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Executive Committee of
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PROJECT PROPOSALS: EGYPT

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

- Phasing out ODS in six domestic refrigeration plants (UNIDO)
- Elimination of CFCs in the manufacture of Commercial Refrigeration Equipment (two enterprises) (UNDP)
- Conversion to CFC-free Technology in the Manufacturing of Rigid PU Foam (seven enterprises) (UNDP)
- Conversion to CFC-free Technology in the Manufacture of Flexible Slabstock PUF at El-Tawil Manufacturing Company (UNDP)

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Egypt
PROJECT TITLE:	Phasing out ODS in the domestic refrigeration plants of: (1) Alaska (2) Helwan Company for Metallic Appliances (3) Iberna (4) El-Nasr Company for Electrical and Electronic Apparatus (5) Siltal (6) Super Bosh
BUDGET:	Capital Costs: US $4,963,266 Operating Costs[1]: US $ 533,506
INCREMENTAL COSTS:	US $5,496,772
ODS PHASE-OUT:	144 MT (111 MT CFC-11 and 33 MT CFC-12)
COST EFFECTIVENESS:	US $38 per Kg ODP saved
PROJECT DURATION:	18 months
IMPLEMENTING AGENCY:	UNIDO
NATIONAL COORDINATING AGENCY:	Egyptian Environmental Affairs Agency (EEAA)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. Six project proposals are addressed together in these comments.

2. Implementation of the six projects will result in an estimated annual phase-out of 111 MT of CFC-11 and 33 MT of CFC-12, and will result in the conversion of all the domestic refrigeration sub-sector in Egypt.

[1] Calculated for six months of operation

3. The replacement alternatives chosen by the six companies are cyclopentane as foam blowing agent and HFC-134a as refrigerant. The projects include the redesign of all current refrigerator models and the conversion of the plants. The conversion of the production facilities at the six plants will cover the refrigeration system, insulating foam blowing system as well as the refrigeration service carried out by the six companies. Cyclopentane and HFC-134a technologies are ultimate conversion solutions. The six projects will be implemented within 18 months.

4. Refrigerator model redesign and the technical aspects of the conversion, including safety measures associated with cyclopentane application, will be supervised by a Chief Technical Advisor and specialized consultants appointed and fielded by UNIDO. A General Contractor will also be appointed by UNIDO for the implementation of the major project components (foaming system, refrigeration system, fire protection system, exhausting and ventilation system, on-the-job training, etc.). These arrangements would ensure a proper technology transfer and safe operations.

5. Incremental operational costs are associated with new HFC-134a compressor, refrigeration system optimization, higher cost of the refrigerant and extra polyurethane foam due to increased density. Incremental operational costs are calculated on the basis of average European price level for six months of operation. The companies accepted six month duration of operational costs.

6. Currently, in Egypt a new HFC-134a compressor plant is under construction by MCMC with the support of the MFMP. According to the rules of the MFMP, either the components manufacturing or the assembling company is eligible to receive incremental cost support, however, the new compressors from MCMC will not be available in time. Thus, the incremental cost of HFC-134a imported compressors at US $5 per piece is taken into account.

7. A new HFC-134a compressor could be made available from other sources of supply at a lower price. The Secretariat and UNIDO are of the opinion that incremental operating costs are likely to decrease during the coming two years and maybe sooner. The incremental operational costs will be incurred only after the full production of a new product is started, i.e. 18 months from the time funds are received. Thus the companies have accepted to charge operating costs for only six months.

8. It is to be noted that cost effectiveness of these projects (average of US $38/kg ODP) is lower than that of the three projects in this sub-sector approved at the Thirteenth Meeting of the Executive Committee (US $23.5/kg ODP).

SECRETARIAT'S RECOMMENDATION

9. The Fund Secretariat recommends approval of the six projects and approval of incremental costs as follows:

Company	Actual Production units/year	ODS phase out MT/yr	Capital Costs* US $	Operating Costs (6 mo) US $	Total per company
Alaska	52,000	55	1,297,839	220,767	1,518,606
Helwan	9,000	8	606,294	37,945	644,239
Iberna	16,000	17	784,810	67,928	852,738
El Nasr	15,500	22	786,313	68,377	854,690
Siltal	22,000	29	772,938	93,495	866,633
Super Bosh	10,000	14	715,072	44,994	760,066
Total	124,500	144	4,963,266	533,506	5,496,772

* includes 10 per cent contingency charges.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Egypt
PROJECT TITLE:	Elimination of CFCs in the Manufacture of Commercial Refrigeration Equipment (two enterprises)
BUDGET:	US $1,023,000
INCREMENTAL COSTS:	US $1,023,000
ODS PHASE-OUT:	32.3 MT/year
COST EFFECTIVENESS:	US $31.7 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. Under this project, two companies will eliminate 32.3 tonnes of CFCs (R-11, R-12 and R-502) in the production of rigid polyurethane insulation panels and spray foams through application of cyclopentane technology. Refrigeration equipment will be converted to HFC-134a technology. According to UNDP, there remains only two more commercial refrigerator producing companies in Egypt that will develop projects in the future.

