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

Twelfth Meeting
Montreal, 28-30 March 1994

PROJECT PROPOSALS: EGYPT

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

Projects presented by UNDP

1. Conversion to CFC-free Technology in the Manufacture of Rigid Molded and Miscellaneous PUF (five enterprises)

2. Conversion of CFC-free Technology in the manufacturing of Flexible Slabstodk Polyurethane foams

3. Conversion to CFC-Free Technology in the Commercial Refrigeration Sector (Five Enterprises)

Projects presented by UNIDO

1. Investment Project for Phasing out ODS at Delta Industrial Co.

2. Investment Project for Phasing out ODS at Electrostar for Refrigeration Co.

3. Investment Project for Phasing out ODS at Kiriazi Refrigerators Manufacturing Co.

Document presented by UNIDO

1. Executive Summary of a Strategy for the Phase-out of ODS in the Refrigeration Industry

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Egypt
PROJECT TITLE:	Conversion to CFC-free Technology in the Manufacture of Rigid Molded and Miscellaneous PUF (five enterprises)
BUDGET:	US $870,000
INCREMENTAL COSTS:	US $870,000
ODS PHASE-OUT:	44.2 tonnes CFC-11/year
COST EFFECTIVENESS:	US $19.7 per Kg. ODP saved
PROJECT DURATION:	One year
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	Egyptian Environmental Affairs Agency (EEAA)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. Five companies, producing simulated wood parts and insulation panels for air handling equipment, plan to eliminate 44.2 tonnes of CFC-11 by introducing water/HCFC-141b technology which will be replaced, at a later stage, with a fully water based or HFC-134a technology.

2. The capital costs include the procurement of high pressure foaming units and technology transfer costs. The choice of high pressure equipment will facilitate the step to a truly ODS-free system without additional capital costs as they mature.

3. The savings gained in eliminating the use of CFC-11 are offset by the higher cost of the substitute, HCFC-141b and the additional costs of MDI required. Therefore, there are no incremental recurring costs.

4. The project has been reviewed and is supported by a member of UNDP's Technical Review Panel.

SECRETARIAT'S RECOMMENDATIONS

1. The Secretariat recommends final approval in the amount requested, i.e., US $870,000.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Egypt
PROJECT TITLE:	Conversion of CFC-free Technology in the manufacturing of Flexible Slabstodk Polyurethane foams
BUDGET:	US $525,000
INCREMENTAL COSTS:	US $525,000
ODS PHASE-OUT:	170 tonnes of CFC-11
COST EFFECTIVENESS:	US $3.10 per kg ODP saved
PROJECT DURATION:	Nine months
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	Egyptian Environmental Affairs Agency (EEAA)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. Under this project 170 tonnes of CFC-11 will be phased out in the manufacture of flexible slabstock polyurethane foams at two Egyptian companies, through conversion to the technology based on methylene chloride.

2. The funding of incremental capital costs is requested at US $525,000 to cover the equipment modification and safety measures.

3. No operating incremental costs are requested.

4. The cost-effectiveness is comparable with similar projects approved by the Executive Committee.

SECRETARIAT'S RECOMMENDATION

1. The requested amount of US $525,000 is recommended for approval.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Egypt
PROJECT TITLE:	Conversion to CFC-Free Technology in the Commercial Refrigeration Sector (Five Enterprises)
BUDGET:	US $2,100,000
INCREMENTAL COSTS:	US $2,100,000
ODS PHASE-OUT:	225 tonnes
COST EFFECTIVENESS:	US $9.33 per kg ODP saved
PROJECT DURATION:	One year
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	Egyptian Environmental Affairs Agency (EEAA)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. Under this project, five companies will eliminate 225 tonnes of CFCs in the production of rigid polyurethane insulation panels and spray foams through application of cyclopentane technology. Refrigeration and mobile air-conditioning equipment will be converted to HFC-134a technology.

2. Cyclopentane is a flammable material. Safety related modifications and training will be covered by the capital costs.

3. The existing foam equipment will be replaced with high pressure foaming units. CFC based charging and recycling equipment will be replaced with HFC-134a units.

4. Consultations with refrigeration equipment vendors during the project evaluation process brought out a more cost-effective solution to refrigeration equipment replacement.

5. No operating incremental costs are requested in the project.

SECRETARIAT'S RECOMMENDATION

1. The requested amount of US $2,100,000 is recommended for approval. The cost of refrigeration equipment at US $163,000 should be verified by UNDP in consultation with the Secretariat.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Egypt
PROJECT TITLE:	Investment Project for Phasing out ODS a) Delta Industrial Co. b) Electrostar for Refrigeration Co. c) Kiriazi Refrigerators Manufacturing Co.
BUDGET:	(Table attached)
ODS PHASE-OUT:	a) 97 tonnes of CFC-11 and CFC-12 b) 46 tonnes of CFC-11 and CFC-12 c) 137 tonnes of CFC-11 and CFC-12
INCREMENTAL COSTS:	a) US $4,818,338 b) US $2,225,185 c) US $4,156,906
COST EFFECTIVENESS[1]:	a) US $47.9/kg b) US $48.4/kg c) US $30.3/kg
PROJECT DURATION:	18 months
IMPLEMENTING AGENCY:	UNIDO
NATIONAL COORDINATING AGENCY:	Egyptian Environmental Affairs (EEAA)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. These projects cover the conversion of domestic refrigerator production and recovery of CFC-12 through service centre at Delta, Electrostar and Kiriazi in Egypt to alternative technologies based on HFC-134a (refrigerant) and cyclopentane (blowing agent). The estimate phase-out of ODS is 171 tonnes of CFC-11 and 109 tonnes of CFC-12.

2. There are 9 domestic refrigerator producers in Egypt. The three companies represent 60 per cent of the total production in this sector.

3. These projects constitute part of the "Strategy for the Phase-out of ODSs in the Refrigeration Industry" for Egypt being submitted by UNIDO at this meeting. The strategy contemplates the phase-out of CFC refrigerants by using HFC-134a from 1994 to 1998; the

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

phase-out of CFC foaming agents by using cyclopentane as the ultimate solution and HCFCs as an interim solution from 1996 to 1999; servicing training programme and recycling/reclamation programme. The Executive Summary of this strategy is attached to these comments.

4. Although no funds are requested for technology transfer agreements in the three projects, considerable amount of funds are requested for training both on the job and at technology suppliers abroad.

5. The technical reviewer's paper commented on several issues. The Fund Secretariat discussed, among other things, the issues raised by the technical reviewer with UNIDO. Several of the issues raised were resolved. However, the issue of whether the Fund should support all the requested incremental operating costs is being discussed by UNIDO with the Government of Egypt.

6. UNIDO has revised projects costs, however, there is still some disagreement regarding the cost of some of the items in the Kiriazi project which could not be considered as eligible for funding.

7. UNIDO is in the process of revising these cost items as well as some other cost items, e.g. the cost of Technical Chief Adviser, with the project proposals.

SECRETARIAT'S RECOMMENDATION

1. The Fund Secretariat recommends granting permission to proceed to UNIDO regarding the three projects with the view that both capital and operational costs of the three projects should be revised and resubmitted at the next meeting of the Executive Committee.

PROJECT COST

	Delta Industrial Co.	Electrostar for Refrigeration Co.	Kiriazi Refrigerators Manufacturing Co.
Unit production	207,914	42,000	70,000
Project cost:			
Capital cost	US $2,373,048	US $1,429,910	US $2,348,622
Operational cost	US $1,890,968	US $539,280	US $1,330,056
Total	US $4,264,016	US $1,969,190	US $3,678,678
13% Overhead	US $554,322	US $255,995	US $478,228

PROJECT COVER SHEET

COUNTRY:	**EGYPT**
PROJECT TITLE:	Conversion to CFC-free Technology in the Manufacture of Rigid Molded and Miscellaneous PUF (five enterprises)
SECTOR COVERED:	Foamed Plastics
ODS USE IN SECTOR:	722 tons CFCs (722 tons ODSP) in 1991
PROJECT IMPACT:	Phaseout of the use of 44.2 tons/year CFC-11 (1993) in the manufacturing of rigid polyurethane foam (molded).
PROJECT DURATION:	One year
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	USD 870,000 Incremental Capital Cost
PROPOSED MLF GRANT:	USD 870,000
COST EFFECTIVENESS:	USD 3.20/kg/y (unit abatement cost)
COORDINATING NATIONAL BODY:	Egyptian Environmental Affairs Agency (EEAA)
IMPLEMENTING AGENCY:	UNDP

PROJECT SUMMARY

Under this project, Egypt will substantially complete the phaseout of CFCs in the production of molded and miscellaneous applications of rigid polyurethane foams, leading to an annual reduction of 44.2 tons ODS/year.

The five companies involved will install high pressure foam dispensing equipment allowing the use of CFC-free systems. The phaseout strategy will be based on maximum use of water based systems, complemented initially by HCFC-141b where needed. In a later stage HCFC-141b will be replaced by a fully non-ODP system (fully water based or HFC-134a). Such systems are currently in the first stage of industrial application.

TECHNICAL ASSESSMENT: The project is reviewed and supported by Bert Veenendaal from UNDP's technical review panel. His comments are attached.

PROJECT OF THE GOVERNMENT OF EGYPT

ELIMINATION OF CFCS IN THE MANUFACTURE OF RIGID POLYURETHANE FOAM AT FIVE (5) FACTORIES

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs molded and miscellaneous rigid polyurethane foam enterprises in Egypt.

2. SECTOR BACKGROUND

The CFC consumption in 1991 in the Egyptian foam sector--excluding foams for domestic and commercial appliances--has been established at 722 tons, with an annual growth rate of 15-20% (Egyptian Country Program). Uninhibited growth would lead to an estimated CFC consumption of 1,000 tons in 1993 and 2,050 tons in the year 2000. EEAA, with assistance of UNDP has designed a strategy for this sector, targeting annual consumption reductions beginning 1993. Finalization of the projects submitted so far to the IMLF would bring the actual implementation of this strategy well in line with the target. A complete phaseout of the use of CFCs in the foam sector could be reached in 1998.

3. ENTERPRISE BACKGROUND

The five factories are serving several markets; from decorative simulated wood parts to insulation panels for air handling equipment in large buildings. However, they use essentially the same rigid polyurethane technology and foam machines. The machines may differ in size, but the process is the same and will require the same basic technology. Detailed backgrounds of the individual companies are given in ANNEX A.

4. PROJECT DESCRIPTION

Four of the factories use the rigid foam in a light duty insulation application. The fifth factory makes decorative simulated wood moldings. The basic program is to replace the existing low pressure machines with high pressure machines that will be able to process the higher viscosities of the current low ODS systems and also any of the developing ODS-free systems.

The companies are committed to the phaseout of CFCs. As immediately available technology, they have identified the maximization of the use of CO2, generated from the water/isocyanate reaction. This will decrease the amount of CFC used by 50%. Subsequently, a 100% phaseout of CFCs will be implemented by replacing the remaining CFC-11 by initially using HCFC-141b followed by the introduction of full water blown foam or through a direct switch to water blown foam or HFC-134a.

The new raw material systems are expected to be somewhat more expensive, leading to slightly higher operating costs for each company. However, in the four factories where the rigid foam is used for insulation, the panels are thin and foam costs are a very small portion of the final costs. The factory making the decorative woodlike parts has more cost in molds and finishing than in the foam, so the chemical cost impact will be minor.

In time, higher expected costs for CFCs and more competitive chemical pricing may reduce or eliminate this difference. The companies will not request any subsidizing of incremental operational costs.

5. TECHNOLOGY

5.1 SELECTION

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

- o CFC-11 > partial water/HCFC-141b > ?
- o CFC-11 > partial water/ HCFC-22, 142b > HFC-134a, 152a
- o CFC-11 > Pentane

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

The first solution--the "liquid" solution-- employs technology that is closely related to the existing one. The final step in this process is not yet decided. One potential solution is HFC-356, but full water blown foam with improved cell structure remains an option, specifically in "lesser demanding" systems such as water heaters, were dimensional changes--although costly-- are possible.

The second one--the "gas" solution--utilizes a gaseous mixture of physical blowing agents, requires always new equipment, and extensive adjustments. The final step in this process is seen as the introduction of (gaseous) HFC's.

Cyclopentane technology is lately commercial introduced in Germany. Its flammable character requires safety conditions and limits its use. Several companies currently offer cyclopentane packages, including equipment. In these factories, the use of cyclopentane would be cost prohibitive from a safety standpoint.

5.2 PROCESS MODIFICATIONS

The existing equipment at all five factories is based on low pressure metering of the material components. It is not suited for the higher viscosities that are required for systems with maximized water content. In addition, the mixer efficiency is insufficient for high viscosity. Replacement of the seven (7) units currently in place is required. The modifications have to be complemented by training and some lay-out adjustments.

6 PROJECT COSTS

6.1 TOTAL PROJECT COSTS

The following is a summary of the expected costs of investment and related activities:

DESCRIPTION	SUBTOTAL (USD)	TOTAL (USD)
5 High pressure foaming units		540,000
1 Spray machine		25,000
1 Spuehl machine		75,000
Freight		25,000
Trials		35,000
Installation		60,000
Pre/Post Assesment		20,000
Contingency		90,000
GRAND TOTAL		**870,000**

6.2 OPERATING COSTS

The elimination of CFCs will be offset by increased use of water/isocyanate to obtain the same density. Slight increase in cost of raw materials will be partly balanced against elimination of solvents used in flushing and improved yields due to better cell structure control. Incremental operating costs are not to be considered.

6.3 UNIT ABATEMENT COST

a)	ODS Reduction Project Costs	USD 870,000
b)	**Annual Incremental Operating Costs**	**USD 0**
c)	**Project Useful Life**	**10 years**
d)	ODS reduction/y	**kg 44,200**
e)	Capital Recovery Factor	0.16275

Unit Abatement Costs [{a(e)+ b}/d] **USD/kg/y 3.2**

7. FINANCING PLAN

The companies are requesting reimbursement to the amount of the full project costs of USD 975,000.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

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

8.2 PROCUREMENT

It is foreseen to assign the procurement of the project to UNDP's Office for Project Services (OPS). OPS will procure at the same time about ten projects in Egypt, several of them similar in equipment requirements. This will result in procedural, time and cost efficiencies. OPS will be assisted by the local UNDP office as well as by EEAA, and receive technical assistance from UNDP-ENR.
The OPS policies on bidding procedures, contractor selection, disbursement procedures and project certification will apply, assuring fair bidding and accountable financial management.

8.3 SCHEDULE

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

9. PROJECT IMPACT

This project will eliminate the use of 44.2 tons of CFCs (1993 base) in the first year of implementation, growing to 75 t/y for subsequent years.

10. ANNEXES

ANNEX A: INDIVIDUAL COMPANY BACKGROUND
ANNEX B: TECHNICAL ASSESSMENT

Annex-B

TECHNICAL ASSESSMENT

PROJECT TITLE:	Conversion to CFC-free Technology in the Manufacture of Rigid Molded and Misc. PUF
CATEGORY:	Foamed Plastics Rigid PUF MLD & MISC
RECOMMENDATION:	The project is supported
INFORMATION:	adequate
TECHNOLOGY:	It is recommended to combine the two first conversion steps--50% CFC and HCFC-141b to one step. This saves time, ODS and trials
REFERENCES:	Similar projects in Egypt, Malaysia and Thailand. Technical choices similar
ENVIRONMENTAL:	HCFC-141b has an ODP and is a transition technology. This is addressed in the project
SAFETY:	HCFC-141b is moderately flammable. Pre/post safety audit recommended
COST EFFECTIVENESS:	Better than Malaysia (Island Resources), not comparable with Thailand and higher than Egypt (Olympic)
OTHER ISSUES:	None
REVIEWER:	Bert Veenendaal
DATE:	February 10, 1994

PROJECT COVER SHEET

COUNTRY:	**EGYPT**
PROJECT TITLE:	Conversion to CFC-free Technology in the Manufacture of Flexible Polyurethane Foam
SECTOR COVERED:	Foamed Plastics
ODS USE IN SECTOR:	722t CFCs (722t ODP) in 1991
PROJECT IMPACT:	Phaseout of the use of 170 tons/year CFC-11 (170 t ODP; 1993)
PROJECT DURATION:	Nine Months
PROJECT ECONOMIC LIFE:	Ten Years
TOTAL PROJECT COST:	USD 525,000 Incremental Capital Cost
PROPOSED MLF GRANT:	USD 525,000
COST EFFECTIVENESS:	USD 0.50/KG/Y (unit abatement cost)
COORDINATING NATIONAL BODY:	Egyptian Environmental Affairs Agency (EEAA)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	February 8, 1994

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PROJECT SUMMARY

Under this project, Egypt will essentially complete the phaseout of CFCs in the manufacture of flexible polyurethane (slabstock). The two companies participating used together 190 t/y CFC-11. Both have made considerable effort on their own to replace this substance with methylene chloride, but did not succeed. Problems in product quality and workplace safety were the main cause for the lack of success.

These issues are addressed in this project, which will include the assistance of an international process expert, the improvement of ventilation systems and the methylene chloride metering systems. Also, the installation of water lances and a quick cooling system for fire safety.

TECHNICAL ASSESSMENT: The project is reviewed and supported by Mr. Bert Veenendaal from UNDP's technical review panel. His comments are attached.

PROJECT OF THE GOVERNMENT OF EGYPT

CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF FLEXIBLE SLABSTOCK POLYURETHANE FOAM

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of flexible slabstock PUF at two remaining companies in Egypt.

2. SECTOR BACKGROUND

The CFC consumption in 1991 in the Egyptian foam sector, (excluding foams for domestic and commercial appliances), has been established at 722 tons, with an annual growth rate 15-20% (Egyptian Country Program). Uninhibited growth would lead to an estimated CFC consumption of 1,000 tons in 1993 and 2,050 tons by the year 2000.

EEAA, with the assistance of UNDP, has designed a strategy for this sector, targeting annual consumption reductions beginning in 1993. Finalization of the projects submitted to the MLF so far would bring the actual implementation of this strategy well within the target. A complete phaseout of the use of CFCs in the foam sector could be achieved by 1998.

3. ENTERPRISE BACKGROUND

The manufacturing of flexible slabstock polyurethane foam is well established in Egypt with many of the factories in existence for up to 20 years. In general, the industry has taken an agressive approach toward the elimination of CFCs from their manufacturing process. Most have made attempts over the past two years to switch from CFC-11 to methylene chloride with varying degrees of success. The major problems continue to be workplace safety, processing issues, and core discoloration of the product.

The primary markets for the foamers are mattresses and furniture. Many of the foam factories have their own line of bedding and furniture.

4. PROJECT DESCRIPTION

Under this project, the enterprises will phaseout the use of CFCs through the conversion to methylene chloride as an ABA in the slabstock foams.

Although the products manufactured are different at the two locations, the equipment is very similar and the solutions will also be similar. The project will include improved ventilation, improvement of the methylene chloride metering system, and appropriate fire safety. Profiles of the two enterprises are included in Annex-A.

5. TECHNOLOGY

5.1 OVERVIEW

There are numerous technologies to replace the use of CFCs in flexible foams by non ODS or low ODS options. We refer to publications by UNEP and documentation available through UNDP for summaries of these technologies. Methylene chloride is one of the most cost effective technologies and is usually applied where process, industrial hygienic and regulatory conditions will permit its use.

5.2 SELECTION

The enterprises intend to phaseout CFCs in the slabstock production through replacement by methylene chloride being the most economical solution. The use of forced cooling at one factory is requird to address the discoloration. Fire safety will be addressed with water lances at the new hooded sections in both factories.

5.3 REQUIRED MODIFICATIONS

In all areas where methylene chloride and isocyanate are processed, adequate vapor containment and ventilation will have to be installed to assure safe workplace conditions. Regular checkups should be performed to assure continued compliance.

The production lines will need additional metering systems for the use of methylene chloride. A polyol that is BHT free should be used in order to eliminate the white plume from the extraction system on the quick cool apparatus and water lines with lances will be installed at the new hoods.

6. PROJECT COSTS

6.1 SUMMARY OF PROJECT COSTS

The total project incremental cost of USD 552,000 is based on the incremental capital costs. The net incremental recurrent costs are expected to offset the recurrent savings.

