both the environmental and economic benefits of cyclo-pentane, HCFC 141b was selected as a first stage, interim, replacement for CFC 11 because of concerns that cyclo-pentane technology could not be safely introduced in the existing workplace environment.

HCFC 141b is recognised by Westell as a CFC 11 replacement that is:

- proven technology in both processing and product performance
- environmentally acceptable
- available in the Colombian market
- a technology that can be implemented safely and cost effectively within their existing factory configurations

The provision of high pressure foam dispensing equipment will facilitate the subsequent step to a final zero-ODP insulating foam system and Westell accepts that any additional capital costs associated with such a change is for its own account.

5.1.3. IMPACT ON THE PRODUCTION PROCESS

The use of HCFC 141b technology will be facilitated through the purchase of high pressure foam production equipment with the MLF contributing the incremental costs of a high pressure 45 Kgs/min capacity machine versus an equivalent low pressure one.

HCFC 141b is a non-flammable liquid (no flash point), but moderately flammable in the gaseous state. The flammability limits are 7.6 - 17.1% by volume in air. The usually recommended PEL (Permissable Exposure Limit) is 500 ppm on an eight-hour time-weighted average. In the intended application, the use of HCFC 141b should not pose a significant risk, but UNDP will, as part of its safety audit programme, perform a monitoring check at commissioning to ensure the adherence to safe worker exposure levels. Ventilation will be installed if the results idicate the need.

Westell uses only metal cabinet and door liners. The change to HCFC 141b requires no changes to these materials.

Foam density adjustments will be necessary to obtain equivalent insulation values.

5.2. REPLACEMENT OF CFC 12.

5.2.1. OVERVIEW

HFC 134a is universally accepted as a replacement for CFC 12 in unitary commercial refrigeration equipment. HFC 134a is widely available and the technology is mature. Replacement of CFC 12 with HFC 134a requires relatively modest changes to existing production facilities.

Whilst hydrocarbon refrigerant (iso-butane) is being increasingly used in the manufacture of domestic refrigerators in several Developed Countries, the transfer of this technology to Developing Countries is not always cost effective. It also raises questions about safety issues and remains conditional on the support of a technology partner experienced in the production of comparable refrigerators and freezers on a commercial scale. It is further dependent on the technology partner providing assurances in writing on safety issues, and, of course, the availability of adequate supplies of both compressors and hydrocarbon refrigerant of the required quality.

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 commercially available.

5.2.2. SELECTION

The selected technology is HFC 134a. The CFC 12 based technology used by Westell was developed "in-house" with assistance from compressor, component, and refrigerant suppliers. Westell has no formal technology transfer agreements with internationally recognised commercial refrigeration equipment manufacturers or compressor suppliers.

The new HFC 134a based technology will be developed by the enterprise with assistance from compressor and refrigerant suppliers. The project budget makes provision for formal technology assistance from compressor and refrigerant suppliers, as well as the relevant UNDP consultants, in order to ensure successful implementation of the 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 levels are not exceeded. At the present time this means ensuring that exposure levels do not exceed

1000 parts per million on an 8-hour time-weighted average basis. This is the same as the Occupational Exposure Limit (OEL)/Threshold Limit Value (TLV) for CFC 12 and thus no changes from current practices are required.

There will be an approximately 10% reduction in the mass charge of HFC 134a compared with CFC 12 for a refrigerator system of the same capacity. This is taken into account in the calculation of the incremental operational costs.

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

Because system cleanliness and moisture content are paramount to the successful manufacture of unitary HFC 134a refrigeration equipment, Westell will need to carefully re-assess production procedures and re-train production personnel as appropriate. Provision for this is also made within the proposed project budget.

The conversion from CFC 12 to HFC 134a will take place on a model by model basis, so that Westell will be producing both CFC 12 and HFC 134a refrigeration units 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.

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.

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

- 1 x Airseco 4053 TLB-6-1 R12 Refrigerant Charging Machine
- 1 x Robinair 668253 R12 Refrigerant Charging Machine
- 5 x Ritchie Model 93000 Vacuum Pumps, 8.5 M3/hr capacity
- 1 x Robinair Model 15030 Vacuum Pump, 25 M3/hr capacity
- 5 x GE H10 hand-held electronic leak detectors

Three of the vacuum pumps are in service, with two on stand-by duty. The project proposal includes provision for two new R134a charging machines and one new vacuum pump. Provision is also made for retrofit of the remaining vacuum pumps where considered feasible, or this funding will be used towards the purchase of new vacuum pumps, at the discretion of the enterprise.