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-12 based charging and recycling equipment will be replaced with HFC-134a units.

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

5. The cost effectiveness of this projects is much lower than those previously approved for Egypt.

SECRETARIAT'S RECOMMENDATION

6. The requested amount of US $1,023,000 is recommended for approval.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Egypt
PROJECT TITLE:	Conversion to CFC-Free Technology in the Manufacturing of Rigid PU Foam (seven enterprises)
BUDGET:	US $780,000
INCREMENTAL COSTS:	US $780,000
ODS PHASE-OUT:	68.8 MT CFC-11/yr
COST EFFECTIVENESS:	US $11.34 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. The project proposal covers seven low consuming enterprises involved in the manufacture of water heaters, solar panels, thermos bottles, construction panels and spray applications of rigid polyurethane foams. Implementation of the project will lead to the phase-out of 68.8 MT CFC-11 per year.

2. The "full water" blown foam is the chosen technology for the conversion of the seven enterprises, which will eliminate the use of CFC-11 as the blowing agent. High pressure foam machines are thus required to ensure the production of foam with the right density.

3. Savings resulting from avoidance of the use of CFC-11 are offset by higher costs of foam ingredients and maintenance.

4. UNDP stated that the project is "a demonstration project for the global strategy for small ODS-users in the foam industry". It is to be recalled that the Executive Committee approved at its Thirteenth Meeting the preparation by UNDP of such a strategy.

5. The project is more cost-effective than similar projects approved in the sub-sector for Egypt.

SECRETARIAT'S RECOMMENDATION

6. The Secretariat recommends final approval of the project and of the requested US $780,000.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Egypt
PROJECT TITLE:	Conversion to CFC-Free Technology in the Manufacture of Flexible Slabstock PUF at El-Tawil Manufacturing Company
BUDGET:	US $121,000
INCREMENTAL COSTS:	US $121,000
ODS PHASE-OUT:	36 MT CFC-11/yr
COST EFFECTIVENESS:	US $3.36 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. The project will phase out the use of about 36 MT CFC-11 per year in the manufacture of flexible slabstock foam at El-Tawil; the only remaining company in Egypt which manufactures flexible polyurethane foam.

2. Methylchloride will replace CFC-11 as the foaming agent. A containment system for methyl chloride is thus requested.

3. No operating costs are requested since the saving from avoidance of the use of CFC-11 will be offset by high percentage of waste in the trial period.

4. The project is cost effective.

SECRETARIAT'S RECOMMENDATION

5. The Secretariat recommends approving this project and approval of US $121,000.

PROJECT COVER SHEET

Country:	Egypt
Project Title:	**Phasing out ODS at the ALASKA, Helwan Company for Metallic Appliances, IBERNA, El Nasr Company for Electrical and Electronic Apparatus, SILTAL and SUPER BOSH domestic refrigeration plants**
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 111 mt CFC-11, 14 mt CFC-12 in the production and a gradual phase out of currently used 32 mt CFC-12 in the service sector (Total ODP = 143)
Project Duration:	18 months
Project Economic Life:	10 years
Total Project Cost:	US$ 5,496,772 (Total of capital cost and incremental operating cost for six month of operation)
Capital Cost:	US$ 4,963,266
Incremental Operating Cost:	US$ 533,506 (six month of operation)
Implementing Agency's Overheads (13%):	US$ 714,580
Proposed MF Financing:	US$ 6,211,352
Cost Effectiveness:	Unit Abatement Cost - 9.38 US$/kg
Counterpart Enterprise:	Egyptian refrigerator companies as indicated in the title
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 the selected Egyptian refrigerator companies indicated in the title. The chosen replacement alternatives are cyclopentane 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.

I. BACKGROUND

A. 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 approximately 7,000,000 refrigerators and freezers are in use in Egypt of which about 10 percent per year will be serviced and a part of them recharged during refrigeration service with 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 up to 200 percent excess CFC-12 consumption in the service sector.