6.2 CAPITAL COSTS

The following costs are expected to be incurred:

FOAM INDUSTRIAL

#	Reimbursement for isolation wall to separate ABA vapors from the Fabrication area	USD 10,000
#	Upgrading of ventilation and encapsulation systems	USD 90,000
#	Water lines and lances	USD 6,000
#	Additional metering systems	USD 15,000
#	Forced cooling apparatus	USD 175,000
#	Technology transfer for fabrication and installation of cooling apparatus	USD 25,000
#	Trials, training, IH survey	USD 20,000
#	Miscellaneous safety equipment	USD 5,000
	Total Foam Industrial	USD 336,000

HYMA FOAM

# Upgrading of ventilation and encapsulation systems	USD	80,000
# Water lines and lances	USD	6,000
# Additional metering systems	USD	15,000
# Trials, training, IH survey	USD	20,000
# Miscellaneous safety equipment	USD	5,000
Total Hyma Foam	USD	121,000
Sub-total	USD	457,000
Pre/Post Auditing, Implementation Monitoring, Commissioning	USD	20,000
Contingency and Rounding	USD	48,000
Total Capital Costs	**USD**	**525,000**

6.3 OPERATING COSTS

Methylene chloride is lower priced than CFC-11, resulting in lower material costs. Offsetting that is waste, related to more difficult processing, higher costs of catalysis and polyol, operating costs of the forced cooling apparatus, annual training and maintenance. These costs are difficult to calculate in advance as individual formulation changes and operating conditions tend to be site specific. However, expected annual savings on methylene chloride will approximately match the extra processing and chemical costs . Therefore, no recurrent incremental costs will be considered on this project. Annex-B provides more detailed information.

6.4 UNIT ABATEMENT COSTS

a)	Incremental Capital Costs	USD	525,000
b)	Project Life Time		10 years
c)	Incremental Recurrent Costs	USD	-,-
d)	CFC Consumption	kg	170,000
e)	Capital Recovery Factor		0.16275
	UNIT ABATEMENT COSTS [(a(e)+ c)/d]	USD/kg/yr	0.50

7. FINANCING PLAN

The company requests an MLF grant, representing all eligible incremental costs in the amount of

USD 525,000

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP will be the implementing agency for this project and will work with the recipient of project execution under the guidance of the Government (EEAA).

8.2 PROCUREMENT

UNDP will review and supervise the procurement process, following UNDP guidelines and regulations.

8.3 SCHEDULE

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

9. REQUIRED REGULATORY ACTION

The project does not require regulatory action.

10. PROJECT IMPACT

This project will eliminate the use of at least 170 tons of CFC-11 in the first year of implementation. The project employs commercially available and environmentally acceptable technology.

11. ANNEXES

Annex A: Individual Enterprise Background.
Annex B: Detailed information on Incremental Capital Costs.
Annex C: Detailed information on Incremental Recurrent Costs.
Annex D: Technical Assessment

ANNEX A:

1. FOAM INDUSTRIAL COMPANY

Foam Industrial is one of Egypt's earliest manufacturers of flexible slabstock polyurethane foam. They are unique in offering a line of specialty foam products from 16 kilo to 60 kilo densities at hardnesses above the norm at each respective density. The company began experimenting with conversion to a non-ODS auxiliary blowing agent in 1991. The conversion to methylene chloride has been made, but difficulty with production yields, core discoloration of the foam blocks, and worker safety continue to be a problem.

Because of ABA vapors, the company has increased the height of a wall separating the foam production area from the cutting area. The company wants to pursue a complete safety program and eliminate the core discoloration in the manufacture of slabstock foams by this substance. The worker safety will require improved process encapsulation and venting in addition to some minor process modifications. The discoloration can be eliminated by replacing the methylene chloride black iron storage and metering system.

Foam Industrial is one of the main manufacturers of flexible PUF in Egypt with an annual production of about 1,500 tons and related use of auxiliary blowing agent (ABA) of 150 tons per year. The company employs approximately 70 people with 20 of those in foam production.

Foam Industrial's main activity is the manufacture and fabrication of slabstock foams. The company operates a low pressure foam machine, utilizing a short, inclined conveyor and a long transport conveyor to the Cut-Off-Saw. With 95% of their production at the very low densities, the large volume lends itself to the application of quick cooling for fire safety and workplace vapor control.

2. HYMA FOAM INDUSTRY

Hyma Foam is also one of Egypt's earliest foamers with an annual production of about 1,000 tons. They specialize in higher density foams and produce only 200 tons per year of the low densities that require an ABA. They began the conversion to a non-ODS auxiliary blowing agent in 1992 and have experienced the same difficulties that others have and are going through. They employ 50 people with 15 that are involved in foam production. The company operates a low pressure foam machine with a short transition conveyor to the Cut-Off-Saw.

The use of methylene chloride as the non-ODS ABA will require proper ventilation for workplace safety but, the lower volume of low density foams means that fire safety can be handled by water lances.

ANNEX C
RECURRENT INCREMENTAL COSTS

Both enterprises began the conversion from CFC-11 to methylene chloride approximately two years ago. They have been on a learning curve throughout that period. It is normal to drop about 5% in prime yield in factories where that change in ABA is instituted. The companies experienced approximately that degree of loss, but have regained about half. With some process training and the proposed forced cooling, they should complete the the curve over the next year. In the process 170 tons/year of ODS is replaced by an equal tonnage of methylene chloride. In addition, the catalysts and polyol have to be changed, recurrent safety training, operating costs for the forced cooling and increased maintenance will be needed. This will impact the operating costs as follows:

ITEM	BEFORE	AFTER
170 T/Y CFC-11 @ 2500	USD 425,000	
170 T/Y Methylene Chloride @ 1500	-,-	USD 255,000
5 T/Y Softening Additive @ 3000	-,-	USD 15,000
1 T/Y Extra Amine Catalyst @ 7500	-,-	USD 7,500
2 T/Y Extra Tin Catalyst @ 5600	-,-	USD 11,200
1430 T/Y BHT free polyol @ 22.05 increase	-,-	USD 31,500
Annual electricity for forced cooling	-,-	USD 7,500
Training, Maintenance		USD 20,000
TOTAL	**USD 425,000**	**USD 347,700**
DIFFERENCE		**USD + 77,300**

INCURRED COSTS FROM PRIOR CONVERSION EFFORTS:

First year yield:
Incremental Gain = USD 77,300
Loss = 5% x 2500 T/Y @ 1550 = - 193,750
\- 116,450 x 1.0000 = USD -116,450

Second year yield:
Incremental Gain = USD 77,300
Loss = 2.5% x 2500 T/Y @ 1550 = - 96,875
\- 19,575 x 0.9090 = USD - 17,794

Third year yield:
Incremental Gain = USD 77,300
Loss = 0% x 2500 T/Y @ 1550 = - 0
\+ 77,300 x 0.8260 = USD + 63,850

Fourth year yield:
Incremental Gain = USD 77,300
Loss = 0% x 2500 T/Y @ 1550 = - 0
\+ 77,300 x 0.7513 = USD + 58,750

NET FOUR YEAR TOTAL...............USD -11,644

On the balance, a slight increase in incremental recurrent costs appears to exist over the 4 year transitional period. However, it is acknowledged that these figures are estimates. Individual formulation modifications will result from the process trials and yields may differ from the predicted costs, but they certainly won't be better than the original CFC formulas. On that basis, recurrent incremental costs will not be considered.

TECHNICAL ASSESSMENT

PROJECT TITLE:	Conversion to CFC-free Technology in the Manufacture of Flexible Polyurethane Foam
CATEGORY:	Foamed Plastics; Flexible PUF Slabstock
RECOMMENDATION:	The project is supported
INFORMATION:	Adequate
TECHNOLOGY:	Methylene Chloride is an acceptable choice. The deficiencies of the technology are adequately addressed
REFERENCES:	Similar projects in China, Egypt, Indonesia use the same or comparable technology
ENVIRONMENTAL:	Methylene chloride is currently not restricted in Egypt, but is in some other countries. Regulatory situation to be monitored. The quick cooling technology would allow to go to full water blown systems in such a case
SAFETY:	Issues on workplace safety and fire risks are adequately addressed
COST EFFECTIVENESS:	Good/very good for the category (0.50-1.50)
OTHER ISSUES:	None
REVIEWER:	Bert Veenendaal
DATE:	February 10, 1994

PROJECT COVER SHEET

COUNTRY:	Egypt
PROJECT TITLE:	Conversion to CFC-free Technology in the Commercial Refrigeration Sector (five enterprises)
SECTOR COVERED:	Refrigeration/Air Conditioning
ODS USE IN SECTOR:	1,040 tons CFCs (870 tons ODS) in 1991
PROJECT IMPACT:	Phaseout of the use of 205 tons/year CFC-11, 17.5 t/y CFC-12 and 10 t/y R-502 (1993) in the manufacture of commercial refrigeration equipment. (224.4 t/y ODS)
PROJECT DURATION:	One year
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	USD 2,100,000 Incremental Capital Cost
PROPOSED MLF GRANT:	USD 2,100,000
COST EFFECTIVENESS:	USD 1.53kg/y (unit abatement cost)
COORDINATING NATIONAL BODY:	Egyptian Environmental Affairs Agency (EEAA)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	February 10, 1994

PROJECT SUMMARY

Under this project, Egypt will complete the first phase of the elimination of the use of CFCs in the manufacture of commercial refrigeration equipment. Five companies are participating in this project that will eliminate the use of 225.t ODP/y (base 1993).

The project includes the replacement of CFC-11 in the production of rigid PUF insulation--panels and spray, the replacement of the use of CFC-12 and R-502 in refrigeration units and a line of car air conditioners and the recovery and recycling of CFC-12/R-502 from servicing operations.

TECHNICAL ASSESSMENT: The project is reviewed and supported by Bert Veenendaal from UNDP's technical review panel. His comments are attached.

PROJECT OF THE GOVERNMENT OF EGYPT

ELIMINATION OF CFCS IN THE MANUFACTURING AND SERVICING OF COMMERCIAL REFRIGERATION UNITS AT FIVE (5) FACTORIES

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs at the five companies in the manufacturing of commercial refrigeration panels and sprayed cold room insulation. At those companies where refrigerating units are being assembled and filled, units using new technology to replace CFC-12 and R-502 will be phased in and reclaim/recycle equipment will be used to service existing units when they need repair.

2. SECTOR BACKGROUND

The CFC consumption in 1991 in the Egyptian refrigeration sector--including foams for domestic and commercial appliances--has been established at 1,045 tons, with an annual growth rate of 5% (Egyptian Country Program). Uninhibited growth would lead to an estimated CFC consumption of 1,210 tons in 1994 and 1,621 tons in the year 2000. EEAA, with assistance of UNDP has designed a strategy for this sector, targeting annual consumption reductions beginning 1994. Finalization of the projects submitted so far to the IMLF would bring the actual implementation of this strategy well in line with the target. Because of the long life of refrigerators, there will be a residual demand for servicing beyond the year 2000. The Country Program assumes any CFC-12 based compressors would become obsolete by 2010. A complete phaseout of the use of CFCs in the commercial insulation foam sector could be reached in 1996.

3. ENTERPRISE BACKGROUND

The five factories are primarily serving the refrigeration market with one company also doing automotive air conditioning. All of the companies are involved in the use of rigid urethane foam for insulation of cold storage applications. The replacement foam machines may differ in size, but the process is the same and will require the same basic technology. For the refrigeration and air conditioning units, two companies will need reclaim/recycle equipment and training to enable them to use it properly. Detailed backgrounds of the individual companies are given in ANNEX A.

4. PROJECT DESCRIPTION

All of the factories use the rigid foam in cold storage insulation applications. Some is for refrigerated transport truck boxes and the balance for fixed locations. Two companies are also importing equipment for refrigeration and one of those, for automotive air conditioning. The new foam machines for the rigid insulation should be high pressure machines that will be able to process the higher viscosities of the current low ODS systems and also any of the developing ODS-free systems.

The companies which are involved in the refrigeration and air conditioning equipment have to work out a conversion schedule to non ODS technology with the supplier(s) of the units. In the meantime, they can reduce the quantity of ODS materials consumed in their service operations by obtaining reclaim/recycle equipment for the present R-12 and R-502. They will also require proper training in the use of the equipment.

The refrigeration equipment suppliers are beginning a switch to R-134a in 1994. Reftruck and MISR Panel will also need equipment to service the new units.

5. TECHNOLOGY

5.1 SELECTION

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

- CFC-11 > partial water/HCFC-141b > ?
- CFC-11 > partial water/ HCFC-22, 142b > HFC-134a, 152a
- CFC-11 > Pentane

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

The first solution--the "liquid" solution-- employs technology that is closely related to the existing one. The final step in this process is not yet decided. One potential solution is HFC-356, but full water blown foam with improved cell structure remains an option, specifically in "lesser demanding" systems such as water heaters, were dimensional changes--although costly-- are possible.

The second one--the "gas" solution--utilizes a gaseous mixture of physical blowing agents, requires always new equipment, and extensive adjustments. The final step in this process is seen as the introduction of (gaseous) HFC's.

Cyclopentane technology has recently been introduced commercially in Germany. Its flammable character requires safety conditions and limits its use. Several companies currently offer cyclopentane packages, including equipment. Based on economics as well as environmental considerations, cyclopentane would be the best choice for these applications. From a safety standpoint, the factories will require ventilation improvement, possible replacement of some electrical equipment in the foaming areas, and vapor sensing units.

In the refrigeration and air conditioning equipment, the present trend is toward R-134a as the refrigerant. The equipment suppliers in the Egyptian market have indicated that they will begin to supply compressors using 134a during 1994. Those companies involved in assembly and service of that equipment will need reclaim/recycle equipment for the new units as well as for the existing R-12 and R-502 refrigerants. Technicians will have to be trained on the proper use of the servicing equipment.

5.2 PROCESS MODIFICATIONS

The existing rigid foam equipment at all five factories is based on low pressure metering of the material components. It is not suited for water/cyclopentane systems. Replacement of the seven (7) stationary units currently in place is required. The modifications have to be complemented by training and some plant safety adjustments. There are also six (6) mobile spray units that will need to be replaced.

6 PROJECT COSTS

6.1 TOTAL PROJECT COSTS

The following is a summary of the expected costs of investment and related activities:

DESCRIPTION	SUBTOTAL (USD)	TOTAL (USD)
Charging Units for R-134a		USD 100,000
Recovery and Recycle Unit for R-12		USD 10,000
Gauge Sets		USD 3,000
Leak Detectors		USD 20,000
7 High Pressure Foaming Units		USD 880,000
4 Blending Units		USD 260,000
Building Modifications for Safety		USD 280,000
6 Spray Machines		USD 210,000
Freight		USD 31,000
Installation, Training and Trials		USD 80,000
Contingency and Rounding		USD 196,000
GRAND TOTAL		**USD 2,100,000**

Annex B: Cost Per Company

6.2 OPERATING COSTS

The elimination of CFCs will be offset by increased use of water/isocyanate to obtain the same density. A possible slight increase in cost of raw materials will be balanced against elimination of solvents used in flushing and improved yields due to better cell structure control. Incremental operating costs are not to be considered.

6.3 UNIT ABATEMENT COST

a: ODS Reduction Project Costs	USD	2,100,000
b: Annual Incremental Operating Costs	USD	0
c: Capital Recovery Factor		0.16275
d: ODS reduction/y:	kg.	224,400

Unit Abatement Costs **USD/kg/y** **1.53**
{a(c)+b}/d

7. FINANCING PLAN

The companies are requesting reimbursement to the amount of the full project costs of USD 2,100,000

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 PROCUREMENT

It is foreseen to assign the procurement of the project to UNDP's Office for Project Services (OPS). OPS will be assisted by the local UNDP office as well as by EEAA, and receive technical assistance from UNDP-ENR.

The OPS policies on bidding procedures, contractor selection, disbursement procedures and project certification will apply, assuring fair bidding and accountable financial management.

8.3 SCHEDULE

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

9. PROJECT IMPACT

This project will eliminate the use of 232 tons of CFCs (224.2 t/y ODS), (1993 base) in the first year of implementation.

10. ANNEXES

ANNEX A: INDIVIDUAL COMPANY BACKGROUND
ANNEX B: INDIVIDUAL COMPANY INCREMENTAL CAPITAL COST
ANNEX C: TECHNICAL ASSESSMENT

ANNEX A:

SCIB CHEMICAL COMPANY

SCIB Chemical supplies chemicals to the construction industry and installs/applies sprayed urethane foam insulation for cold storage and roofing applications. The insulation division was established in August of 1990 and uses two foam machines. The company has 92 employees of which 9 are involved in this division. Current usage of raw materials is 73 metric tons per year which contain 12.4 tons of CFCs.

REFTRUCK COMPANY

Reftruck is involved in the following areas of activity:

- Refrigerated transport, where they manufacture and service truck refrigeration boxes.

- Mobile air-conditioning where they install and service passenger and bus a/c systems.

For the truck business, Reftruck manufactures the rigid foam insulated truck boxes and imports assembled refrigeration units which they install and charge. The passenger car a/c business includes installation contracts with Opel and Volkswagen. They also do retail customer a/c installation and service, including mobile service.

Most of the truck refrigeration units are pre-assembled electrically driven systems for eutectic plates. A few engine driven systems are installed each year. Current usage of R-12 is 3.1 tons and R-502 is 2.5 tons/year. Chemical usage for the box insulation is 125 tons per year which contains 22 tons of CFC-11.

The suppliers of the compressor units will be switching to R-134a in 1994 and Reftruck will need charging and servicing equipment as well as training. In order to reduce the demand for R-12 in the service sector, Reftruck will need recovery and recycle equipment and training for the service technicians.

In order to switch to reduced CFC and ultimately zero-ODS systems for the rigid foam insulation, Reftruck will require high pressure foam machines that can process the higher viscosity materials.

MISR PANEL (The Egyptian Company for Cold Storage Industries)

MISR Panel is involved in the following refrigeration activities:

- Refrigerated transport, where they manufacture and service truck refrigeration boxes.

- "Walk-in" chillers for commercial applications which they manufacture, install, and service.

- Large cold stores of 500 to 3,000 tons storage capacity.

For the truck business, MISR Panel manufactures the rigid foam insulated truck boxes and imports assembled compressor units which they install and charge. A small number of units come in all ready charged with R-12. Most of the units are electrically driven for eutectic plate applications although a few engine driven units are used each year. Cold stores and "walk-in" chillers are to customer specifications with MISR Panel carrying out design, procurement, panel manufacturing, installation, charging, and commissioning. The company has 5 service centers throughout Egypt.

Chemical usage for rigid foam is 350 tons which contains 60 tons of CFC-11. The annual usage of refrigerant R-12 is 14.4 tons and R-502 is 7.5 tons. It should be noted that about 20% of the material was purchased by the customer where large cold stores were involved. MISR Panel did the installation and charging of the refrigeration units.

Refrigeration units using R-22 and 134a are available from Carrier (MISR Panel's supplier), but they cannot meet the -32 degree Centigrade requirement for ice cream trucks. Market forces will drive the change to non-ODS refrigerants. MISR Panel is dependant upon their supplier for technological change. They will need equipment and training for the new products.

In order to switch to reduced CFC and ultimately zero-ODS systems for the rigid foam insulation, MISR Panel will require high pressure foam machines that can process the higher viscosity materials.

ICON (Industrial Engineering Company for Construction & Development)

ICON is involved in the following refrigeration activities:

- "Walk-in" chillers for commercial applications for which they manufacture and install insulated panels .

- Large cold stores of 500 to 3,000 tons storage capacity.

Cold stores and "walk-in" chillers are to customer specifications with ICON carrying out design, panel manufacturing, and installation. They use about 300 tons per year of rigid foam chemicals which contains 51 tons of CFC blowing agent. The new foam machines should be high pressure so that they can handle the higher viscosity materials associated with the 50% reduced CFC and ultimately zero-ODS systems.

AL-FATEH

AL-FATEH is involved in the following refrigeration activities:

- "Walk-in" chillers for commercial applications for which they manufacture and install insulated panels .

- Large cold stores of 500 to 3,000 tons storage capacity.

Cold stores and "walk-in" chillers are to customer specifications with ICON carrying out design, panel manufacturing, and installation. They use about 547 tons per year of rigid foam chemicals which contains 59 tons of CFC blowing agent. The new foam machines should be high pressure so that they can handle the higher viscosity materials associated with the 50% reduced CFC and ultimately zero-ODS systems.