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS

CAPITAL COST FOR CFC 11 PHASE-OUT

HIGH PRESSURE FOAMING MACHINE (45 Kgs/min)	50,000*
TRAINING, TEST TRIALS & TECHNOLOGY TRANSFER	10,000
CONTINGENCIES (10%)	6,000

* Incremental cost - new high vs. low pressure machine

Subtotal (US$)	**66,000**

CAPITAL COST FOR CFC 12 PHASE-OUT

R134a CHARGING EQUIPMENT (2 off)	50,000
NEW VACUUM PUMPS (Factory - 1 off)	3,000
RETROFITTING VACUUM PUMPS (Factory - 5 off)	2,500
R134a LEAK DETECTION EQUIPMENT (Factory - 2 off)	1,000
R134a MANIFOLD GAUGE SETS & HOSES (6 off)	1,200
NEW VACUUM PUMPS (6 off)	18,000
R134a LEAK DETECTION EQUIPMENT (6 off)	3,000
R12/R502 RECOVERY & RECYCLE MACHINES (4 off)	16,000
TRAINING	5,000
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION & RELIABILITY TEST TRIALS (6 models)	40,000
TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	15,000
CONTINGENCIES (10%)	15,500
Subtotal (US$)	**170,200**
TOTAL INCREMENTAL CAPITAL COST (US$)	**236,200**

6.2 INCREMENTAL OPERATING COSTS

Calculation of the incremental operating costs is based on 50% of the actual production for Jan - Dec 1994 inclusive. Annex A. provides detailed explanations, the costs are summarized below:

PHASE-OUT OF CFC 11

Costs for Materials (see Annex A. Part 1.) :	**29,990**

PHASE-OUT OF CFC 12

Costs for Materials (see Annex A. Part 2.) :	**15,648**
TOTAL INCREMENTAL OPERATING COST (US$)	**45,638**

6.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital + Operational) (US$)	**281,838**
% Article 5.1 Country Ownership	**100%**
FUNDING REQUESTED FROM MLF (US$)	**281,838**

6.4 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs	236,200
b. Capital Recovery Factor (10% p.a.)	0.16275
c. Incremental Operating Costs	45,638
d. ODS Reduction (ODP Kgs Jan - Dec 1994)	20,370
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	4.13

THE PROJECT UNIT ABATEMENT COST IS 4.13 US$/Kg

6.5 PROJECT COST EFFECTIVENESS (US$/Kg)

Total Project Cost	=	281,838	US$
ODS Eliminated	=	20,370	ODP Kgs
Project Cost Effectiveness	=	13.84	US$/Kg

THE PROJECT COST EFFECTIVENESS IS 13.84 US$/Kg

7. FINANCING PLAN

INDUSTRIAS WESTELL Ltda requests reimbursement of US$ 281,838 representing 100% of the incremental Capital and Operating Costs of this project in line with the Article 5.1 country ownership of the enterprise.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

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

8.2 SCHEDULE

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

9. PROJECT IMPACT

Based on 1994 consumption data, this project will eliminate the use of 20.37 ODP tons per year.

10. ANNEXES

Annex A: Incremental Operational Cost Calculations.
Annex B: Project Technical Reviews.
Annex C: WESTELL letter relating to HCFC 141b technology selection.

Notes relating to the calculation of the Incremental Operational Costs

Note 1.

Figures in the following tables are based on the actual production volumes for unitary and non-unitary refrigeration equipment (where relevant) for the 12 month period January to December 1994 obtained from Industrias Westell Ltda 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 chemical prices used in the following tables are current weighted average prices for the principal domestic and commercial refrigerator manufacturers in Colombia. Compressor prices are weighted average prices for the enterprise. With the large differences in compressor capacity, and hence price, between the three enterprises it is not appropriate to use "National" weighted average prices for compressors.

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.