ANNEX B

INCREMENTAL CAPITAL COSTS

SCIB

Spray machine: 2 x USD 35,000	USD 70,000
Freight:	USD 2,000
Training and Startup	USD 5,000
Contingency and Rounding	USD 8,000
Total	USD 85,000

REFTRUCK

Charging Units for R-134a: 2 x 30,000	USD 60,000
Recovery and Recycle Unit for R-12:	USD 10,000
Rigid Foam Machine:	USD 120,000
Blowing Agent Blending Machine:	USD 65,000
Building Modifications for Safety	USD 40,000
Spray machine:	USD 35,000
Freight:	USD 5,000
Training and Startup	USD 15,000
Contingency and Rounding	USD 35,000
Total	USD 385,000

MISR PANEL

Charging Unit, Large, 2 Stage, for R-134a:	USD 40,000
Charging Unit, Small, for R-134a:	USD 30,000
Manifold Gauge Set: 6 x 500	USD 3,000
Leak Detectors for R-134a: 6 x 3,333	USD 20,000
Rigid Foam Machine:	USD 120,000
Rigid Foam Machine: 2 Mix Heads	USD 160,000
Blowing Agent Blending Machine:	USD 65,000
Building Modifications for Safety	USD 80,000
Spray machine:	USD 35,000
Freight:	USD 8,000
Training and Startup	USD 20,000
Contingency and Rounding	USD 55,000
Total	USD 636,000

ICON

Rigid Foam Machine: 2 x 120,000	USD 240,000
Blowing Agent Blending Machine:	USD 65,000
Building Modifications for Safety	USD 80,000
Spray machine:	USD 35,000
Freight:	USD 8,000
Training and Startup	USD 20,000
Contingency and Rounding	USD 50,000
Total	USD 498,000

Rigid Foam Machine: 2 x 120,000	USD 240,000
Blowing Agent Blending Machine:	USD 65,000
Building Modifications for Safety	USD 80,000
Spray machine:	USD 35,000
Freight:	USD 8,000
Training and Startup	USD 20,000
Contingency and Rounding	USD 48,000
Total	USD 496,000
GRAND TOTAL	USD 2,100,000

Annex - C

TECHNICAL ASSESSMENT

PROJECT TITLE: Conversion to CFC-free Technology in the Commercial Refrigeration Sector

CATEGORY: RAC; Commercial Refrigeration

RECOMMENDATION: The project is supported

INFORMATION: Somewhat brief on the safety consequences of cyclopentane

TECHNOLOGY: (Cyclo)pentane technology is acceptable. The deficiencies of the technology are adequately addressed

REFERENCES: Similar projects in Malaysia, India, Thailand. Lack of pentane supply seems the main reason that in these countries HCFC-141b has been selected

ENVIRONMENTAL: Hydrocarbons are VOCs and photochemically active. However there is no regulatory limitation in Egypt

SAFETY: Issues on workplace safety and fire risks are a priority and to be addressed in the implementation

COST EFFECTIVENESS: Good/very good for the category (1.50-3.00)

OTHER ISSUES: The combination of foam and refrigerant in one project was not practiced before in commercial refrigeration. it seems a cost effective approach

REVIEWER: Bert Veenendaal

DATE: February 10, 1994

PROJECT COVER

Country	:	Egypt
Project Title	:	**Investment Project for Phasing out ODS at DELTA INDUSTRIAL Co.**
Sectors Covered	:	Domestic Refrigeration / Rigid Foam / Refrigerant
ODS Use in Sector (1990)	:	1,830 MT of CFC 11 and CFC 12
Project Impact	:	Phase out of annual consumption of 40 MT CFC 11, 50 MT CFC 12 in the production and a gradual phase out of currently used 7 MT CFC 12 in the service sector (Total ODP = 97)
Project Duration	:	18 months
Project Economic Life	:	10 years
Total Proposed Project Cost	:	Total of capital cost and operating incremental cost (first year of operation) US$ 4,264,016
Project Cost	:	US$ 2,373,048
Implementing Agency's Overheads (13 percent)	:	US$ 554,322
Incremental Operating Costs/Year	:	US$ 1,890,968 (first year of operation)
Proposed MF Financing	:	US$ 4,818,338
Cost Effectiveness	:	See Annex C: Unit Abatement Cost
Counterpart Enterprise	:	DELTA INDUSTRIAL CO.; plants at ALMAZA and NASR CITY, Cairo
Implementing Agency	:	United Nations Industrial Development Organization (UNIDO)
Coordinating Ministry	:	Egyptian Environmental Affairs Agency (EEAA)

PROJECT SUMMARY

This project will phase out 100 percent of the use of CFC 11 and CFC 12 for the production of refrigerators and freezers at DELTA INDUSTRIAL CO.'s plants ALMAZA and NASR CITY, Cairo. The chosen replacement alternatives are cyclo pentane as foam blowing agent and HFC 134a as refrigerant. The project will include the redesign of all current refrigerator models and the conversion of the plants. The redesign of the existing refrigerator models covers activities like prototyping, testing, trial manufacturing and adaptation as well as reliability tests. The conversion of the production facilities covers the refrigeration system, insulating foam blowing system as well as the refrigeration service carried out by the company. The replacement alternatives and the time frame for phasing out the use of ODS will be in line with EEAA's ODS phase out programme.

Date: 1 February 1994

BACKGROUND

SECTOR BACKGROUND

The subsector for domestic refrigerators and freezers in Egypt consists of 9 manufacturers of which four to five companies are responsible for over 80 percent of the ODS consumption of CFC 11 and CFC 12.

Egypt does not produce any ODS. All ODS used in the country are directly imported by the users. In 1990 the total consumption was 1.830 MT of ODS.

The total installed production capacity for refrigerators and freezers is about 1,000,000 units per year, but the present production is only about 525,000 units per year. The manufacturers expect an increase of about 10 percent per year.

In total about 7,000,000 refrigerators and freezers are in use in Egypt of which about 10 percent per year will be recharged during refrigeration service with CFC 12 equally to about 350 MT CFC 12.

Because of lack of environmental awareness, know-how and equipment in the service sector, service staff very often use CFC 12 for washing/flushing of the cooling systems, instead of using vacuum pumps and charging boards. This causes a 100 percent to 200 percent higher CFC 12 consumption in the service sector, estimated at about 350 MT.

Currently no Egyptian company manufactures low energy refrigerators and freezers with an insulation thickness of 40 to 50 mm for refrigerators and 90 mm to 100 mm for freezers; however, the introduction of a limit for maximum energy consumption could be expected in the near future.

DELTA's BACKGROUND

DELTA INDUSTRIAL Co. (DELTA) is a public company and the largest manufacturer of refrigerators in Egypt. It employs more than 1,000 staff and the installed annual production capacity is about 420,000 units in one shift. From September 1992 to September 1993 the actual production was 207,914 units. DELTA expects a 5 - 10 percent increase in the production for each of the next four years because of a low price policy.

DELTA is using the brand name "IDEAL" and is running two factories, one called ALMAZA and another, called NASR CITY.

For the insulation of the refrigerators produced by ALMAZA, polyurethane "plates", supplied from another company are being used. No change of this cheap, but very energy inefficient insulation technology is planned for the time being. (It has, however, been estimated that through a better capacity utilization of the existing high pressure foaming machines at NASR CITY plant all cabinets could be foamed for ALMAZA plant.)

In 1992 DELTA used 40 MT of CFC 11 and 50 MT of CFC 12 for the manufacturing process and 7 MT of CFC 12 for the refrigeration service.

DELTA is currently manufacturing 2 models of two-door fridge/freezers and 3 models of single-door refrigerators. The main products are 9 and 10 cu ft single-door refrigerators, of which currently 125,000 units are being manufactured annually.

DELTA covers a share of about 50 percent of the local market and exports less than 2 percent (to Libya, earlier also to Russia and Romania).

DELTA has imported the currently applied technologies and know-how from Bosch/Germany as well as from other European manufacturers.

The insulation thickness of the refrigerators produced at NASR CITY plant is 35/55 mm and [illegible] mm for the freezer section.

DELTA has imported the currently applied technologies and know-how from Bosch/Germany as well as from other European manufacturers.

The insulation thickness of the refrigerators produced at NASR CITY plant is 35/55 mm and 68 mm for the freezer section.

More detailed information on the current plant layouts and the production equipment employed, as well as on the proposed new plant layouts is shown in Annex D: "Current and Proposed New Plant Layouts".

DELTA has already recognized the need to be in compliance with the stipulations made in the Montreal Protocol and has agreed to participate in Egypt's ODS phase out programme.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of ODS such as CFC 11 and CFC 12 in the production of domestic refrigerators and in the refrigeration service at DELTA through conversion to the use of HFC 134a as refrigerant for the cooling system and cyclo pentane as blowing agent for the polyurethane insulation foam.

PROJECT DESCRIPTION

DELTA is prepared to phase out ODS as soon as the new technologies have been acquired, the necessary machinery and equipment installed and the technical staff trained.

DELTA has accepted to replace CFC 12 with HFC 134a because the new type of compressors are available and the technology is mature and commercially applied outside Egypt.

Initially, DELTA considered to start in 1994 on their own initiative with 50% CFC - reduced foam. Now, DELTA decided to avoid the application of any transitional substance and to introduce as an ultimate solution cyclo pentane as blowing agent for polyurethane foam.

Through the project assistance will be provided in:

a. Procurement of new machinery and equipment;

b. Rebuilding of presently used machinery and equipment wherever technically and economically feasible;

c. Redesign, reconstruction, prototype manufacturing and testing of refrigerators/freezers;

d. Installation, commissioning, trial operation, start-up and on-the-job training;

e. Servicing.

The following machinery and equipment need to be rebuilt, replaced or added:

A. Refrigeration System

- The charging equipment and vacuum pumps must only be used for HFC 134a and in meeting the demand for cleaner and dryer cooling systems the existing charging equipment has to be replaced including the vacuum control.

- The charging boards have to be replaced by boards suitable for HFC 134a.

- To optimize the cooling system for the application of HFC 134a and new specification for components used, performance tests for each model of refrigerator are needed. Therefore, a minimum specification of refrigeration test equipment needs to be provided and to be added to already existing test equipment which can also be used for the new technology.

- To improve the performance of the cooling system and compensate for a little lower polyurethane insulation value due to the conversion to HFC 134a as the new refrigerant and cyclo pentane for the foam, it is necessary to optimize the cooling system as well as the energy consumption to keep an acceptable TEWI value. Therefore, it is necessary to redesign, reconstruct and carry out performance tests for all redesigned models of refrigerators / freezers.

- The technical requirements for components such as tubes, condensers, evaporators, capillary tubes, heat exchangers and suction accumulators have to be in line with established standards, like DIN 8964, i.e. new rules for dryness and cleanliness need to be applied.

- The drier has to be equipped with 3 AA desiccant molecular sieves.

- The cooling system must not contain any chlorine and max. 1 percent non-condensable gases.

- The capillary tube has to be optimized for an increased resistance at low evaporating temperatures.

- It will be necessary to train DELTA's manufacturing and service technicians at the equipment suppliers' place in the new foaming technology as well as in design/calculation and performance testing of cooling systems. During the installation and run-in of the new machinery and equipment the suppliers engineers will have to train DELTA's technical staff.

B. Foam System

- To adapt the currently used high pressure foaming machines for cyclo pentane, the polyol part of the machines has to be made explosion proof and encapsulated. It is also necessary to replace the stirrer in the polyol daily tank as well as the electrical components of the polyol part of the foaming machines.

- Since cyclo pentane and polyol cannot be delivered premixed in drums or tanks (like CFC 11 and polyol), and following the current and the proposed new plant layout (NASR CITY plant), it will be necessary to provide two mixing stations to serve one foaming machine each for cabinets and one mixing station for the two foaming machines for doors.

- For work safety when using the highly flammable and explosive cyclo pentane and in order to meet the relevant requirements of the local authorities, it is recommended to have a gas detector system as well as a fire protection system installed in the foaming department.

- It is necessary to provide one tank for cyclo pentane and adapt the existing tanks for the other components to automatically deliver the components to the mixing stations.

- To make the foaming jigs explosion-proof, it is necessary to replace the electric heating elements by a water heating system. (A cheaper option would be to automatically disconnect the existing electrical heating just before foam injection, using the control system of the foaming machine and a timer. For the sake of high operational safety it is, however, recommended to apply the water heater option.)

- To keep control over the quality of the foam it is recommended to introduce a minimum specification of test equipment. Since currently no test equipment is being used by DELTA it can, however, not be provided under this project.

- The workers's clothes and shoes have to be made of antistatic material and the floor needs to be covered with an antistatic paint.

- The provision and installation of an exhausting and ventilation system in the foaming department is necessary in order to achieve compliance with established safety rules for the machinery and the plant;

- Because of the flammable and explosive cyclo pentane, all machinery and equipment which may come in contact with the chemical or the mix of polyol and cyclo pentane must be encapsulated and explosion-proof;

- To make the foaming jigs and plugs for the cabinets explosion-proof the electrical heating elements have to be replaced by copper tubes in which hot water can circulate. The electric valves and microswitches to be used in connection with the foaming jigs need to be explosion-proof.

- All foaming jigs and plugs must be equipped with a good earth connection to avoid the appearance of static electricity.

C. Refrigeration Service

- DELTA serviced in 1992 about 158,000 refrigerators and freezers. Out of them about 12,000 were recharged, using 0.6 kg CFC 12 each, totalling to 7.2 MT. In the same period about 4,505 compressors were changed, using also about 0.6 kg each, totalling to 2.7 MT. The total quantity of CFC 12 used was abaut 9.9 MT. Out of this quantity it is estimated that through better service technologies 2/3, about 7 MT could gradually be saved in future.
- For DELTA's refrigeration service a central recovery and recycling unit as well as 100 simple mobile recovery units for CFC 12 (one for each of the 37 service cars currently used, plus additional units to be exchanged with the central recovery and recycling unit) will be provided in order to prevent venting of CFC 12 and to reuse it. (The recovery units consist of a metal or plastic case, filled with activated carbon to absorb the remaining CFC 12 from the system. The CFC 12 will later be recovered from the activated carbon at the central recovery and recycling unit.)
- 37 new mobile evacuation and charging boards for HFC 134a for service will also be provided (one each for the service cars currently used).

- Training of DELTA's service personnel in using HFC 134a as well as in CFC 12 recovery and recycling.

D. Justification for Selection of Alternative Technologies

As new refrigerant for domestic refrigerators and freezers all major manufacturers of compressors have chosen HFC 134a as replacement for CFC 12. This means that for the manufacturers of refrigerators and freezers there is for the time being no other option commercially available.

As new blowing agent for the polyurethane foam the situation is quite different. Some manufacturers use:

HCFC 141b with ODP = 0.11
HCFC 142b with ODP = 0.065
HCFC 142b + HCFC 22 with ODP = 0.16
HFC 134a with ODP = 0
Cyclo Pentane with ODP = 0

This means, that the use of HCFC 141b, HCFC 142b and HCFC 142b + HCFC 22 blend could only be accepted as transitional substance for a limited time.

Currently all major European manufacturers are carrying out tests or have already started using cyclo pentane. Therefore, EEAA recommends that the Egyptian manufacturers should introduce an ultimate solution as blowing agent and should not use any transitional substances.

At present HFC 134a is too expensive and, therefore, it is very unlikely that it may become the ultimate blowing agent for polyurethane foam.

INPUTS

1. **Capital Goods Replacement**

The following equipment for DELTA's two plants needs to be rebuilt, replaced, as well as new equipment to be provided as specified below:

A. Refrigeration System

a1.	6 pcs.	HFC 134a charging boards with vacuum pump, leak check as well as refrigerant supply pump;
a2.	6 pcs.	HFC 134a leak detectors;
a3.	2 sets	HFC 134a test equipment (one set for each plant; minimum specification to be added to the existing test equipment);
a4.	1 pce	recovery/recycling unit for CFC 12;
a5.	139 pcs.	existing vacuum pumps cleaned.

B. Foam System

b1.	4 pcs.	existing high pressure foaming machines (2 for cabinets and doors each) have to be ex-proofed;
b2.	3 pcs.	mixing station for cyclo pentane and polyol with daily tank;
b3.	1 set	water heater system for foaming jigs/plugs;
b4.	1 set	gas detector system;
b5.	1 set	exhausting and ventilation system;
b6.	12 sets	foaming jigs/plugs for cabinets (rebuilt);
b7.	2 sets	foaming jigs/plugs for doors (rebuilt);
b8.		floor cover (antistatic);
b9.	3 sets	pipe installation (ex-proof) from mixers to foaming machines;
b10.	1 pce	tank for cyclo pentane with pumps and pipe work;
b11.	1 set	fire protection system;
b12.	1 set	pumps and pipework from tank to mixers;
b13.	1 pce	water chiller for foaming machines.

C. Refrigeration Service

c1.	37 pcs.	HFC 134a mobile evacuation and charging boards;
c2.	100 pcs.	simple CFC 12 recovery units;
c3.	1 pce	recovery/recycling unit for CFC 12.

2. Conversion/Training

Within the framework of this project, technicians from DELTA will be trained in (among others) the following areas:

- management and production control;
- quality control in relation to conversion;
- operation of the new machinery and equipment;
- maintenance of the new machinery and equipment;
- refrigeration laboratory tests;
- new technologies for foam and refrigerant;
- specifications for materials;
- safety regulations for flammable/explosive chemicals;
- refrigeration service.

3. Model Redesign

It is foreseen that for all models redesign and reconstruction are required, followed by the manufacture of some prototypes and refrigeration performance tests.

The model redesign will be carried out by DELTA's staff under the supervision of the Chief Technical Advisor for this project.

As a common practice, modifications of the production lines will be carried out during evenings and off-days and will, therefore, not cause any costs under this project.

PROJECT IMPLEMENTATION

The project implementation will be carried out by UNIDO in close cooperation with DELTA. Necessary local coordination will be done by EEAA.

To substantively assist, coordinate and supervise the project implementation on behalf of UNIDO, a Chief Technical Advisor will be appointed.

For the implementation of major project components (foaming system, refrigeration system, fire protection system, exhausting and ventilation system, etc.) a General Contractor will be appointed by UNIDO and subcontracts will be concluded after competitive bidding. The General Contractor will be responsible for the supply of equipment, installation, commissioning and on-the-job training of DELTA's staff. The detailed Terms of Reference for the services to be provided by the General Contractor and for the subcontracts will be elaborated after project approval.

In order to guarantee a proper transfer and safe operation, in particular of the new foaming technology using the highly flammable and explosive cyclo pentane, the proposed General Contractor will issue an "Operational Safety Statement".[1]

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[1]For negotiations to act as General Contractor, UNIDO has already established contacts with Messrs. POLYFA Trading A.S., DK-2650 Copenhagen-Hvidovre, Denmark.

The final equipment specification, the work plan and, consequently the Operational Safety Statement can only be elaborated after approval of the basic approach for project implementation by the Multilateral Fund for the Implementation of the Montreal Protocol (MFMP).

The permission from the local authorities for the introduction of the new technologies under this project will have to be obtained by DELTA. DELTA will also be responsible for the compliance of the new technologies with established national standards.

Having accepted the conversion of its plants to the use of non-ODS under this project, DELTA will be committed to provide the following inputs:

- All activities and costs involved for construction work needed (including the provision of technical infrastructure) to accommodate the new technologies introduced under this project. The relevant construction work will have to be arranged by DELTA under the supervision of the General Contractor and in line with the established Milestones for this project. (The costs for construction work are, therefore, not reflected in the project budget. The specification for construction work needed will be elaborated by the General Contractor after project approval and necessary site inspection.);
- Technical staff as required by the General Contractor;

- Provision of tools, transportation and lifting equipment as required;

- Local transport, communication and secretarial facilities for the General Contractor's and UNIDO's staff involved in the project's implementation.

UNIDO as Implementing Agency has the necessary experience and capabilities for the successful implementation of projects at enterprise level. Upon the approval by the MFMP, the project's budget will be transferred to UNIDO. The respective project allotment document will then be issued by UNIDO's Finance Section. Any substantive or financial deviation from the approved project is subject to approval by the MFMP and UNIDO.

For the project implementation, milestones are set hereunder:

```
                                      m o n t h
MILESTONES                1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

1.  Sign the project,      X
    receive funding
2.  Appointment of           X
    General Contractor,
    site inspection
3.  Elaboration of a         X
    detailed project
    workplan
4.  Draft of plant           X
    layouts

FOAM: (applic. for NASR CITY plant only)

5. Training                          X       XX
6. Selection of equipment,   XXX
   bidding
7. Rebuild foaming machines                XX
8. Rebuild foam. jigs/plugs                XX
9. Purchase, installation       XXXXXXXXXXXXXX
   commissioning
10. Prototyping & testing                     XX
11. Start production with cyclo pentane        XXXXXXXXXXXXXXXXXXXXXXX

REFRIGERANT

I. (NASR CITY plant and first line of ALMAZA plant)

12. Redesign  of models,      XXX
    training
13. Selection of equipment,   XX
    bidding
14. Purchase, installation      XXXXXXXXXXXX
    commissioning and training
15. Prototyping & testing                   XXXXXXXXXXXX
16. Start production with HFC 134a              XXXXXXXXXXXXXXXXXXXXXX

II. (Second line of ALMAZA plant)

17. Redesign of models,       XXX
    training
18. Selection of equipment,   XX
    bidding
19. Purchase, installation      XXXXXXXXXXXXXXX
    commissioning and training
20. Prototyping & testing                      XXXXXXXXXXXXX
21. Start production with HFC 134a                  XXXXXXXXXXXXXXXXXXX

REFRIGERATION SERVICE

22. Selection of equipment,    XX
    bidding
23. Purchase and training        XXXX
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It is estimated that after 18 months the complete conversion will have been carried out.

PROJECT COSTS

I. INCREMENTAL OPERATING COSTS

The currently produced models will require the following modifications, based on an average European price level:

1. ALMAZA plant:

Modification	Incremental Cost (US$)
HFC 134a compressor	7.60
Capillary tube	0.20
Evaporator/Condenser	0.15
Drier 3 AA	0.03
HFC 134a refrigerant (0,15kg)	0.78
Total US$	8.76[2]

The incremental operating costs for **ALMAZA plant** for the first year of operation are calculated for 141,075 units at US$ 8.76;

total US$ 1,235,817

2. NASR CITY plant:

Modification	Incremental Cost (US$)
HFC 134a compressor	7.40
Capillary tube	0.20
Evaporator/Condenser	0.15
Drier 3 AA	0.03
HFC 134a refrigerant (0.190 kg)	0.99
Cyclo pentane	-0.33
Extra polyurethane foam	2.88
HIPS for innerliner	1.51
Total US$	12.83[2]

The incremental operating costs for **NASR CITY plant** for the first year of operation are calculated for 51,064 units at US$ 12.83;

total US$ 655,151

The above mentioned prices are showing the difference between the component prices for CFC 11 and CFC 12 versus component prices for HFC 134a and cyclo pentane.

The price increase will be caused by:

- compressor plus 8 percent to 10 percent for the new HFC 134a compressor and plus about 10 percent for a 1 size bigger compressor (to cope with the lower capacity at low evaporating temperature, but no heavy duty compressor, coping with

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[2]The above calculation includes the incremental costs for the HFC 134a compressor to be imported. Currently in Egypt the construction of a new HFC compressor plant is ongoing at MCMC. THis project is being supported by the MFMP. According to the rules of the MFMP, either the components manufacturing or the assembling company is eligible to receive incremental cost support. Therefore, as soon as the new HFC 134a compressors from MCMC will become available, Delta is requested to switch to those compressors and to return to all remaining funds received to support the import of modifies compressors to the MFMP.

significant voltage fluctuations), totalling to an average of about 15 to 20 percent;

- capillary tube average 1 m longer;

- evaporator/condenser 2 m longer;

- HFC 134a filling average about 10 percent less compared with CFC 12, 0.15kg for ALMAZA plant at US$ 0.78 and 0.19 kg for NASR CITY plant at US$ 0.99 (based on the price for CFC 12 at US$ 1.88/kg and the current price for HFC 134a at US$ 7.07/kg, excluding any customs tax);

- cyclo pentane at US$ 1.55/kg will be used in a lower quantity as CFC 11 at US$ 1.80/kg;

- for polyurethane foaming about 15 percent more of the complete mix needs to be charged because of the higher density foam (34 to 36 kg/m^3) produced when using cyclo pentane;

- instead of polystyrene (PS) material (US$ 1.5 - 1.75/kg for an acceptable quality for CFC 11 application), HIPS or ABS has to be used for the innerliner (for HIPS the price will be US$ 2.0/kg).

Based on above, the total incremental operating costs for DELTA (ALMAZA plant and NASR CITY plant) for the first year of operation are:

US$ 1,890,968

The required budgets for the incremental operating costs for the years two to four will be calculated at the end of each preceding year and applied for as a revision of this project with the MFMP for funding.

The operating cost of DELTA after the conversion is not expected to change, therefore no incremental cost will be incurred.

Costs for transport and insurance of capital goods are included in the budgeted allocations for the respective items.

Costs for equipment installation, commissioning and on-the-job training of DELTA's staff are calculated separately.

II. CONTINGENCY FUND

A contingency fund (15 percent of the total project budget) was calculated. The MFMP is proposed to cover unforeseen expenses which might be incurred during the project implementation, e.g. purchase of small testing instruments whose needs will be caused during the conversion process, miscellaneous expenses, etc.

III. TOTAL COSTS

- Investment costs will cover capital investment costs (at CIF basis) for modification of manufacturing facilities, materials, new machinery, testing equipment (see Annex A: "Equipment Specification and Cost Breakdown"), training, installation and consultancy services for modifications (see Annex B: "Project Budget for DELTA").
- The incremental operating costs associated with this project are as above.
- Implementing Agency's overhead costs are 13 percent.
- For the complete costs breakdown see Annex B: "Project Budget for DELTA".
- For the calculation of the unit abatement cost see Annex C: "Unit Abatement Cost".
- Requested funding by the MFMP: US$ 4,818,338
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Annex A: Equipment Specification and Cost Breakdown

Description:	Qty.	Unit cost US$	Total cost US$
Almaza:			
Refrigeration System:			
Charging board for production	4	31,300	125,200
Cooling of vacuum pumps for production	100	600	60,000
Leak detectors	4	9,000	36,000
Equipment for test lab+ prototyping for HFC 134a (minimum specification)	1	50,000	50,000
Nasr City:			
Refrigeration System:			
Charging board for production	2	31,300	62,600
Cleaning of vacuum pumps for prod.	39	600	23,400
Leak detector	2	9,000	18,000
Recovery/recycling unit	1	50,000	50,000
Foaming System			
High pressure foaming machine(rebuilt)	4	50,000	200,000
Mixing station	3	80,000	240,000
Water heater system	1 set	50,000	50,000
Gas detecting system	1 set	130,000	130,000
Exhausting & ventilation	1 set	120,000	120,000
Pipe installation from mixers	3 sets	20,000	60,000
Antistatic floor	div.m2	5,000	5,000
Fire protection system	1 set	75,000	75,000
Rebuild foam.jigs/plugs(cabin.)	12 sets	14,000	168,000
Rebuild foam.jigs/plugs(doors)	2 sets	14,000	28,000
Tank for cycle pentane, pumps and pipework	1 set	33,000	33,000
Pumps and pipes from tank to mixers	1 set	46,000	46,000
Equipment for test lab. and prototyping for HFC 134a	1 set	50,000	50,000
Water chiller	1	11,000	11,000
Refrigeration Service			
Evac. & charging board	37	3,000	111,000
Recovery/recycling unit	1	50,000	50,000
Mob.recovery for CFC 12	100	500	50,000
		Total US$	1,852,200

Estimated costs for equipment installation, commissioning, trial operation and on-the-job training of DELTA's staff:

A. Refrigeration System	US$
Two manufacturer's supervisors for 3 weeks on site:	
1. Roundtrip airticket Europe - Cairo at US$ 2,000 each	4,000
2. Fee for 21 days each at US$ 550/day	21,100
3. Daily subsistence allowance for 21 days at US$ 130/day	5,460
Subtotal	32,560
B. Foam System	
1. Two manufacturer's supervisors for 5 weeks each and one engineer for 4 weeks (two missions) on site:	
1.1. Roundtrip airticket Europe - Cairo at US$ 2,000 each x 4	8,000
1.2. Fee for 35 days at US$ 550/day x 2	38,500
1.3. Fee for 28 days at US$ 750/day	21,000
1.4. Daily subsistence allowance for 98 days total at US$ 130/day	12,740
2. Local Subcontract for piping and installation for six weeks at US$ 100/day	10,800
Subtotal	91,040
C. Refrigeration service	
One manufacturer's supervisor for 2 weeks on site:	
1. Roundtrip airticket at US$ 2,000	2,000
2. Fee for 14 days at US$ 550/day	7,700
3. Daily subsistence allowance for 14 days at US$ 130/day	1,820
Subtotal	11,520
Total	135,120

Annex B: Project Budget for Delta

		Duration work months	US$
BL 11-01	Chief Technical Advisor	4.0	50,000
BL 11-51	Consultant for monitoring of project implementation, participation in Project Implementation Review Meetings (2 missions)	0.5	12,000
BL 21-01	Subcontract for provision of General Contractor's services for conversion of DELTA's ALMAZA and NASR CITY plants to the use of non-ODS in refrigerating foam blowing and as refrigerant, in particular: * technical and managerial expertise for foam blowing, using cyclo pentane as foam blowing agent and HFC 134a as refrigerant; * new plant layout for using c.p. and HFC 134a technologies; * equipment supply; * installation and commisioning of equipment; * rebuilding and ex-proofing of equipment; * on-the-job training of DELTA's staff; including: - foaming machines, cabinet/door foaming jigs/plugs, mixing stations, water heater system, water chiller; - antistatic floor; - gas detector systems, fire protection systems; - exhausting and ventilation systems; - pumps, pipework, storage tank; - charging boards, vacuum pumps, leak detectors,recovery and recycling units.		1,987,320
BL 32-01	Study tour for two DELTA technicians to foaming equipment supplier for technical inspection and training purposes	0.5	8,000
BL 32-02	Study tour for two DELTA technicians to supplier of refrigeration equipment for technical inspection and training purposes	0.5	6,200
BL 51-00	Miscellaneous (15 percent Contingency Fund)		309,528
Subtotal I			2,373,048
Incremental operating costs			1,890,968
Subtotal II			4,264,016
Implementing Agency's overheads (13 percent)			554,322
TOTAL		US$	4,818,338

Annex C: Calculation of Unit Abatement Cost

A	ODS Phase out		Total Project
A1	Average use of CFC 11 per year	MT	40
A2	ODP of CFC 11		
A3	ODP-weighted CFC 11 phase (A1*A2)	MT	40
A4	Average use of CFC 12 per year	MT	57
A5	ODP of CFC 12		
A6	ODP weighted CFC 12 phase out (A4*A5)	MT	57
A7	Total ODP-weighted phase out	MT	97
B	Annualized capital cost		
B1	Total investment cost (model redefinition + production conversion)	US$	2,373,048
B2	Equipment life	Year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	386,095
C	Annual incremental operating cost	US$	1,890,968
D	Unit Abatement cost		
D1	Annualized capital cost per kg ODS phased out (B4/A7*1000)	$/kg	3.98
D2	Annual incremental operational cost per kg ODP phased out (C/A7*1000)	$/kg	19.49
D3	Unit abatement cost (D1+D2)	$/kg	23.47

REVIEW EGYPT PROJECTS
DELTA INDUSTRIAL Co.

GENERAL REMARKS

In order to assess the project review it is very important to have more details and the condition of the production facilities e.g.:

type and manufacturer of the foaming stations,
leak test facilities,
charging stations,
vacuum pumps.

If possible, this information should be included in the project review (see also recommendations of the OORG).

PROJECT SUMMARY

The chosen replacement alternatives for the refrigerant CFC12 and the foam blowing agent CFC 11 are the refrigerant HFC134a and cyclo pentane as the foam blowing agent. This solution can be recommended due to the following aspects:

- Long term solution (low GWP, zero ODP)
- Compressors for HFC134a are available from all major suppliers world-wide, at present in Egypt the construction of a new HFC134a compressor plant is under way. All other components such as dryers and oil for the compressors are available on the market.
- Due to its zero ODP and very low GWP the foam blowing agent cyclo pentane is the industrial solution in the major refrigerator companies in Germany and Italy in order to achieve CFC- and HFC-free refrigeration system. Equipment for the foaming system can be modified or replaced from the main suppliers (Germany, Italy).
- Refrigerators with HFC134a as the refrigerant are in production world-wide, refrigerators with cyclo pentane blown foam are already in production in Europe. Experience for construction and production using HFC134a as the refrigerant and cyclo pentane as the blowing agent is available and the technology is mature.

BACKGROUND

SECTOR BACKGROUND

Beside the lack of equipment for the service sector, training programmes are required in order to reduce emission of refrigerants during repair and to avoid moisture problems with HFC134a and the ester-based oil.

Due to expected energy regulations in Egypt in the near future, the impact on energy efficiency should also be considered and design modifications with an increased insulation thickness are important.

DELTA's BACKGROUND

The above mentioned design modifications require test facilities as well as training of the staff for the optimization of the refrigeration system and the insulation. Without these measures, a replacement of ODS in refrigerators with HCF134a and a new foam blowing agent will not lead to reliable refrigerators.

PROJECT OBJECTIVE

PROJECT DESCRIPTION

To phase out ODS in Egypt in the refrigerator sector, hydrocarbons are also a possible alternative, but for Egypt the HCF134a solution should be recommended due to new types of compressors, which will also be produced in Egypt. The necessary production equipment is commercially available or existing equipment can be modified and the technology is mature and commercially applied outside Egypt.

The foam blowing agent cyclo pentane is a long term alternative to avoid transitional substances using H-CFC's as a blowing agent, which have a higher global warming potential (GWP) and ozone depleting potential (ODP).

It is recommended to examine if the insulation thickness is sufficient under the climatic conditions in Egypt.

The present refrigerator design needs to be optimized in order to reduce the energy consumption of the system (Total Equivalent Warming Impact) using HCF134a. The optimization requires test facilities including measurement equipment.

DESCRIPTION OF SERVICING

For servicing refrigerators in field, a vacuum pump (not mentioned in the project cover) and a small filling station are necessary. Combined vacuum and filling systems are also available on the market which should be used either with HCF134a or CFC12. A recovery and recycling unit for service purposes is not recommended, because the amount of refrigerant inside the system is too small for a proper operation of this equipment and this method is not used in Europe. Instead of a recovery and recycling system another cost effective and simple method is recommended, where a small tube filled with activated carbon is connected to the refrigerator and the refrigerant is absorbed by activated carbon (patent AEG Hausgeräte AG, Germany, licences are available). After recovery, the absorbed refrigerant can be recycled using a central recycling station.

For servicing refrigerators at a service station, a recovery unit is recommended instead of the activated carbon system.

Furthermore, leak detectors for the service cars are recommended. Detectors which can detect CFC12 as well as HFC134a are available.

A. Refrigeration System

- The installed charging equipment and the vacuum pumps after some modifications can also be used with HFC134a if the status of the existing equipment allows this measure. For the conversion it is necessary to replace all flexible hoses and sealings of the charging stations with HFC134a approved materials. For the vacuum pumps in the production line only backflow valves should be installed in order to prevent a backflow of oil vapour from the pump to the refrigerator. Modern vacuum pumps have been installed with such a backflow valve.
- For leak testing in the production, different methods can be implemented:
  - helium leak detection systems including a mass spectrometer (best solution but very cost intensive)
  - HFC134a leak detectors (require the system to be filled with HFC134a and after approved leak test the refrigerant has to be removed using a recovery / recycling unit).
- The cleaning procedure for the vacuum pumps cannot be recommended and it is not necessary (installing a backflow valve).
- The time frame for testing and optimization of the refrigerators (capillary tube adaption, establishing new rules for dryness and cleanliness) will take more than 3 weeks. Furthermore, reliability tests over a longer period (at least 2000 h for each model) are recommended in order to confirm the reliabilty of the new models.

- Training programs are recommended for the optimization of the refrigerators and during installation of the new equipment.
- In the absence of national standards for the technical requirement of the components are existing, European or American standards should be used.

B. Foam System

- High pressure foaming machines are used in Europe for cyclopentane as blowing agent. The conversion of these machines to cyclo pentane has been performed in Germany and Italy.
- The safety aspects using cyclo pentane as a blowing agent are influenced by the installed equipment, e.g. stationary foaming stations or caroussel systems. In Germany ex-proofed systems are **n o t** required, if a sufficient ventilation system is installed around the foaming equipment and gas detectors are installed, which switch offf the system in case of higher concentrations. Antistatic material is also not necessary, a detailed description of accepted and approved measures is available from the manufacturers of the foaming maschines.
- It is recommended due to safety aspects, that the cavity is rendered inert before foaming; this measure is laid down in Germany and recommended by Hennecke. In case of applying inertizing and switching off the electic heaters before injection, an installation of a water system for heating is not necessary for safety reasons.
- Furthermore, a training for the technical staff controlling and maintaining the saftety devices relating to the foaming stations is necessary, the safety standards should be similar to European standards.
- For checking the new foaming chemicals and the foam quality, tests should be performed in cooperation with the suppliers of the machines and the distributors of the chemicals during installation. Further tests with refrigerators should be performed in order to measure the heat loss as a function of time, the foam distribution inside the housing etc. and other measures which are important for a proper quality. Detailed investigations of the foam should be performed by external institutions.

C. Refrigeration Service

- The amount of CFC12 in the failed system is too low and therefore proper operation of the recovery unit is not possible. For recovery of CFC12 it is recommended to use simple tools which are more cost effective and in use in Germany instead of expensive recovery units (cylinders filled with activated carbon). Therefore a central recycling station (model which can handle CFC12 and HFC134a) is recommended including testequipment for the refrigerant quality.

- One vacuum pump, one charging cylinder and a leak detector (model which can handle CFC12 and HFC134a) are necessary for the evacuation, charging and leak detection of the system for each of the 25 service cars.

D. Justification for Selection of alternative Technologies

Beside HFC134a, hydrocarbons are alternative refrigerants for household applications. Hydrocarbons have the environmental advantage of a low GWP compared with HFC134a, but the incremental costs are higher because new compressors are necessary (e.g. higher swept volume for isobutane) and additional safety equipment in the production line is required. Today compressors for hydrocarbons are not commercially available.

Cyclo pentane as a blowing agent for the foam is a long term solution. Another ODP-free solution for the foam blowing agent could be HFC134a, but in comparison with cyclo pentane it is more expensive and high pressure foaming stations are required. All other technical options are transitional substances because they are not ODP-free or under investigations and not approved at present (e.g. CO_2).

INPUTS

1. Capital Goods Replacement

A. Refrigeration System

- 25 pcs. leak detectors for service cars (for CFC12 and HFC134a)
- 1 pcs. recovery / recycling unit at each production line for HFC134a after leak test
- 100 pcs. of recovery systems for service cars (activated carbon systems).

B. Foam System

- ex-proofed systems not necessary if an adaquate ventilation system is installed
- water heaters not required if electric heaters are switched off before injection
- 1 set gas detector system for each foaming station including electronic control
- foam test equipment has to be specified (cooperation with foam / system suppliers)
- floor cover not necessary
- 1 fire protection system for each foaming machine
- compressor cooler should be specified

2. Conversion / Training

- all measures are recommended

3. Model Redesign

- modifications at the production lines will cause losses in regular production due to problems during the new installation and the necessary test phase, if these measures are performed in parallel; therefore a stepwise modification is recommended.

PROJECT IMPLEMENTATION

MILESTONES

The foam and refrigerant technology should be changed stepwise at the parallel production lines in order to solve initial problems during production and to transfer the experience to the other production lines. In this case, failures and problems will not lead to a total breakdown of the production lines.

Furthermore, design changes (e.g. increase of the insulation thickness, heat exchangers etc.) require modifications of the housing and the inner liner. These modifications are not mentioned in the time frame, therefore the time frame for redesign of the models including equipment changes in the production line should be enlarged.

PROJECT COSTS

The recommended measures in this review effect also the cost statement of the project. Without having any detailed information about the equipment which is suggested in the project proposal for the modification of the production lines and the service sector, it is not possible to value these.

ANNEX D : Cleaning Technologies for Vacuum Pumps

The cleaning procedure for vacuum pumps is not recommended.

PROJECT COVER

Country	: Egypt
Project Title	: **Investment Project for Phasing out CFCs at ELECTROSTAR for REFRIGERATION Co.**
Sector Covered	: Domestic Refrigeration / Rigid Foams / Refrigerant.
ODS Used in Sector (1990)	: 1,830 tons of CFC 11 and CFC 12
Project Impact	: Phase out of annual consumption of 30 MT CFC 11, 14 MT CFC 12 in the production and a gradual phase out of currently used 2 MT CFC 12 in the service sector (Total ODP = 46 MT)
Project Duration	: 18 months
Project Economic Life	: 10 years
Total Proposed Project Cost	: Total of capital cost and operating : incremental cost (first year of operation) US$ 1,969,190
Project Cost	: US$ 1,429,910
Implementing Agency's Overheads (13%)	: US$ 255,995
Incremental Operating Costs/Year	: US$ 539,280 (first year of operation)
Proposed MF Financing	: US$ 2,225,185
Cost Effectiveness	: See Annex C: Unit Abatement Cost
Counterpart Enterprise	: ELECTROSTAR FOR REFRIGERATION Co., 6th of October City.
Implementing Agency	: United Nations Industrial Development Organization (UNIDO)
Coordinating Ministry	: Egyptian Environmental Affairs Agency (EEAA)

PROJECT SUMMARY

This project will phase out 100 percent of the use of CFC 11 and CFC 12 for the production of domestic refrigerators and freezers at ELECTROSTAR FOR REFRIGERATION Co.. The chosen replacement alternatives are cyclo pentane as foam blowing agent and HFC 134a as refrigerant. The project will include the redesign of all current refrigerator models and the conversion of the plant.

The redesign of the existing refrigerator models covers activities like prototyping, testing, trial manufacturing and adaptation, as well as reliability tests. The conversion of the production facilities covers the refrigeration system, insulation foam blowing system as well as the refrigeration service carried out by the company. The replacement alternatives and the time frame for phasing out the use of ODS will be in line with EEAA's ODS phase out programme.
Date: 1 February 1994.

BACKGROUND

SECTOR BACKGROUND

The subsector for domestic refrigerators and freezers in Egypt consists of 9 manufacturers of which four to five companies share some 80 percent of the total ODS consumption of CFC 11 and CFC 12.

Egypt does not produce any ODS. All ODS used in the country are directly imported by the users. In 1990 the total consumption was 1,830 MT of ODS.

The total installed production capacity for refrigerators and freezers is about 1,000,000 units per year, but the present production is only about 525,000 units per year. The manufacturers expect an increase of about 10 percent per year.

In total about 7,000,000 refrigerators and freezers are in use in Egypt, of which annually about 10 percent will be recharged during refrigeration service with new CFC 12, equally to about 350 MT of CFC 12.

Because of lack of environmental awareness, know-how and equipment in the service sector, service staff very often use CFC 12 for washing/flushing of the cooling systems, instead of using vacuum pumps and charging boards. This causes a 100 percent to 200 percent higher CFC 12 consumption in the service sector, estimated at about 350 MT.

Currently no Egyptian company manufactures low energy consumption refrigerators and freezers with an insolation thickness of 40 to 50 mm for refrigerators and 90 to 100 mm for frezers; however, the introduction of a limit for maximum energy consumption could be expected in the near future.

ELECTROSTAR's BACKGROUND

ELECTROSTAR FOR REFRIGERATION Co. (ELECTROSTAR), is a private company and one of the five largest manufacturers of domestic refrigerators and freezers. It employs 175 staff and the installed annual production capacity is about 52,500 units. Between September 1992 and September 1993 the actual production was 42,000 units. ELECTROSTAR expects an increase of 10 percent for each of the next 4 years because of the introduction of 5 newly developed no-frost refrigerators as well as redesign of the current models.

In 1993 ELECTROSTAR used about 30 MT of CFC 11 and 14 MT of CFC 12 in the production process and 2 MT of CFC 12 in the refrigeration service.

Based on the installed capacity the budget for 1994 was made for 20,000 units of the 3 models fridge/freezers with two-doors, 15,000 units of the 3 models of refrigerators with one door, 10,000 units of 4 models of upright freezers, 13,000 units of 3 models of new no-frost fridge/freezer and freezers, 3,000 units of new defrost fridge/freezers as well as hotel absorption refrigerators, totalling to about 62,000 units.

ELECTROSTAR covers a share of about 8 to 10 percent of the local market; less than 2 percent of the units produced are being exported to Libya.