ANNEX A. INCREMENTAL OPERATIONAL COST CALCULATIONS

1. Incremental Costs resulting from replacing the CFC 11 Blowing Agent in the Insulation Foam with HCFC 141b, including both Unitary and Non-Unitary Equipment (US$)

INDUSTRIAS WESTELL Ltda	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$/Kg			
d. Polyol	2.61	2.74	0.13
e. MDI	2.15	2.15	-
f. Blowing Agent	2.00	4.00	2.00
g. Liner (Type: Metal)	n/a	n/a	-
Cost per Kg of Foam Produced			
h. = a. x d. Polyol	0.914	1.000	0.086
i. = b. x e. MDI	1.075	1.075	-
j. = c. x f. Blowing Agent	0.300	0.540	0.240
k. = h+i+j Total Cost per Kg of Foam	2.289	2.615	0.326
Materials Used per Refrigeration Unit			
l. Kg of Foam per Refrigeration Unit (avg)	21.066	23.173	2.107
m. Kg of Liner material per Refn. Unit (avg)	-	-	-
Cost per Refrigeration Unit			
n. = l. x k. for Refrigerator Foam	48.220	60.597	12.377
o. = m. x g. for Refrigerator Liner	-	-	-
p. = n. + o. Total per Refrigerator	48.220	60.597	12.377
q. = No. of Refrigerators (see Note 1.)	2,423		
TOTAL INCREMENTAL OPERATIONAL COST (US$)	**29,990**		

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

INDUSTRIAS WESTELL Ltda.	CFC 12	HFC 134a	Diff
1. Refrigerant			
a. Price per Kg of Refrigerant	2.60	8.50	
b. Kg of Refrigerant per Refrigerator (avg.)	0.642	0.578	
c. No. of Refrigerators Produced (see Note 1.)	1,727	1,727	
1d. Cost for Refrigerant = a x b x c	2,883	8,485	5,602
2. Compressors			
a. Cost for Compressor (see Note 2.)	55.14	60.26	
b. No. of Compressors (see Note 1.)	1,727	1,727	
2c. Cost for Compressors = a x b	95,227	104,069	8,842
3. Condensers			
a. Cost per Condenser	N/C	N/C	
b. No. of Condensers	1,727	1,727	
3c. Cost for Condensers = a x b	-	-	-
4. Filter/Dryer			
a. Cost per Filter/Dryer (average)	1.410	1.560	
b. No. of Filter/Dryers (see Note 1.)	1,727	1,727	
4c. Cost for Filter/Dryers = a x b	2,435	2,694	259
5. Capillary Tubes			
a. Cost per Capillary Tube (average)	2.189	2.736	
b. No. of Capillary Tubes (see Note 1.)	1,727	1,727	
5c. Cost for Capillary Tubes = a x b	3,780	4,725	945
TOTAL INCREMENTAL OPERATIONAL COST (US$) = 1d + 2c + 3c + 4c + 5c (Diff)		**15,648**	

Country of origin: COLOMBIA

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Unitary Commercial Refrigeration Equipment (Three companies: Industrias de Refrigeracion Super Nordico, Industrias Westell Ltda and Friomix S.A.)

Sector/sub-sector Commercial refrigeration

Relationship to country program UNDP (CP in preparation)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

- All manufacturers in this project have chosen for a conversion of their production to the HFC-134a technology. Part of the products will be converted from R-502 to R-502 replacements (e.g. R-404A, no final decision seems to be made here yet).
- In commercial refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption. Also R-502 replacements like R-404A are acceptable technologies to reduce CFC consumption.
- The companies in this project do not have a formal technology transfer agreement. However, all of them plan to develop the HFC-134a technology with assistance from compressor and refrigerant suppliers. This holds for both the unitary equipment produced by all manufacturers and the non-unitary equipment of Westell. Furthermore provisions for external assistance are present. Due to these facts, a successful project implementation can be expected at all three companies.
- Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of safety issues related to the use of flammable refrigerants in commercial equipment (relatively large charges) and because of the lack of commercially available compressors. From the zero ODP technologies HFC-134a is a cost effective solution.

Environmental impact

HFC-134a has an ODP of zero and a GWP of 0.27.

Project costs

Unitary equipment (for all three companies)

- The equipment requested is essential for the conversion process of the unitary equipment. Costs of equipment, redesign, training, testing and technical assistance are reasonable.
- Incremental operational costs are reasonable and correctly applied (for six months).
- If the UAC value is calculated for the refrigerant conversion part of the project, values of 1.83 USD/kg/y (Friomix, a low value due to the high foreign ownership), 14.1 USD (Super Nordico) and 8.0 USD (Westell) are found, which are reasonable values for commercial refrigeration projects, unitary products.
- The foreign ownership of the Friomix company is correctly taken into account.