The technologies and know-how currently applied were imported from Zanussi/Italy, Electrolux/Sweden, Derby/Denmark and National/Japan.

ELECTROSTAR is currently running three separate production lines for foaming. This will be reduced to two lines in future. The company has no refrigerator design capabilities and no refrigeration performance test laboratory facilities. For this purpose, contacts have been established with NATIONAL/Japan to receive assistance in the redesign of refrigerators and in performance tests.

More detailed information on the current plant layout and the production equipment employed, as well as on the proposed new layout is shown in Annex D: "Current and proposed new plant layout".

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of ODS such as CFC 11 and CFC 12 in the production of domestic refrigerators and freezers and in the refrigeration service at ELECTROSTAR through conversion to the use of HFC 134a as refrigerant for the cooling system and cyclo pentane as blowing agent for the polyurethane insulation foam.

PROJECT DESCRIPTION

ELECTROSTAR is prepared to phase out ODS as soon as the new technologies have been acquired, the necessary machinery and equipment installed and the technical staff trained.

Among the technological options currently available on commercial basis and in line with the established policy of the Government of Egypt to phase out the use of ODS, ELECTROSTAR has chosen to replace CFC 12 by HFC 134a, because the new type compressors are available and the technology is mature and commercially applied outside Egypt.

As blowing agent for polyurethane foam ELECTROSTAR decided to avoid the application of any transitional substance and to introduce as ultimate solution cyclo pentane.

Through the project assistance will be provided in:

a. Procurement of new machinery and equipment;

b. Rebuilding of currently used machinery and equipment wherever technically and economically feasible;

c. Redesign, reconstruction, prototype manufacturing and testing of refrigerators and freezers;

d. Installation, commissioning, trial operation, start-up and on-the-job training

e. Servicing.

The following machinery and equipment need to be rebuilt, replaced or added:

A. Refrigeration system

- The charging equipment must only be used for HFC 134a and in meeting the demand for cleaner and dryer cooling systems the existing charging system has to be replaced, including vacuum control.
- The charging boards have to be replaced by boards suitable for HFC 134a.
- Because the leak detectors react on Cl molecules, they need to be replaced.
- The currently used vacuum pumps, after being cleaned can also be used for HFC 134a.

- To optimize the cooling system for the application of HFC 134a and the new specification of components used, performance tests for each model of refrigerator and freezer are needed. Therefore, a minimum specification of refrigeration test equipment needs to be provided to be added to already existing test equipment which can also be used for the new technology.

- To improve the performance of the cooling system and compensate for a little lower polyurethane insulation value due to the conversion to HFC 134a as the new refrigerant and cyclo pentane for the foam, it is necessary to optimize the cooling system as well as the energy consumption to keep an acceptable TEWI value. Therefore , it is necessary to redesign, reconstruct and carry out performance tests for all models of refrigerators and freezers.

- The technical requirements for components such as tubes, condensers, evaporators, capillary tubes, heat exchangers, compressors and suction accumulators have to be in line with established standards like DIN 8964, i.e. new rules for dryness and cleanliness need to be applied.

- The drier has to be equipped with 3AA desiccant molecular sieves.

- The cooling system must not contain any chlorine and max. 1 percent non-condensable gases.

- The capillary tube has to be optimized for an increased resistance at low evaporating temperatures.

- It will be necessary to train ELECTROSTAR's technicians at the equipment suppliers place in new foaming technology as well as in design/ calculation and performance testing of cooling systems. During the installation and run-in of the new machinery and equipment the suppliers engineers will have to train ELECTROSTAR's technical staff. UNIDO will elaborate the training programmes and arrange the training.

B. Foam System

- In order to achieve an acceptable foam quality and insulation value at lowest price, high pressure foaming machines need to be introduced and ex-proofed.

- Since cyclo pentane and polyol cannot be delivered premixed in drums or tanks (as CFC 11) it is necessary to provide mixing stations.

- For work safety when using the highly flammable and explosive cyclo pentane and in order to meet the relevant requirements of the local authorities, it is recommended to have a gas detector system as well as a fire protection system installed in the foaming department

- It is necessary to provide one tank for polyol, one for cyclo pentane and one tank for isocyanate to automatically deliver the components to the mixing stations .

- To make the foaming jigs explosion-proof, it is necessary to replace their electrical heating elements by a water heating system.(A cheaper option would be to automatically disconnect the existing electrical heating just before foam injection, using the control system of the foaming machine and a timer. For the sake of high operational safety it is, however, recommended to apply the water heater option.)

- The workers' clothes and shoes have to be made of antistatic material and the floor need to be covered with an antistatic paint.

- The provision and installation of an exhausting and ventilation system in the foaming department is necessary in order to achieve compliance with established safety rules for the machinery and the plant.

- Because of the flammable and explosive cyclo pentane all machinery and equipment which may come in contact with the chemical or the mix of polyol and cyclo pentane must be explosion-proof.

- The electrical heating elements in the foaming jigs have to be replaced by copper tubes in which hot water can circulate to make them explosion-proof. The foaming inner mould plugs need partially to be replaced/ rebuilt by the use of aluminium sheets to guarantee a constant temperature at the inner foam plug.

- All foaming jigs and plugs must be equipped with a good earth connection to avoid the appearance of static electricity.

C. Refrigeration Service

- For ELECTROSTAR's refrigeration service a central recovery and recycling unit as well as 50 simple mobile recovery units (one for each of the service cars currently used) for CFC 12 will be provided in order to prevent venting of CFC 12 and to reuse the CFC 12. (The recovery units consist of a metal or plastic case, filled with activated carbon to absorb the remaining CFC 12 from the systems. The CFC 12 will later be recovered from the activated carbon at the central recovery and recycling unit.)

- Fifteen new mobile evacuation and charging boards for HFC 134a for service will also be provided (one each for the service cars currently used).

- Training of Electrostar's service personnel in using HFC 134a as well as in CFC 12 recovery and recycling.

D. Justification for Selection of Alternative Technologies

As new refrigerant for domestic refrigerators and freezers all major manufacturers of compressors have accepted to use HFC 134a as replacement for CFC 12. This means that for the manufacturers of refrigerators and freezers there is for the time being no other option commercially available.

As new blowing agent for the polyurethane foam the situation is quite different. Some manufacturers use:

HCFC 141b with ODP = 0.11
HCFC 142b with ODP = 0.065
HCFC 142b + HCFC22 with ODP = 0.06
HFC 134a with ODP = 0
Cyclo Pentane with ODP = 0

This means that the use of HCFC 141b, HCFC 142b and HCFC 142b + HCFC 22 blend will only be accepted as transitional substance for a limited time.

Currently all major European manufacturers are carrying out tests or have already started using cyclo pentane. Therefore, EEAA recommends that the Egyptian manufacturers should introduce an ultimate solution as blowing agent and should not use any transitional substances.

At present HFC 134a is too expensive and, therefore, it is very unlikely that it may become the ultimate blowing agent for polyurethane foam.

INPUTS

1. **Capital Goods Replacement**

The following equipment needs to be rebuilt, replaced, as well as new equipment to be provided as specified below:

A. Refrigeration System

a1.	3 pcs.	HFC 134a refrigerant charging boards with vacuum pump, refrigerant supply pump and leak check;
a2.	5 pcs.	existing vacuum pumps cleaned;
a3.	3 pcs.	HFC 134a leak detectors;
a4.	1 set	HFC 134a test equipment (minimum specification to be added to the existing test equipment);
a5.	1 pce	recovery/recycling unit for CFC 12;

B. Foam System

b1.	1 pce	high pressure foaming machine with two heads for cabinets ex-proofed to be used for cyclo pentane);
b2.	1 pce	high pressure foaming machine with two heads for doors ex-proofed to be used for cyclo pentane);
b3.	2 pcs.	mixing stations for cyclo pentane and polyol with daily tank;
b4.	1 set	water heater system for foaming jigs/plugs;
b5.	1 set	gas detector system;
b6.	1 set	exhausting and ventilation system;
b7.	7 pcs.	foaming jigs (rebuilt);
b8.	11 sets	foaming plugs (rebuilt);
b9.		floor cover antistatic;
b10.	2 sets	pipe installation (ex-proof) from mixers to foaming machines;
b11.	1 set	fire protection system;
b12.	1 pce	tank for cyclo pentane with pumps and pipework;
b13.	1 pce	pumps and pipework from tank to mixers;
b14.	1 pce	water chiller for foaming machine.

C. Refrigeration Service

c1.	15 pcs.	HFC 134a mobile evacuation and charging boards;
c2.	14 pcs.	simple CFC 12 recovery units.

2. **Conversion/Training**

Within the framework of the project, personnel from ELECTROSTAR will be trained (among others) in the following areas:

- management and production control;
- quality control in relation to conversion;
- operation of the new machinery and equipment;
- maintenance of the new machinery and equipment;
- refrigeration laboratory tests;
- new technologies for foam and refrigerant;
- specifications for material;
- safety regulations for flammable/explosive chemicals;
- refrigeration service.

3. **Model Redesign**

It is foreseen that for all models redesign and reconstruction are required, followed by the manufacture of some prototypes and refrigeration performance tests.

The model redesign will be carried out by ELECTROSTAR's staff under the supervision of the Chief Technical Advisor for this project.

As a common practice, modifications of the production lines will be carried out during evenings and off-days and will, therefore, not cause any costs under this project.

PROJECT IMPLEMENTATION

The project implementation will be carried out by UNIDO in close cooperation with ELECTROSTAR.

Necessary local coordination will be done by EEAA.

To substantively assist, coordinate and supervise the project implementation on behalf of UNIDO, a Chief Technical Advisor will be appointed.

For the implementation of major project components (foaming system, refrigeration system, fire protection system, exhausting and ventilation system, etc.) a General Contractor will be appointed by UNIDO and subcontracts will be concluded after competitive bidding. The General Contractor will be responsible for the supply of equipment, installation, commissioning and on-the-job training of ELECTROSTAR's staff. The detailed Terms of Reference for the services to be provided by the General Contractor and for the subcontracts will be elaborated after project approval.

In order to guarantee a proper transfer and a safe operation, in particular of the new foaming technology using the highly flammable and explosive cyclo pentane, the proposed General contractor will issue an "Operational Safety Statement".[1]

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[1]For negotiations to act as Gerneral Contractor, UNIDO has already established contacts with Messrs. POLYFA Trading, DK-2650 Copenhagen-Hvidovre, Denmark.

The final equipment specification, the work plan and, consequently the Operational Safety Statement can only be elaborated after approval of the basic approach for the project implementation by the Multilateral Fund for the Implementation of the Montreal Protocol (MFMP).

The permission from the local authorities for the introduction of the new technologies under this project will have to be obtained by ELECTROSTAR. ELECTROSTAR will also be responsible for the compliance of the new technologies with established national standards.

Having accepted the conversion of its plant to the use of non-ODS under this project, ELECTROSTAR will be committed to provide the following inputs:

- All activities and costs involved for construction work needed (including the provision of technical infrastructure) to accommodate the new technologies introduced under this project. The relevant construction work will have to be arranged by ELECTROSTAR under the supervision of the General Contractor and in line with the established Milestones for this project. (The costs for construction work are, therefore, not reflected in the project budget. The specification for construction work needed will be elaborated by the General Contractor after project approval and necessary site inspection.);

- Technical staff as required by the General Contractor;

- Provision of tools, transportation and lifting equipment as required;

- Local transport, communication and secretarial facilities for the General Contractor's and UNIDO's staff involved in the project's implementation.

UNIDO as Implementing Agency has the necessary experience and capabilities for the successful implementation of projects at enterprise level. Upon approval by the MFMP, the project's budget will be transferred to UNIDO. The respective project allotment document will then be issued by UNIDO's Finance Section. Any substantive or financial deviation from the approved project will be subject to approval by the MFMP and UNIDO.

For the project implementation, milestones are set hereunder.

MILESTONES	month 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
1. Sign the project, receive funding.	X
2. Appointment of General Contractor, site inspection	X
3. Elaboration of a detailed project workplan	X
4. Draft of plant layout	X
FOAM	
4. Selection of equipment, bidding	XXX
5. Training	X XX
6. Rebuild jigs+plugs	XXXXXXXXXXXXXXX
7. Purchase, installation, commissioning	XXXXXXXXXXXXXXX
8. Prototyping and testing	XX
9. Start production with cyclo pentane	XXXXXXXXXXXXXXXXXXXX
REFRIGERANT	
10. Redesign of models, training	XXXX
11. Selection of equipment, bidding	XX
12. Purchase, installation and commissioning	XXXXXXXXXXX
13. Prototyping and testing	XXXXXXXXXXXXXXXXXXXXXXXX
14. Start production with HFC 134a	XXXXXXXXXXXXXXXXXXXXXXXXX
REFRIGERATION SERVICE	
15. Selection of equipment, bidding	XX
16. Purchase and training	XXX

It is estimated that after 18 months the complete conversion will have been carried out.

PROJECT COSTS

I. INCREMENTAL OPERATING COSTS

The currently produced models will require the following modifications, based on an average European price level:

Modification	Incremental cost (US$)
HFC 134a compressor	7.52
Capillary tube modification	0.20
Evaporator modification	0.15
3 AA drier	0.03
HFC 134a refrigerant	1.45
Cyclo pentane	-0.34
Extra polyurethane foam	2.34
HIPS for inner liner	1.51
Total	US$ 12.84[1]

The above mentioned prices are showing the difference between the component prices for CFC 11 and CFC 12 versus component prices for HFC 134a and cyclo pentane.

The price increase will be caused by:

- compressor plus 8 percent to 10 percent for the new HFC 134a compressor and plus about 10 percent for a 1 size bigger compressor (to cope with the lower capacity at low evaporating temperature, but no heavy duty compressor, coping with significant voltage fluctuations), averaging to about 15 to 20 percent.
- capillary tube average 1 m longer;
- evaporator average 2 m longer for freezers, calculated for 33 percent of total production;
- HFC 134a filling average about 10 percent less compared with CFC 12, 0.25 kg at US$ 1.45/kg; (based on the price for CFC 12 at US$ 1.88/kg and a current price for HFC 134a at US$ 7.07/kg, excluding any customs tax);
- cyclo pentane at US$ 1.55/kg will be used in a lower quantity as CFC 11 at US$ 1.80/kg;
- for polyurethane foaming about 15 percent more of the complete mix needs to be charged because of the higher foam density (34 to 36kg/m^3) produced when using cyclo pentane;
- instead of the polystyrene (PS) material (US$ 1.5 - 1.75/kg for an acceptable quality for CFC 11 application), HIPS or ABS

[1] The above calculation includes the incremental costs for the HFC 134a compressor to be imported. Currently in Egypt the construction of a new compressor plant is ongoing at MCMC. This project is being supported by the MFMP. According to the rules of the MFMP, either the components manufacturing or the assembling company is eligible to receive incremental cost support. Therefore, as soon as the new compressors from MCMC will become available, ELECTROSTAR is requested to switch to those compressors and to return all remaining funds received to support the import of modified compressors to the MFMP.

has to be used for the innerliner (for HIPS the price will be US$ 2.0/kg)

Based on the above calculation the incremental operating costs for the first year of operation are calculated for 42,000 units at US$ 12.84 are

totalling to **US$ 539,280**

The required budgets for the incremental operating costs for the years two to four will be calculated at the end of each preceding year and applied as a revision of this project with the MFMP for funding.

The operating cost of ELECTROSTAR after the conversion is not expected to change, therefore no incremental cost will be incurred.

Costs for transport and insurance of capital equipment are included in the budgeted allocations for the respective items. Costs for equipment installation, commissioning and on-the-job training of ELECTROSTAR's staff are calculated separately.

II. CONTINGENCY FUND

A contingency fund (15 percent of the total budget) was calculated. The MFMP is proposed to cover unforseen expenses which might be incurred during the project implementation, e.g. purchase of small testing instruments whose needs will be caused during the conversion process, miscellaneous expenses, etc.

III. TOTAL COSTS

- Investment cost will cover capital investment costs (at CIF basis) for modification of manufacturing facilities, new machinery, materials, testing equipment, (see Annex A: "Equipment Specification and Cost Breakdown"), training, installation and consultancy services for modifications (see Annex B: Project Budget for ELECTROSTAR")
- The net incremental recurring operating costs associated with this project are as above.
- Implementing Agency's overhead costs are 13 percent.
- For the complete cost breakdown see Annex B: "Project Budget for ELECTROSTAR".
- For the calculation of the unit abatement cost see Annex C: "Unit Abatement Cost".
- Requested funding by the MFMP: US$ 2.225,185

Annex A: Equipment Specification and Cost Breakdown

Description	Qty.	Unit cost US$	Total cost US$
Refrigeration System			
Charging board	3	31,300	93,900
Vacuum pump (cleaned)	5	600	3,000
Leak detector	3	9,000	27,000
Equipment for test lab + prototyping for HFC 134a (minimum specification)	1	50,000	50,000
Recovery & recycling unit	1	50,000	50,000
Foaming System			
High press.foam mach.(cab.)	1	160,000	160,000
High press.foam mach.(doors)	1	110,000	110,000
Mixing station	2	80,000	160,000
Water heating system	1	15,000	15,000
Gas detecting system	1	75,000	75,000
Exhausting and ventilation	1 set	45,000	45,000
Rebuilding of foam jigs	7	4,500	31,500
Rebuilding of foam plugs	11 set	5,000	55,000
Antistatic floor	m^2	3,000	3,000
Pipe installation for 2 mc.	2	15,000	30,000
Tank for c.p.,pumps,pipework	1	33,000	33,000
Fire protection system	1 set	30,000	30,000
Pumps, pipework from tank to mixers	1 set	45,000	45,000
Water chiller	1	11,000	11,000
Refrigeration Service			
Mob.Evac.& Charg. board	15	3,000	45,000
Mobile recovery unit for CFC 12	50	500	25,000
		Total US$	1,097,400

Estimated costs for equipment installation, commissioning, trial operation and on-the-job training of ELECTROSTAR's staff:

A. Refrigeration System

		US$
One manufacturer's supervisor for 2 weeks on site:		
1.	Roundtrip airticket Europe - Cairo at US$ 2,000	2,000
2.	Fee for 14 days at US$ 550/day	7,700
3.	Daily Subsistence allowance for 14 days at US$ 130/day	1,820
	Subtotal	11,520

B. Foam System

1.	Two manufacturer's supervisors for 3 weeks each and one engineer for 1 week on site:	
1.1.	Roundtrip airticket Europe - Cairo at US$ 2,000 each x 3	6,000
1.2.	Fee for 21 days at US$ 550/day x 2	23,100
1.3.	Fee for 7 days at US$ 750/day	5,250
1.4.	Daily subsistence allowance for 49 days total at US$ 130/day	6,370
2.	Local Subcontract for piping and installation for 6 weeks at US$ 100/day	10,800
	Subtotal	51,520

C. Refrigeration Service

One manufacturer's supervisor for 1 week on site:		
1.	Roundtrip airticket at US$ 2,000	2,000
2.	Fee for 7 days at US$ 550/day	3,850
3.	Daily subsistence allowance for 7 days at US$ 130/day	910
	Subtotal	6,760
	Total	69,800

Annex B: Project Budget for ELECTROSTAR

		Duration work months	US$
BL 11-01	Chief Technical Advisor	4.0	50,000
BL 11-51	Consultant for monitoring of project implementation, participation in Review Meetings (2 missions)	0.5	12,000
BL 21-01	Subcontract for provision of General Contractor's services for conversion of ELECTROSTAR's plant to the use of non-ODS in refrigerating foam blowing and as refrigerant, in particular: * technical and managerial expertise for foam blowing, using cyclo pentane as foam blowing agent and HFC 134a as refrigerant; * new plant layout for using c.p. and HFC 134a technologies; * equipment supply; * installation and commissioning of equipment; * rebuilding and ex-proofing of equipment; * on-the-job training of ELECTROSTAR's staff; including: - foaming machines, cabinet/door foaming jigs/plugs,mixing stations, water heating systems, water chiller, - antistatic floor; - gas detecting systems, fire protection systems; - exhausting and ventilation systems; - pumps, pipework, storage tank; - charging boards, vacuum pumps, leak detectors, recovery and recycling units.		1,167,200
BL 32-01	Study tour for two ELECTROSTAR technicians to foaming equipment supplier for technical inspection and training purposes	0.5	8,000
BL 32-02	Study tour for one ELECTROSTAR technician to supplier of refrigeration equipment for technical inspection and training purposes	0.5	6,200
BL 51.00	Miscellaneous (15 percent Contingency Fund)		186,510
Subtotal I			1,429,910
Incremental operating costs			539,280
Subtotal II			1,969,190
Implementing Agency's Overheads (13 percent)			255,995
TOTAL		US$	2,225,185

Annex C: Calculation of Unit Abatement Cost

A	ODS Phase out		Total Project
A1	Average use of CFC 11 per year	MT	30
A2	ODP of CFC 11		1
A3	ODP-weighted CFC 11 phase (A1*A2)	MT	30
A4	Average use of CFC 12 per year	MT	16
A5	ODP of CFC 12		1
A6	ODP weighted CFC 12 phase out (A4*A5)	MT	16
A7	Total ODP-weighted phase out	MT	46
B	Annualized capital cost		
B1	Total investment cost (model redefinition + production conversion)	US$	1,429,910
B2	Equipment life	Year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	232,647
C	Annual incremental operating cost	US$	539,280
D	Unit Abatement cost		
D1	Annualized capital cost per kg ODS phased out (B4/A7*1000)	$/kg	5.06
D2	Annual incremental recurrent cost per kg ODP phased out (C/A7*1000)	$/kg	11.72
D3	Unit abatement cost (D1+D2)	$/kg	16.78

REVIEW EGYPT PROJECTS
ELECTROSTAR for RFRIGERATION Co.

GENERAL REMARKS

In order to assess the project review it is very important to have more details and the condition of the production facilities e.g.:

type and manufacturer of the foaming stations,
leak test facilities,
charging stations,
vacuum pumps.

If possible, this information should be included in the project review (see also recommendations of the OORG).

PROJECT SUMMARY

The chosen replacement alternatives for the refrigerant CFC12 and the foam blowing agent CFC 11 are the refrigerant HFC134a and cyclo pentane as the foam blowing agent. This solution can be recommended due to the following aspects:

- Long term solution (low GWP, zero ODP)
- Compressors for HFC134a are available from all major suppliers world-wide, at present in Egypt the construction of a new HFC134a compressor plant is under way. All other components such as dryers and oil for the compressors are available on the market.
- Due to its zero ODP and very low GWP the foam blowing agent cyclo pentane is the industrial solution in the major refrigerator companies in Germany and Italy in order to achieve CFC- and HFC-free refrigeration system. Equipment for the foaming system can be modified or replaced from the main suppliers (Germany, Italy).
- Refrigerators with HFC134a as the refrigerant are in production world-wide, refrigerators with cyclo pentane blown foam are already in production in Europe. Experience for construction and production using HFC134a as the refrigerant and cyclo pentane as the blowing agent is available and the technology is mature.

BACKGROUND

SECTOR BACKGROUND

Beside the lack of equipment for the service sector, training programmes are required in order to reduce emission of refrigerants during repair and to avoid moisture problems with HFC134a and the ester-based oil.

Due to expected energy regulations in Egypt in the near future, the impact on energy efficiency should also be considered and design modifications with an increased insulation thickness are important.

ELECTROSTAR's BACKGROUND

The above mentioned design modifications require test facilities as well as training of the staff for the optimization of the refrigeration system and the insulation. Without these measures, a replacement of ODS in refrigerators with HCF134a and a new foam blowing agent will not lead to reliable refrigerators.

PROJECT OBJECTIVE

PROJECT DESCRIPTION

To phase out ODS in Egypt in the refrigerator sector, hydrocarbons are also a possible alternative, but for Egypt the HCF134a solution should be recommended due to new types of compressors, which will also be produced in Egypt. The necessary production equipment is commercially available or existing equipment can be modified and the technology is mature and commercially applied outside Egypt.

The foam blowing agent cyclo pentane is a long term alternative to avoid transitional substances using H-CFC's as a blowing agent, which have a higher global warming potential (GWP) and ozone depleting potential (ODP).

It is recommended to examine if the insulation thickness is sufficient under the climatic conditions in Egypt.

The present refrigerator design needs to be optimized in order to reduce the energy consumption of the system (Total Equivalent Warming Impact) using HCF134a. The optimization requires test facilities including measurement equipment.

DESCRIPTION OF SERVICING

For servicing refrigerators in field, a vacuum pump (not mentioned in the project cover) and a small filling station are necessary. Combined vacuum and filling systems are also available on the market which should be used either with HCF134a or CFC12. A recovery and recycling unit for service purposes is not recommended, because the amount of refrigerant inside the system is too small for a proper operation of this equipment and this method is not used in Europe. Instead of a recovery and recycling system another cost effective and simple method is recommended, where a small tube filled with activated carbon is connected to the refrigerator and the refrigerant is absorbed by activated carbon (patent AEG Hausgeräte AG, Germany, licences are available). After recovery, the absorbed refrigerant can be recycled using a central recycling station.

For servicing refrigerators at a service station, a recovery unit is recommended instead of the activated carbon system.

Furthermore, leak detectors for the service cars are recommended. Detectors which can detect CFC12 as well as HFC134a are available.

A. Refrigeration System

- The installed charging equipment and the vacuum pumps after some modifications can also be used with HFC134a if the status of the existing equipment allows this measure. For the conversion it is necessary to replace all flexible hoses and sealings of the charging stations with HFC134a approved materials. For the vacuum pumps in the production line only backflow valves should be installed in order to prevent a backflow of oil vapour from the pump to the refrigerator. Modern vacuum pumps have been installed with such a backflow valve.
- For leak testing in the production, different methods can be implemented:
  - helium leak detection systems including a mass spectrometer (best solution but very cost intensive)
  - HFC134a leak detectors (require the system to be filled with HFC134a and after approved leak test the refrigerant has to be removed using a recovery / recycling unit).
- The cleaning procedure for the vacuum pumps cannot be recommended and it is not necessary (installing a backflow valve).
- The time frame for testing and optimization of the refrigerators (capillary tube adaption, establishing new rules for dryness and cleanliness) will take more than 3 weeks. Furthermore, reliability tests over a longer period (at least 2000 h for each model) are recommended in order to confirm the reliabilty of the new models.

- Training programs are recommended for the optimization of the refrigerators and during installation of the new equipment.
- In the absence of national standards for the technical requirement of the components are existing, European or American standards should be used.

B. Foam System

- High pressure foaming machines are used in Europe for cyclopentane as blowing agent, low pressure foaming machines can also be modified for cyclopentane (e.g. CANNON, at present no information about modified low pressure foaming machines for cyclo pentane is available).
- The safety aspects using cyclo pentane as a blowing agent are influenced by the installed equipment, e.g. stationary foaming stations or caroussel systems. In Germany ex-proofed systems are **n o t** required, if a sufficient ventilation system is installed around the foaming equipment and gas detectors are installed, which switch offf the system in case of higher concentrations. Antistatic material is also not necessary, a detailed description of accepted and approved measures is available from the manufacturers of the foaming maschines.
- It is recommended due to safety aspects, that the cavity is rendered inert before foaming; this measure is laid down in Germany and recommended by Hennecke. In case of applying inertizing and switching off the electic heaters before injection, an installation of a water system for heating is not necessary for safety reasons.
- Furthermore, a training for the technical staff controlling and maintaining the saftety devices relating to the foaming stations is necessary, the safety standards should be similar to European standards.
- For checking the new foaming chemicals and the foam quality, tests should be performed in cooperation with the suppliers of the machines and the distributors of the chemicals during installation. Further tests with refrigerators should be performed in order to measure the heat loss as a function of time, the foam distribution inside the housing etc. and other measures which are important for a proper quality. Detailed investigations of the foam should be performed by external institutions.

C. Refrigeration Service

- The amount of CFC12 in the failed system is too low and therefore proper operation of the recovery unit is not possible. For recovery of CFC12 it is recommended to use simple tools which are more cost effective and in use in Germany instead of expensive recovery units (cylinders filled with activated carbon). Therefore a central recycling station (model which can handle CFC12 and HFC134a) is recommended including testequipment for the refrigerant quality.

- One vacuum pump, one charging cylinder and a leak detector (model which can handle CFC12 and HFC134a) are necessary for the evacuation, charging and leak detection of the system for each of the 25 service cars.

D. Justification for Selection of alternative Technologies

Beside HFC134a, hydrocarbons are alternative refrigerants for household applications. Hydrocarbons have the environmental advantage of a low GWP compared with HFC134a, but the incremental costs are higher because new compressors are necessary (e.g. higher swept volume for isobutane) and additional safety equipment in the production line is required. Today compressors for hydrocarbons are not commercially available.

Cyclo pentane as a blowing agent for the foam is a long term solution. Another ODP-free solution for the foam blowing agent could be HFC134a, but in comparison with cyclo pentane it is more expensive and high pressure foaming stations are required. All other technical options are transitional substances because they are not ODP-free or under investigations and not approved at present (e.g. CO_2).

INPUTS

1. Capital Goods Replacement

A. Refrigeration System

- 25 pcs. leak detectors for service cars (for CFC12 and HFC134a)
- 1 pcs. recovery / recycling unit at each production line for HFC134a after leak test
- 100 pcs. of recovery systems for service cars (activated carbon systems).

B. Foam System

- ex-proofed systems not necessary if an adaquate ventilation system is installed
- water heaters not required if electric heaters are switched off before injection
- 1 set gas detector system for each foaming station including electronic control
- foam test equipment has to be specified (cooperation with foam / system suppliers)
- floor cover not necessary
- 1 fire protection system for each foaming machine
- compressor cooler should be specified

2. **Conversion / Training**

- all measures are recommended

3. **Model Redesign**

- modifications at the production lines will cause losses in regular production due to problems during the new installation and the necessary test phase, if these measures are performed in parallel; therefore a stepwise modification is recommended.

PROJECT IMPLEMENTATION

MILESTONES

The foam and refrigerant technology should be changed stepwise at the parallel production lines in order to solve initial problems during production and to transfer the experience to the other production lines. In this case, failures and problems will not lead to a total breakdown of the production lines.

Furthermore, design changes (e.g. increase of the insulation thickness, heat exchangers etc.) require modifications of the housing and the inner liner. These modifications are not mentioned in the time frame, therefore the time frame for redesign of the models including equipment changes in the production line should be enlarged.

PROJECT COSTS

The recommended measures in this review effect also the cost statement of the project. Without having any detailed information about the equipment which is suggested in the project proposal for the modification of the production lines and the service sector, it is not possible to value these.

ANNEX D : Cleaning Technologies for Vacuum Pumps

The cleaning procedure for vacuum pumps is not recommended.

PROJECT COVER

Country	:	Egypt
Project Title	:	**Investment Project For Phasing out ODS at KIRIAZI Refrigerators Manufacturing Co.**
Sectors Covered	:	Domestic Refrigeration / Rigid Foam / Refrigerant
ODS Use in Sector	:	1.830 MT of CFC 11 & CFC 12
Project Impact	:	Phase out of annual consumption of 101 MT of CFC 11, 30 MT of CFC 12 in the production and a gradual phase out of currently used 6 MT of CFC 12 in the service sector
Project Duration	:	18 months
Project Economic Life	:	10 years
Total Proposed Project Cost	:	Total of capital cost and operating incremental cost (first year of operation) US$ 2,348,622
Project Cost	:	US$ 3,678,678
Implementing Agency's Overheads (13%)	:	US$ 478,228
Incremental Operating Costs/Year	:	US$ 1,330,056 (first year of operation)
Proposed MF Financing	:	US$ 4,156,906
Cost Effectiveness	:	See Annex C: Unit Abatement Cost
Counterpart Enterprise	:	KIRIAZI Refrigerators Manufacturing Co., 10th of Ramadan City
Implementing Agency	:	United Nations Industrial Development Organization (UNIDO)
Coordinating Ministry	:	Egyptian Environmental Affairs Agency (EEAA)

PROJECT SUMMARY

This project will phase out 100 percent of the use of CFC 11 and CFC 12 for the production of refrigerators and freezers at KIRIAZI Refrigerators Manufacturing Co. The chosen replacement alternatives are cyclo pentane as foam blowing agent and HFC 134a as refrigerant. The project will include the redesign of all current refrigerator models and the conversion of the plant. The redesign of the existing refrigerator models covers activities like prototyping, testing, trial manufacturing and adaptation as well as reliability tests. The conversion of the production facilities covers the refrigeration system, insulating foam blowing system and the refrigeration service sector carried out by the company. The replacement alternatives and the time frame for phasing out the use of ODS will be in line with EEAA's ODS phase out programme.

Date: 1 February 1994

BACKGROUND

SECTOR BACKGROUND

The subsector for domestic refrigerators and freezers in Egypt consists of 9 manufacturers of which four to five companies are responsible for over 80 percent of the ODS consumption of CFC 11 and CFC 12.

Egypt does not produce any ODS. All ODS used in the country are directly imported by the users. In 1990 the total consumption was 1.830 MT of ODS.

The total installed production capacity for refrigerators and freezers is about 1,000,000 units per year but the present production is only about 525,000 units per year. The manufacturers expect an increase of about 10 percent increase per year.

In total about 7,000,000 refrigerators and freezers are in use in Egypt of which about 10 percent per year will be recharged during refrigeration service with CFC 12 equally to about 350 MT of CFC 12.

Because of lack of environmental awareness, know-how and equipment in the service sector, service staff very often use CFC 12 for washing/flushing of the cooling systems, instead of using vacuum pumps and charging boards. This causes a 100 percent to 200 percent higher CFC 12 consumption of the service sector, estimated at about 350 MT.

Currently no Egyptian company manufactures low energy refrigerators and freezers with an insulation thickness of 40 to 50 mm for refrigerators and 90 to 100 mm for freezers; however, the introduction of a limit for maximum energy consumption could be expected in the near future.

KIRIAZI's BACKGROUND

KIRIAZI Refrigerators Manufacturing Co. (KIRIAZI), is a private company and one of the five largest manufacturers of domestic refrigerators and freezers. It employs 512 people and the installed annual production capacity is about 150,000 units in one shift. Between December 1992 and December 1993 the actual production was 93,600 units. KIRIAZI expects a 10 percent increase in the production for each of the next four years because of a low price policy, combined with high product quality.

KIRIAZI is planning to build a new refrigerator and freezer factory in connection with a newly built factory for washing machines and cookers.

In 1993 KIRIAZI used 101 MT of CFC 11 and 30 MT of CFC 12 in the production as well as 6 MT of CFC 12 in the service sector.

KIRIAZI has already tested 50 percent CFC-reduced polyurethane foam, but until now normal CFC 11 mixed with polyol is being used.

KIRIAZI currently manufactures 2 models of two-door fridge/freezers, 1 model of no-frost fridge/freezer with two-doors as well as 3 sizes of chest freezers. The main production is a 330 liters fridge/freezer with two doors of which currently 60,000 units are being manufactured annually. Of the other models about 10,000 units each are being manufactured annually.

KIRIAZI covers a share of about 20 to 25 percent of the local market and exports less than 2 percent (to Libya, earlier also to Russia and Romania).

KIRIAZI imported the currently applied technologies and know-how from Zerowatt/Italy.

The company has developed its own chest freezer range, however it does not have its own refrigeration test facilities.

The insulation thickness of KIRIAZI's refrigerators is only 25 mm, 40 mm for the freezer section and only 50 mm for the chest freezers. Therefore, any attempt to change the current product range to a polyurethane foam system without major design modifications, would lead to non-acceptable energy consumption figures, caused by the high insulation losses.

More detailed information on the current plant layout and the production equipment employed, as well as on the proposed new layout is shown in Annex D: "Current and Proposed New Plant Layout".

KIRIAZI has already recognized the need to be in compliance with the stipulations made in the Montreal Protocol and has agreed to participate in Egypt's ODS phase out programme.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of ODS such as CFC 11 and CFC 12 in the production of domestic refrigerators and freezers and in the refrigeration service at KIRIAZI through conversion to HFC 134a as refrigerant for the cooling system and cyclo pentane as blowing agent for the polyurethane insulation foam.

PROJECT DESCRIPTION

KIRIAZI is prepared to phase out ODS as soon as the new technologies have been acquired, the necessary machinery and equipment installed and the technical staff trained.

Among the technological options currently available on commercial basis and in line with the established policy of the Government of Egypt to phase out the use of ODS, KIRIAZI has chosen to replace CFC 12 by HFC 134a, because the new type compressors are available, and the technology is mature and commercially applied outside Egypt.

As blowing agent for polyurethane foam KIRIAZI decided to avoid the use of any transitional substance and to introduce as ultimate solution cyclo pentane.

Through the project assistance will be provided in:

a. Procurement of new machinery and equipment;

b. Rebuilding of presently used machinery and equipment wherever technically and economically feasible;

c. Redesign, reconstruction, prototype manufacturing and testing of refrigerators and freezers;

d. Installation, commissioning, trial operation, start-up and on-the-job training;

e. Servicing.

The following machinery and equipment needs to be rebuilt, replaced or added:

A. Refrigeration System

- The charging equipment and the vacuum pumps must only be used for HFC 134a and in meeting the demand for cleaner and dryer cooling systems the existing charging system has to be replaced, including vacuum control.

- The charging boards have to be replaced by boards suitable for HFC 134a.

- Because the leak detectors react on Cl molecules, they need to be replaced.

- The currently used vacuum pumps, after being cleaned can also be used for HFC 134a.

- To optimize the cooling system for the application of HFC 134a and the new specification of components used, performance tests for each model of refrigerator and freezer are needed. Therefore, a minimum specification of refrigeration test equipment needs to be provided to be added to already existing test equipment which can also be used for the new technology.

- To improve the performance of the cooling system and compensate for a little lower polyurethane insulation value due to the conversion to HFC 134a as the new refrigerant and cyclo pentane for the foam, it is necessary to optimize the cooling system as well as the energy consumption to keep an acceptable TEWI value. Therefore, it is necessary to redesign, reconstruct and carry out performance tests for all models of refrigerators and freezers.

- The technical requirements for components such as tubes, condensers, evaporators, capillary tubes, heat exchangers, compressors and suction accumulators have to be in line with established standards like DIN 8964, i.e. new rules for dryness and cleanliness need to be applied.

- The drier has to be equipped with 3AA desiccant molecular sieves.

- The cooling system must not contain any chlorine and max. 1 percent non-condensable gases.

- The capillary tube has to be optimized for an increased resistance at low evaporating temperatures.

- It will be necessary to train KIRIAZI's technicians at the equipment suppliers place in new foaming technology as well as in design/calculation and performance testing of cooling systems. During the installation and run-in of the new machinery and equipment the suppliers engineers will have to train KIRIAZI's technical staff.

B. Foam System

- The current and future demand for energy conservation requires to increase the insulation thickness of the appliances by a minimum of 5 mm because of the reduced insulation value of the cyclo pentane foam. The current refrigerator and freezer model range produced by KIRIAZI is based on outdated European designs with regard to sufficient insulation thickness. This necessitates a complete redesign of the model range in the framework of this project.

- In order to achieve an acceptable foam quality and insulation value at lowest price, high pressure foaming machines need to be introduced and ex-proofed.

- Since cyclo pentane and polyol cannot be delivered premixed in drums or tanks (as CFC 11), it is necessary to provide mixing stations.

- For work safety when using the highly flammable and explosive cyclo pentane and in order to meet the relevant requirements of the local authorities, it is recommended to have a gas detector system as well as a fire protection system installed in the foaming department.

- It is necessary to provide one tank for cyclo pentane to automatically deliver the component to the mixing stations.

- To make the foaming jigs explosion-proof, it is necessary to replace the electrical heating elements by a water heating system. (A cheaper option would be to automatically disconnect the existing electrical heating just before foam injection, using the control system of the foaming machine and a timer. For the sake of high operational safety it is, however, recommended to apply the water heater option.)

- To keep control over the quality of the foam, it is recommended to introduce a minimum specification of test equipment. Since currently no test equipment is being used by KIRIAZI, it can, however, not be provided under this project.

- The workers' clothes and shoes have to be made of antistatic material and the floor need to be covered with an antistatic paint.

- The provision and installation of an exhausting and ventilation system in the foaming department is necessary in order to achieve compliance with established safety rules for the machinery and the plant.

- All foaming jigs and plugs must be equipped with a good earth connection to avoid the appearance of static electricity.

- Because of the flammable and explosive cyclo pentane, all machinery and equipment which may come in contact with the chemical or the mix of polyol and cyclo pentane must be explosion-proof.

- The electrical heating elements in the foaming jigs and plugs have to be replaced by copper tubes in which hot water can circulate to make them explosion-proof. The foaming inner mould plugs need partially to be replaced/ rebuilt using aluminium sheets to guarantee a constant temperature at the inner foam plug.

C. Refrigeration Service

- For KIRIAZI's refrigeration service a central recovery and recycling unit as well as 75 simple mobile recovery units for CFC 12 (one for each of the 25 service cars currently used, plus additional units to be exchanged with the central recovery and recycling unit) will be provided in order to prevent venting of CFC 12 and to reuse the CFC 12. (The recovery units consist of a metal or plastic case, filled with activated carbon to absorb the remaining CFC 12 from the systems. The CFC 12 will later be recovered from the activated carbon at the central recovery and recycling unit.)

- Twenty five new mobile evacuation and charging boards for HFC 134a for service will also be provided (one each for the service cars currently used).

- Training of KIRIAZI's service staff in using HFC 134a as well as in CFC 12 recovery and recycling.

D. Justification for Selection of Alternative Technologies

As new refrigerant for domestic refrigerators and freezers all major manufacturers of compressors have accepted HFC 134a as replacement for CFC 12. This means that for the manufacturers of refrigerators and freezers there is for the time being no other option commercially available.

As new blowing agent for the polyurethane foam the situation is quite different. Some manufacturers use:

HCFC 141b with ODP = 0.11
HCFC 142b with ODP = 0.065
HCFC 142b + HCFC 22 with ODP = 0.06
HFC 134a with ODP = 0
Cyclo Pentane with ODP = 0

This means, that the use of HCFC 141b, HCFC 142b and HCFC 142b + HCFC 22 blend will only be accepted as transitional substance for a limited time.

Currently all major European manufacturers are carrying out tests or have already started using cyclo pentane. Therefore, EEAA recommends that the Egyptian manufacturers should introduce an ultimate solution as blowing agent and should not use any transitional substances.

At present HFC 134a is too expensive and, therefore, it is very unlikely that it may become the ultimate blowing agent for polyurethane foam.

INPUTS

1. Capital Goods Replacement

The following equipment needs to be rebuilt, replaced as well as new equipment to be provided as specified below:

A. Refrigeration System

a1. 2 pcs. HFC 134a refrigerant charging boards with vacuum pump, refrigerant supply pump and leak check;

a2. 25 pcs. vacuum pumps cleaned and equipped with a backflow valve;

a3. 2 pcs. HFC 134a leak detectors;

a4. 1 set HFC 134a test equipment (minimum specification to be added to the existing test equipment);

a5. 1 pce recovery/recycling unit for CFC 12;

B. Foam System

b1.	2 pcs.	high pressure foaming machines (ex-proofed to be used for cyclo pentane);
b2.	2 pcs.	mixing stations for cyclo pentane and polyol;
b3.	1 set	water heating system for foaming jigs/plugs;
b4.	1 set	gas detector system;
b5.	1 set	exhausting and ventilation system;
b6.	10 pcs.	foaming jigs (rebuilt);
b7.	15 sets	foaming plugs (rebuilt);
b8.		floor cover (antistatic);
b9.	2 sets	pipe installation (ex-proof) from mixers to foaming machines;
b10.	1 set	fire protection system;
b11.	1 pce	tank for cyclo pentane, pump and pipework;
b12.	1 set	pumps and pipework from tank to mixers;
b13.	1 pce	water chiller for foaming machines;
b14.	3 set	plastic injection moulds for uprights (3 pcs. each);
b15.	13 set	punching and bending tools (to be modified);

b16. 16 pcs. foaming moulds (to be modified);

b17. 2 pcs. foaming moulds (new).

C. Refrigeration Service

c1. 26 pcs. HFC 134a mobile evacuation and charging boards;

c2. 26 pcs. simple mobile recovery units.

2. Conversion/Training

Within the framework of this project, personnel from KIRIAZI will be trained (among others) in the following areas:

- management and production control;
- quality control in relation to conversion;
- operation of the new machinery and equipment;
- maintenance of the new machinery and equipment;
- refrigeration laboratory tests;
- new technologies for foam and refrigerant;
- specifications for materials;
- safety regulations for flammable/explosive chemicals;
- refrigeration service.

3. Model Redesign

It is foreseen that for all models redesign and reconstruction are required, followed by the manufacture of some prototypes and refrigeration performance tests.

The model redesign will be carried out by KIRIAZI's staff under the supervision of the Chief Technical Advisor for this project.

As a common practice, modifications of the production lines will be carried out during evenings and off-days and will, therefore, not cause any costs under this project.

PROJECT IMPLEMENTATION

The project implementation will be carried out by UNIDO in close cooperation with KIRIAZI Refrigerators Manufacturing Co.

Necessary local coordination will be done by EEAA.

To substantively assist, coordinate and supervise the project implementation on behalf of UNIDO, a Chief Technical Advisor will be appointed.

For the implementation of major project components (foaming system, refrigeration system, fire protection system, exhausting and ventilation, etc.), a General Contractor will be appointed by UNIDO and subcontracts will be concluded after competitive bidding. The General Contractor will be responsible for the supply of equipment, installation, commissioning and on-the-job training of KIRIAZI's staff. The detailed Terms of Reference for the services to be provided by the General Contractor and for the subcontracts will be elaborated after project approval.

In order to guarantee a proper transfer and a safe operation, in particular of the new foaming technology using cyclo pentane, the proposed General Contractor will issue an "Operational Safety Statement"[1].

The final equipment specification, the workplan and, consequently the Operational Safety Statement can only be elaborated after approval of the basic approach for project implementation by the Multilateral Fund for the Implementation of the Montreal Protocol (MFMP).

The permission from the local authorities for the introduction of the new technologies under this project will have to be obtained by KIRIAZI. KIRIAZI will also be responsible for the compliance of the new technologies with established national standards.

Having accepted the conversion of its plant to the use of non-ODS under this project, KIRIAZI will be committed to provide the following inputs:

- All activities and costs involved for construction work needed (including the provision of technical infrastructure) to accommodate the new technologies introduced under this project. The relevant construction work will have to be arranged by KIRIAZI under the supervision of the General Contractor and in line with the established Milestones for this project. (The costs for construction work are, therefore, not reflected in the project budget. The specification for the construction work will be elaborated by the General Contractor after project approval and necessary project site inspection.);

- Technical staff as required by the General Contractor;

- Provision of tools, transportation and lifting equipment as required;

- Local transport, communication and secretarial facilities for the General Contractor's and UNIDO's staff involved in the project's implementation.

UNIDO as Implementing Agency has the necessary experience and capabilities for the successful implementation of projects at enterprise level. Upon approval by the MFMP the project's budget will be transferred to UNIDO. The respective project allotment document will then be issued by UNIDO's Finance Section. Any substantive or financial deviation from the approved project will be subject to approval by the MFMP and UNIDO.

[1] For negotiations to act as General Contractor UNIDO has already established with Messrs. POLYFA Trading, DK-2650 Copenhagen-Hvidovre, Denmark.

For the project implementation, milestones are set hereunder.