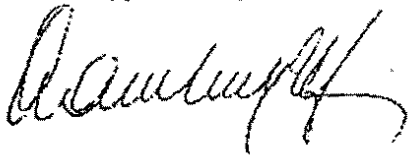
Non-unitary equipment (Westell):

- The refrigeration equipment requested for installing new equipment and for servicing existing equipment (including retrofits) is essential for a successful reduction of CFC-12 usage in the non-unitary sector. The costs claimed are reasonable. The investment in 4 recovery/recycling stations is not very cost effective due to the low CFC-12 reduction involved (only 80 kg ODP/year, however a not quantified additional amount could be recovered) but is still acceptable.

- The estimated value for the ODP reduction is reasonable.

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

Janssen M.J.P.,
Eindhoven, The Netherlands
30-January-1995



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

TECHNICAL REVIEW

1.Country:

Colombia.

2.Project Title:

Elimination of CFCs in the Manufacture of Unitary Commercial Refrigeration equipment at three Firms(Friomix, Super Nordico and Westell).

3.(Sub)Sector:

(Commercial) Refrigeration.
This review covers only the foam part.

4.CP-Relationship:

The CP for Colombia for the phase-out of ODS under the Montreal Protocol was approved at the 12th Meeting of the Executive Committee of the MLF in March '94. Specific Programs for the elimination in the Refrigeration Sector, were approved at the 13th and 15th meetings of the MLF.At the latter meeting, the project of the three commercial refrigeration companies were approved. This project is the planned follow-up in the Commercial Refrigeration Sector to the projects approved at the 15th Executive Committee for Indufrial, Inducol and Wonder.

5.Technology:

All three firms have chosen to substitute CFC11 with HCFC 141b, the main reason being that the HCFC 141b technology is proven, locally available, cost effective and presenting no major safety problems.This reasoning is correct.
Since the Maximum Allowed Concentration in the workplace is 500 ppm (instead of 1000 ppm for CFC 11) extra ventilation must be foreseen.The reviewer realises that this issue is perhaps only critical in the case of Westell, where high weights of polyurethane are used in

the cabinets.It is also noted that this matter will be addressed during the project commissioning.
In the case of the four models of Super Nordico, foreseen with plastic liners, the question of deterioration prevention is well taken care of.

6.Environmental Impact:

It must be stressed that the change to an HCFC as an auxiliary blowing agent is to be considered as an intermediate step to a zero ODS solution.It seems that all three firms have agreed upon that.The reviewer is aware that UNEP and UNDP inform the companies and the Government Counterpart in an adequate way, when an ODS free, safe technological solution is commercially available.
The ODP of HCFC 141b is .1, vs 1. for CFC 11. the GWP is .1 for 141b and 1. for CFC 11.The relative Smog Potential for CFC 11 is .1, for HCFC 141b it is 1., but it is 500 for pentane.

7.Project Costs:

It is understood that polyol:HCFC 141b mixtures is available in Colombia. This may lower raw matertial prices and operating costs.
7.1. FRIOMIX.
The incremental capital costs for Friomix are correctly represented.
The foam chemicals are presently mixed manually and poured into the molds.Since it is recognised that it is necessary to purchase a foam chemicals dispensing machine to be able to use non-CFC technology, the company agrees to contribute to the cost as if they would buy a low pressure machine today, and have the MLF pay for the difference between a high pressure and a low pressure machine. Local prices will be determined during project implementation, as per usual UNDP/UNOPS procedures.
The incremental operating costs are correct as stated.
The cost to eliminate 1 kg of ODS is USD 81,903/6,690 or USD 12.24.

7.2.SUPER NORDICO.
Both incremental capital and operating costs are correctly presented.
The cost for elimination of 1 kg of ODS is USD 81,823/1,950 or USD 41.96.

7.3.WESTELL.
As well the incremental capital, as the incremental operating costs are correctly presented.
The elimination cost of 1 kg of ODS in the foam part becomes: USD (66,000 + 29,990)/13,630 or USD 7.04.

8.Implementation:

The proposed time schedule can be accepted.

9.Recommendation:

Although substantial differences in unit elimination prices of ODS for the three firms are observed, it is recognised that, because only six compagnies produce commercial refrigeration in Colombia, it would be unfair to penalise some just because they are smaller. It is therefore recommended to accept the three projects.

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date:07 March 1995.