```
 MILESTONES                                  m o n t h
                             1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

 1. Sign project,            X
    receive funding
 2. Appointment of             X
    General Contractor,
    site inspection
 3. Elaboration of a           X
    detailed project
    workplan
 4. Draft of plant             X
    layout

    FOAM

 5. Selection of equipment     XXX
    bidding
 6. Training                             X       XX
 7. Manufacture/modify moulds      XXXXXXXXXXXXXXX
 8. Rebuild jigs+plugs             XXXXXXXXXXXXXXX
 9. Purchase,installation          XXXXXXXXXXXXXXX
    commissioning
10. Prototyping and testing                       XXX
11. Start production                                 XXXXXXXXXXXXXXXXXXXX
    with cyclo pentane

    REFRIGERANT

11. Redesign of                XXXX
    models, training
12. Selection of equipment     XX
    bidding
13. Purchase, installation       XXXXXXXXXXX
    and commissioning
14. Prototyping and testing                 XXXXXXXXXXXXXXXXXXXXX
15. Start production with HFC 134a                XXXXXXXXXXXXXXXXXXXXXX

  REFRIGERATION SERVICE

16. Selection of equipment     XX
    bidding
17. Purchase and training        XXX
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It is estimated that after 18 months the complete conversion will have been carried out.

PROJECT COSTS

I. **INCREMENTAL OPERATING COSTS**

The currently produced models will require the following modifications, based on an average European price level:

Modification	Incremental cost (US$)	
HFC 134a compressor	7.50	
Capillary tube modification	0.20	
Evaporator/condens. modif.	0.20	
3 AA drier	0.03	
HFC 134a refrigerant	1.17	
Cyclo pentane	-0.45	
Extra polyurethane foam	4.36	(Totally 6.10, but the balance has to be covered by KIRIAZI)
HIPS for inner liner	1.20	
Total	US$ 14.21[2]	

The above mentioned prices are showing the difference between the component prices for CFC 11 and CFC 12 versus component prices for HFC 134a and cyclo pentane.

The price increase will be caused by:

- compressor plus 8 percent to 10 percent for the new HFC 134a compressor and plus about 10 percent for a 1 size bigger compressor (to cope with the lower capacity at low evaporating temperature, but no heavy duty compressor, coping with significant voltage fluctuations), averaging to about 15 to 20 percent;
- capillary tube average 1 m longer;
- evaporator average 2 m longer for freezers, calculated for 20 percent of total production;
- HFC 134a filling average about 10 percent less compared with CFC 12, 0.225 kg at US$ 1.17, (based on the price for CFC 12 at US$ 1.88/kg and the current price for HFC 134a at US$ 7.07/kg, excluding any customs tax);
- cyclo pentane at US$ 1.55/kg will be used in a lower quantity as CFC 11 at US$ 1.80/kg;
- for polyurethane foaming 15 percent more of the complete mix needs to be charged because of the higher density foam (34 to 36 kg/m^3) produced when using cyclo pentane.
- Additional 20 percent foam because of the required increased insulation thickness by 5 mm will be shared 50/50 percent by KIRIAZI and the project;

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[2] The above calculation includes the incremental costs for the HFC 134a compressor to be imported. Currently in Egypt the construction of a new HFC compressor plant is ongoing at MCMC. This project is being supported by the MFMP. According to the rules of the MFMP, either the components manufacturing or the assembling company is eligible to receive incremental cost support. Therefore, as soon as the new compressors are available, KIRIAZI is requested to switch to those compressors and to return all remaining funds received to support the import of modified compressors to the MFMP.

- instead of polystyrene (PS) material (US$ 1.5 - 1.75/kg for an acceptable quality for CFC 11 application), HIPS or ABS has to be used for the innerliner (for HIPS the price will be US$ 2.0/kg).

Based on the above calculation the incremental operating costs for the first year will be:

US$ 1,330,056

for 93.600 units to be produced with cyclo pentane and HFC 134a.

The required budgets for the incremental operating costs for the years two to four will be calculated at the end of each preceding year and applied for as a revision of this project with the MFMP for funding.

The operating costs of the enterprise after the conversion are not expected to change, therefore no incremental cost will be incurred.

Costs for transport and insurance of capital equipment are included in the budgeted allocations for the respective items. Costs for equipment installation, commissioning and on-the-job training of KIRIAZI's staff are calculated separately.

II. CONTINGENCY FUND

A contingency fund (15 percent of the total project budget) was calculated. The MFMP is proposed to cover unforseen expenses which might be incurred during the project implementation, e.g. purchase of small testing instruments whose needs will be caused during the conversion process, miscellaneous expenses, etc.

III. TOTAL COSTS

- Investment costs will cover capital investment costs (at CIF basis) for modification of manufacturing facilities, new machinery, materials, testing equipment (see Annex A: "Equipment Specification and Cost Breakdown"), training, installation and consultancy services for modifications (see Annex B:" Project Budget for KIRIAZI").

- The net incremental operating costs associated with this project are as above.

- Implementing Agency's overhead costs are 13 percent.

- For the complete cost breakdown see Annex B: "Project Budget for KIRIAZI".

- For the calculation of the unit abatement cost see Annex C: "Unit Abatement Cost".

- Requested funding by the MFMP: US$ 4,156,906

Annex A: Equipment Specification and Cost Breakdown

Description	Qty.	Unit cost US$	Total cost US$
Refrigeration System			
Charging board	2	31,300	62,600
Vacuum pump (cleaned)	26	600	15,600
Leak detector	2	9,000	18,000
Equipment for test lab. + prototyping for HFC 134a (minimum specification)	1	50,000	50,000
Recovery/recycling unit	1	50,000	50,000
Foaming System			
High press.foam.mach.(cab.)	1	160,000	160,000
Hihg press.foam.mach.(doors)	1	110,000	110,000
Mixing station	2	80,000	160,000
Water heating system	1	40,000	40,000
Gas detector system	1 set	75,000	75,000
Exhausting and ventilation	1 set	45,000	45,000
Rebuilding of foam jigs	10	4,500	45,000
Rebuilding of foam plug	15 set	7,000	105,000
Antistatic floor	m^2	3,000	3,000
Pipe installation for 2 mc.	2	15,000	30,000
Tank for c.p.,pump,pipework	1	33,000	33,000
Fire protection system	1	30,000	30,000
Pumps, pipework from tank	1 set	45,000	45,000
Water chiller f.foam mach	1	11,000	11,000
Plastic injection mould	3	116,650	349,950
Punch.+bend. tools(modif.)	13	11,150	144,950
Foaming mould (modified)	16	2,000	32,000
Foaming mould (new)	2	75,000	150,000
Refrigeration Service			
Mob. evac.& charg.board	26	3,000	78,000
Mob.recovery unit for CFC	75	500	37,500
		Total	US$ 1,880,600

Estimated costs for equipment installation, commissioning, trial operation and on-the-job training of KIRIAZI's staff:

A. Refrigeration System

		US$
	One manufacturer's supervisor for 2 weeks on site:	
1.	Roundtrip airticket Europe - Cairo at US$ 2,000	2,000
2.	Fee for 14 days at US$ 550/day	7,700
3.	Daily subsistence allowance for 14 days at US$ 130/day	1,820
	Subtotal	11,520

B. Foam System

1.	Two manufacturer's supervisors for 4 weeks each and one engineer for 2 weeks on site:	
1.1.	Roundtrip airticket Europe - Cairo at US$ 2,000 each	6,000
1.2.	Fee for 28 days at US$ 550/day x 2	30,800
1.3.	Fee for 11 days at US$ 750/day	10,500
1.4.	Daily subsistence allowance for 70 days at US$ 130/day	9,100
2.	Local subcontract for piping and installation for 6 weeks at US$ 100/day	10,800
	Subtotal	67,200

C. Refrigeration Service

	One manufacturer's supervisor for 1 week on site:	
1.	Roundtrip airticket Europe - Cairo at US$ 2,000	2,000
2.	Fee for 7 days at US$ 550/day	3,850
3.	Daily subsistence allowance for 7 days at US$ 130/day	910
	Subtotal	6,760
	Total	85,480

Annex B: PROJECT BUDGET FOR KIRIAZI

		Duration work month	US$
BL 11-01	Chief Technical Advisor	4.0	50,000
BL 11-51	Consultant for monitoring of project implementation, participation in Project Implementation Review Meetings (2 missions)	0.5	12,000
BL 21-01	Subcontract for provision of General Contractor's services for conversion of KIRIAZI's plant to the use of non-ODS in refrigerating foam blowing and as refrigerant, in particular: * technical and managerial expertise for foam blowing, using cyclo pentane as foam blowing agent and HFC 134a as refrigerant; * new plant layout using c.p. and HFC 134a technologies; * equipment supply; * installation and commissioning of equipment; * rebuilding and ex-proofing of equipment; * on-the-job training of KIRIAZI's staff; including: - foaming machines, cabinet/door foaming jigs/plugs, mixing stations, water heating systems, water chiller, - antistatic floor; - gas detecting systems, fire protection systems; - exhausting and ventilation systems; - charging boards, vacuum pumps, leak detectors, recovery and recycling units.		1,966,080
BL 32-01	Study tour for two KIRIAZI technicians to foaming equipment supplier for technical inspection and training purposes	0.5	8,000
BL 32-02	Study tour for one KIRIAZI technician to refrigeration equipment supplier for technical inspection and training purposes	0.5	6,200
BL 51-00	Miscellaneous (15 percent Contingency Fund)		306,342
Subtotal I			2,348,622
Incremental operating costs			1,330,056
Subtotal II			3,678,678
Implementing Agency's Overheads	(13 percent)		478,228
		TOTAL US$	4,156,906

Annex C: Unit Abatement Cost

A	ODS Phase out		Total Project
A1	Average use of CFC 11 per year	MT	101
A2	ODP of CFC 11		
A3	ODP-weighted CFC 11 phase (A1*A2)	MT	101
A4	Average use of CFC 12 per year	MT	36
A5	ODP of CFC 12		
A6	ODP weighted CFC 12 phase out (A4*A5)	MT	36
A7	Total ODP-weighted phase out	MT	137
B	Annualized capital cost		
B1	Total investment cost (model redefinition + production conversion)	US$	2,348,622
B2	Equipment life	Year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	382,121
C	Annual incremental operating cost	US$	1,330,056
D	Unit Abatement cost		
D1	Annualized capital cost per kg ODS phased out (B4/A7*1000)	$/kg	2.79
D2	Annual incremental operating cost per kg ODP phased out (C/A7*1000)	$/kg	9.71
D3	Unit abatement cost (D1+D2)	$/kg	12.50

REVIEW EGYPT PROJECTS
KIRIAZI Refrigerators Manufacturing Co.

GENERAL REMARKS

In order to assess the project review it is very important to have more details and the condition of the production facilities e.g.:

type and manufacturer of the foaming stations,
leak test facilities,
charging stations,
vacuum pumps.

If possible, this information should be included in the project review (see also recommendations of the OORG).

PROJECT SUMMARY

The chosen replacement alternatives for the refrigerant CFC12 and the foam blowing agent CFC 11 are the refrigerant HFC134a and cyclo pentane as the foam blowing agent. This solution can be recommended due to the following aspects:

- Long term solution (low GWP, zero ODP)
- Compressors for HFC134a are available from all major suppliers world-wide, at present in Egypt the construction of a new HFC134a compressor plant is under way. All other components such as dryers and oil for the compressors are available on the market.
- Due to its zero ODP and very low GWP the foam blowing agent cyclo pentane is the industrial solution in the major refrigerator companies in Germany and Italy in order to achieve CFC- and HFC-free refrigeration system. Equipment for the foaming system can be modified or replaced from the main suppliers (Germany, Italy).
- Refrigerators with HFC134a as the refrigerant are in production world-wide, refrigerators with cyclo pentane blown foam are already in production in Europe. Experience for construction and production using HFC134a as the refrigerant and cyclo pentane as the blowing agent is available and the technology is mature.

BACKGROUND

SECTOR BACKGROUND

Beside the lack of equipment for the service sector, training programmes are required in order to reduce emission of refrigerants during repair and to avoid moisture problems with HFC134a and the ester-based oil.

Due to expected energy regulations in Egypt in the near future, the impact on energy efficiency should also be considered and design modifications with an increased insulation thickness are important.

KIRIAZI's BACKGROUND

The above mentioned design modifications require test facilities as well as training of the staff for the optimization of the refrigeration system and the insulation. Without these measures, a replacement of ODS in refrigerators with HCF134a and a new foam blowing agent will not lead to reliable refrigerators.

PROJECT OBJECTIVE

PROJECT DESCRIPTION

To phase out ODS in Egypt in the refrigerator sector, hydrocarbons are also a possible alternative, but for Egypt the HCF134a solution should be recommended due to new types of compressors, which will also be produced in Egypt. The necessary production equipment is commercially available or existing equipment can be modified and the technology is mature and commercially applied outside Egypt.

The foam blowing agent cyclo pentane is a long term alternative to avoid transitional substances using H-CFC's as a blowing agent, which have a higher global warming potential (GWP) and ozone depleting potential (ODP).

Kiriazi agrees to a modification of the insulation thickness by 5 mm. It is recommended to examine if this measure is sufficient under the climatic conditions in Egypt.

The present refrigerator design needs to be optimized in order to reduce the energy consumption of the system (Total Equivalent Warming Impact) using HCF134a. The optimization requires test facilities including measurement equipment.

DESCRIPTION OF SERVICING

For servicing refrigerators in field, a vacuum pump (not mentioned in the project cover) and a small filling station are necessary. Combined vacuum and filling systems are also available on the market which should be used either with HCF134a or CFC12. A recovery and recycling unit for service purposes is not recommended, because the amount of refrigerant inside the system is too small for a proper operation of this equipment and this method is not used in Europe. Instead of a recovery and recycling system another cost effective and simple method is recommended, where a small tube filled with activated carbon is connected to the refrigerator and the refrigerant is absorbed by activated carbon (patent AEG Hausgeräte AG, Germany, licences are available). After recovery, the absorbed refrigerant can be recycled using a central recycling station.

For servicing refrigerators at a service station, a recovery unit is recommended instead of the activated carbon system.

Furthermore, leak detectors for the service cars are recommended. Detectors which can detect CFC12 as well as HFC134a are available.

A. Refrigeration System

- The installed charging equipment and the vacuum pumps after some modifications can also be used with HFC134a if the status of the existing equipment allows this measure. For the conversion it is necessary to replace all flexible hoses and sealings of the charging stations with HFC134a approved materials. For the vacuum pumps in the production line only backflow valves should be installed in order to prevent a backflow of oil vapour from the pump to the refrigerator. Modern vacuum pumps have been installed with such a backflow valve.
- For leak testing in the production, different methods can be implemented:
  - helium leak detection systems including a mass spectrometer (best solution but very cost intensive)
  - HFC134a leak detectors (require the system to be filled with HFC134a and after approved leak test the refrigerant has to be removed using a recovery / recycling unit).
- The cleaning procedure for the vacuum pumps cannot be recommended and it is not necessary (installing a backflow valve).
- The time frame for testing and optimization of the refrigerators (capillary tube adaption, establishing new rules for dryness and cleanliness) will take more than 3 weeks. Furthermore, reliability tests over a longer period (at least 2000 h for each model) are recommended in order to confirm the reliabilty of the new models.

- Training programs are recommended for the optimization of the refrigerators and during installation of the new equipment.
- In the absence of national standards for the technical requirement of the components are existing, European or American standards should be used.

B. Foam System

- The insulation thickness should be increased by more than 5 mm in order to minimize the energy losses. It is recommended to examine the optimal insulation thickness under the specific Egyptian climate conditions. Modifications at the housing due to a thicker insulation require new production tools which are expensive. With regard to future energy regulations in Egypt this effort should be made only once.
- High pressure foaming machines are used in Europe for cyclopentane as blowing agent, low pressure foaming machines can also be modified for cyclopentane (e.g. CANNON, at present no information about modified low pressure foaming machines for cyclo pentane is available).
- The safety aspects using cyclo pentane as a blowing agent are influenced by the installed equipment, e.g. stationary foaming stations or caroussel systems. In Germany ex-proofed systems are **n o t** required, if a sufficient ventilation system is installed around the foaming equipment and gas detectors are installed, which switch offf the system in case of higher concentrations. Antistatic material is also not necessary, a detailed description of accepted and approved measures is available from the manufacturers of the foaming maschines.
- It is recommended due to safety aspects, that the cavity is rendered inert before foaming; this measure is laid down in Germany and recommended by Hennecke. In case of applying inertizing and switching off the electic heaters before injection, an installation of a water system for heating is not necessary for safety reasons.
- Furthermore, a training for the technical staff controlling and maintaining the saftety devices relating to the foaming stations is necessary, the safety standards should be similar to European standards.
- For checking the new foaming chemicals and the foam quality, tests should be performed in cooperation with the suppliers of the machines and the distributors of the chemicals during installation. Further tests with refrigerators should be performed in order to measure the heat loss as a function of time, the foam distribution inside the housing etc. and other measures which are important for a proper quality. Detailed investigations of the foam should be performed by external institutions.

C. Refrigeration Service

- The amount of CFC12 in the failed system is too low and therefore proper operation of the recovery unit is not possible. For recovery of CFC12 it is recommended to use simple tools which are more cost effective and in use in Germany instead of expensive recovery units (cylinders filled with activated carbon). Therefore a central recycling station (model which can handle CFC12 and HFC134a) is recommended including testequipment for the refrigerant quality.
- One vacuum pump, one charging cylinder and a leak detector (model which can handle CFC12 and HFC134a) are necessary for the evacuation, charging and leak detection of the system for each of the 25 service cars.

D. Justification for Selection of alternative Technologies

Beside HFC134a, hydrocarbons are alternative refrigerants for household applications. Hydrocarbons have the environmental advantage of a low GWP compared with HFC134a, but the incremental costs are higher because new compressors are necessary (e.g. higher swept volume for isobutane) and additional safety equipment in the production line is required. Today compressors for hydrocarbons are not commercially available.

Cyclo pentane as a blowing agent for the foam is a long term solution. Another ODP-free solution for the foam blowing agent could be HFC134a, but in comparison with cyclo pentane it is more expensive and high pressure foaming stations are required. All other technical options are transitional substances because they are not ODP-free or under investigations and not approved at present (e.g. CO_2).

INPUTS

1. Capital Goods Replacement

A. Refrigeration System

- 25 pcs. leak detectors for service cars (for CFC12 and HFC134a)
- 1 pcs. recovery / recycling unit at each production line for HFC134a after leak test
- 100 pcs. of recovery systems for service cars (activated carbon systems).

B. Foam System

- ex-proofed systems not necessary if an adaquate ventilation system is installed
- water heaters not required if electric heaters are switched off before injection
- 1 set gas detector system for each foaming station including electronic control
- foam test equipment has to be specified (cooperation with foam / system suppliers)
- floor cover not necessary
- 1 fire protection system for each foaming machine
- compressor cooler should be specified

2. Conversion / Training

- all measures are recommended

3. Model Redesign

- modifications at the production lines will cause losses in regular production due to problems during the new installation and the necessary test phase, if these measures are performed in parallel; therefore a stepwise modification is recommended.

PROJECT IMPLEMENTATION

MILESTONES

The foam and refrigerant technology should be changed stepwise at the parallel production lines in order to solve initial problems during production and to transfer the experience to the other production lines. In this case, failures and problems will not lead to a total breakdown of the production lines.

Furthermore, design changes (e.g. increase of the insulation thickness, heat exchangers etc.) require modifications of the housing and the inner liner. These modifications are not mentioned in the time frame, therefore the time frame for redesign of the models including equipment changes in the production line should be enlarged.

PROJECT COSTS

The recommended measures in this review effect also the cost statement of the project. Without having any detailed information about the equipment which is suggested in the project proposal for the modification of the production lines and the service sector, it is not possible to value these.

ANNEX D : Cleaning Technologies for Vacuum Pumps

The cleaning procedure for vacuum pumps is not recommended.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION

A STRATEGY FOR THE PHASE-OUT OF ODSs IN THE REFRIGERATION INDUSTRY

EXECUTIVE SUMMARY

A Project for the Government of Egypt

Prepared for:
Egyptian Environmental Affairs Agency

Financed by:
Multilateral Fund for the Implementation of the Montreal Protocol

I. OBJECTIVES

In accordance with the requirements of the Montreal Protocol, the primary objective is to phase out the use of ODS based gases in the refrigeration industry in Egypt in two stages:

i) A phase out of ODS refrigerants from Jan 1 1994 to 1998

ii) A phase out of ODS foaming agents from 1996 to Jan 1 1999

In achieving these objectives particular attention will be paid to the following:

a) attaining a consensus for measures in all ODS-using activities, i.e. refrigeration, polyurethane and thermoplastic foaming, air conditioning, aerosol and fire extinguisher production, production of electronic equipment, respective servicing and disposal activities, etc.;

b) introducing a strict Code-of-Conduct at all levels of responsibility for economising on the use of ODSs;

c) establishing, in respect to the new, non-ODS substances, a clear timetable for the introduction of technical standards, safety regulations etc. in keeping with the climatical and other conditions in Egypt.

d) ensuring that the overall electricity consumption by the refrigeration industry does not increase.

e) controlling the disposal of the refrigerants and blowing agents in the existing available units.

II. STRATEGY

Based on an indepth analysis of the domestic, industrial and commercial refrigeration industry (Chapters 3 and 4) and the available technological options (Chapter 5), certain strategic measures have been identified. These measures relate to policy and institutional requirements and to technological solutions for the manufacturing, servicing, disposal and retrofitting of refrigeration equipment.

A. <u>POLICY MEASURES</u>

The EEAA in collaboration with the National Ozone Panel will elaborate a long term plan which establishes a consensus for activities in institutionalising the National Ozone Policy predicated on a prompt phase out of ODS consumption. In accordance with the accelerated phase out plan of ODS adopted by the government (1994-1995) the following measures need to be undertaken:

1. Legislation

a) Legislation to support the selected technologies. This includes:

- elaboration of manufacturing standards for new technologies including safety regulations for hydrocarbons by 1994;.

- introduction of ODP safe maintenance practices in existing refrigeration equipment (especially to collect and recycle CFC-12 refrigerant) and CFC-11 based insulation equipment by 1996;

- banning the use of CFCs in new refrigerators and airconditioning by 1998;

- banning the use of CFCs in insulation foams by 1999

b) Regulations and incentives to support the converted enterprises

- an immediate ban on imports of CFCs based equipment;

- ban on import of CFC12 for refrigerator manufacture by 1995;

- ban on imports of all CFCs in refrigeration and air conditioning by 1998;

- abolishing import taxes on equipment needed for the conversion of refrigerator manufacturing plants to non CFC based refrigerators;

- financial incentives for collecting and scrapping of old CFC based refrigerators;

- higher import duties on CFC chemicals and other CFCs to induce users to switch to non CFC equipment;

- setting limits for energy consumption in the non ODS based plants.

c) Licensing systems for ODS users

Since much of the existing stock of CFC using devices cannot be retrofitted economically, and consequently some CFCs will be imported and used for many years to come, a licensing /quota system for ODS users should be established to maintain the unconvertible units as long as it is technically and economically feasible to do so.

2. Direct support for converted enterprises

This includes:

- necessary support to enterprises for testing parts like new compressors and new insulation;

- support for feasibility studies on national recovery, recycling and disposal systems for ODS based materials;

- support for domestic production of R/R equipment.

3. <u>Training</u>

The EEAA in collaboration with the Ozone Panel and industry should, as a priority measure, initiate a comprehensive training programme for industry and enterprises. The programme must be based on an assessment of the training requirements of service personnel as well as on an assessment of the laboratory and standardisation requirements.

Training programmes in the following areas have been identified:

1) servicing and maintenance of existing CFC based products and equipment;

2) servicing and maintenance of new HFC 134a based products and equipment;

3) redesign of existing CFC based products/installations;

4) design and manufacture of new non CFC based products/installations using cyclopentane, blends and/or HFC 141b as the case may be.In the latter case, the training should include design of critical aspects such as inner plastic liners;

The training programmes should be extended to enterprises, technical schools and universities. It is recommended a special certificate for handling ODS be awarded to the trainees, which after a transitional period, should be made an essential qualification for all operations.

<u>B.TECHNOLOGICAL OPTIONS</u>

Based on an evaluation of the Egyptian refrigeration industry and the technological options for the phase out of ODS; the following options are presented and discussed in the paper:

1. <u>Manufacturing</u>

(a) <u>Refrigerants</u>

It is recommended that HFC-134a be used as the basic refrigerant for new production. This would involve also the introduction of new HFC-134a compressors to optimize the consumption of energy in the cooling system. The new equipment would need to undergo field and laboratory tests and subsequent redesigning if necessary.

In order to support an industry wide transition to HFC-134a refrigerant (also to be used in the local production of new compressors) a substantive retraining of manufacturing and servicing staff will have to be undertaken.

(b) Insulation foam

It is recommended that the use of cyclopentane be considered as the ultimate solution for an ODP/GWP- free foaming technology. Given the present level of development of the industry, this could well be introduced in Egypt in collaboration with European manufacturers.

In the interim period, it is proposed that all enterprises which have already initiated the use of water reduced CFC-11 or HCFC 141b polyurethane foaming agent be allowed to continue using these technologies within the phase out plan limits upto 1999.

The use of a blend of *HCFC-22* and *HCFC-142b* can be considered as an optional solution for plants where the lay-out or the scale of operations are such that safety measures are necessary for the use of *cyclo pentane* blown foams, which would be expensive.

Such options should fall under the restriction measures of the country phase out plan, 1999.

2. Servicing (including recovery, recycling and reclaiming)

a) *Servicing of existing equipment using CFCs:*

The introduction of more efficient ways of servicing existing equipment is a relatively cheap way of reducing *CFCs* consumption immediately. Investment projects for assisting refrigerator manufacturers to change their manufacture to the use of non ODS substances should simultaneously assist in improving their operations with regard to recovery/recycling existing equipment using *CFCs*. In addition the question of improving the efficiency of other companies and workshops who service refrigerators and air conditioners should be given high priority. The possibility of the companies, who are receiving assistance in transforming their refrigerator manufacturing facilities, acting as focal points and providing assistance and training for others who service refrigeration and air conditioning equipment should be considered.

b) *Servicing of new equipment using non-CFCs, i.e. HFC-134a:*

Here the companies receiving assistance in converting their manufacturing facilities to the use of non-ODS refrigerants *(134a)* should also receive assistance for servicing the equipment which uses *134a*. Again, the possibility of these companies acting as focal points and providing assistance to other servicing companies should also be seriously considered.

3. Retrofitting

Retrofitting large refrigeration and air conditioning systems and chillers where economic alternatives have already been developed and applied in other countries should be undertaken. The recovered *CFCs* could be used to form a stock-pile to enable further maintenance of other equipment such as household refrigerators where no cheap way of retrofitting has yet been put into commercial practice. International development in the sector, including eventual developments of cheap ways of retrofitting domestic refrigerators, should be closely monitored.

4. <u>Disposal</u>

The disposal of household refrigerators and the destruction of the *CFCs* they contain is an important issue. At the present time the technology for this is expensive. However research and development programmes e.g. relating to the investigation of low temperature catalytic decomposition of CFC-12 in Japan, are currently being undertaken. Therefore, as in the case of retrofitting, international developments in this regard should be closely monitored.

C. <u>INSTITUTIONAL REQUIREMENTS</u>

In order to achieve the targets and policy prescriptions a comprehensive programme of institutional strengthening and change is imperative for the government, industry and enterprises. This programme must be initiated and led by the government in order to provide the enterprises with the right signals and incentive structures.

Several changes in the structure and working practices of the EEAA will be needed in order to make it the functional organization for implementing the ODS phase out strategy. It is recommended that a special technical bureau be esablished with qualified personnel in ozone layer protection issues and programmes, technicians, economists, information systems analysts, programmers and administrative staff. The Ozone Strengthening Unit's responsibilities would include, apart from its technical functions, public awareness campaigns and information dissemination as well as monitoring international developments in this rapidly evolving sector. Chapter 6 provides details of the envisaged functions of the bureau and EEAA.

III. WORK PLAN

The document outlines a detailed work plan for the government, industry and enterprises to enable the implementation of the strategy. These details are found in chapters 6,7 and 8 of the document.

The work plan includes demonstration workshops on the various components of the Refrigeration Strategy which could serve to illustrate it's relevance for all concerned industrial sectors.

IV. ECONOMIC AND DEVELOPMENTAL IMPLICATIONS OF THE PROPOSED STRATEGY

It is recommended that before the strategic options presented above are put into practice, a detailed analysis of their economic and development implications be undertaken by the EEAA.

At the **micro level** this would entail an estimation of the incremental costs associated with the testing, development and installation of new non ODS technologies and of the firms' competitive position in international markets. Since there is a notable overcapacity in the domestic refrigeration sub sector which cannot be absorbed by domestic demand, the export potential of Egyptian non CFC based products must be explored and exploited.

At the macro level the analysis must focus on: the developmental effects in terms of employment and wealth; backward and forward linkages with related industries, notably air conditioning, cold storage, and cold transport systems, as well as with the professed targets of food security, seasonal crop preservation, and other related export oriented food industries.

The above analysis will enable the EEAA to develop parallel action plans for phasing out of CFCs in the air conditioning sector and to implement the phasing out of ODSs in a systematic manner without necessarily jeopardising the developmental objectives of the concerned industrial sectors.