Three domestic refrigeration conversion projects covering three major Egyptian companies (DELTA, ELECTROSTAR and KIRIAZI) as been recently formulated by UNIDO. These projects were approved on the 13-th Meeting of the Executive Committee.

B. Company Background

i. *La Société Mondiale pour Refroidissement* (trade-name: *ALASKA*), is a private company and one of the five largest manufacturers of domestic refrigerators and freezers. ALASKA is situated in 10-th of Ramadan City, near Cairo. It employs 250 people and the installed annual production capacity is about 100,500 units. In 1993 the actual production was 52,000 units.

In 1993 ALASKA used about 44 mt of CFC-11 and 10.5 mt of CFC-12 in the production process, as well as 0.5 mt of CFC-12 in the refrigeration service.

The Company manufactures four different refrigerator and 8 different freezer models respectively in the range of 140 to 650 l content based on the licenses from Merloni, Italy (chest and upright freezers) and Liebherr, Germany (refrigerators).

ALASKA covers a share of about 15 percent of the local market, it has been in operation since 16 years and manufactured already 695,000 unit. These units are serviced by the five service centres and three service cars run by the Company.

All refrigerator compressors are imported (UNIDAD, DANFOSS), whereas evaporators and condensers are mainly manufactured locally and domestically. The technology required to clean and dry the refrigerator cycle (vacuum pumps) correspond to the CFC-12 technology. Leak detectors and charging equipment are older than ten years.

Two low-pressure foaming machines are used (installed in 1981, 1982) to feed two separate conveyor belts (one line for the refrigerators/upright freezers and another one for the chest freezers).

In order to introduce the cyclopentane insulation foaming technology and HFC-134a as refrigerant all equipment related to these technologies has to be replaced (foaming machines, vacuum pumps, leak detectors charging boards). Cabinet and door jigs and plugs need substantial modification. The cleanliness of the factory and the production discipline have to be substantially improved to avoid serious quality and safety problems after conversion.

The company has no refrigerator design capabilities and no refrigeration performance test facilities.

Because the production flow and the layout of the assembly lines have to be reorganized in order to introduce the new technology the plant management should thoroughly study the possibility to work in parallel with a part of the old equipment and one of the new lines during the conversion period.

ii. *Helwan Company for Metallic Appliances* is a public company in Helwan, near Cairo. It was established in 1962 for the production of various household appliances (refrigerators, gas cookers, water heaters, dish-washers, washing machine etc.). The production of refrigerators and freezers is organized under the still valid license from Kelvinator, USA. All changes of the design of products under license have to be approved by the licensor. One upright freezer (4.8 cu. ft. approx.150 l) was designed by the company and not subject to any license obligation. The company produces about 9,000 to 10,000 units annually, one chest freezer (9 cu. ft.), one upright freezer (4,8 cu. ft.), one one-door refrigerator (300 l) and one two-door no-frost refrigerator (12 cu. ft.) model. Helwan is selling its products only on the local market. About 200 people are employed in the refrigeratior manufacturing.

The plant has three production lines,from which two are used for the production of refrigerators and freezers, the third line was established to manufacture air-conditioners. Most of the equipment was installed already in 1962 with the exception of the foaming machine, charging units and leak detectors (1983).

The refrigeration compressors, condensers evaporators and many others parts are imported from Italy and Kelvinator itself.

The foaming is performed into four jigs per model. The jigs are not heated, heating is carried out in heating tunnels in the traditional way.

The company has no testing facilities, quality control consists of measuring the current only.

Despite of the fact that the products are of up to date design, the technology applied reflects the level of the sixties when the company was established. The international changes in technology have not been introduced in the company ever since then. It is strongly recommended to study of experience of other Egyptian producers, like e.g. Philips, Electrostar and Iberna in order to reach the technological level needed for the introduction of cyclopentane foaming technology and to replace R-12 by HFC-134a.

iii. *International Co. for Refrigeration and Appliances* (trade-name: *IBERNA*) is a private company located in Abu Rawash, near Cairo. It is manufacturing a wide range of refrigerators and freezers (3 refrigerator, 6 chest freezer, 1 no-frost refrigerator/freezer, 2 ice-maker and 1 ice-cream display cabinet models). The products are manufactured mainly under a valid license agreement with IBERNA, Italy. The appliance design and its look is excellent. The total number of appliances manufactured in 1993 with only 35 workers is approximately 16,000 units, whereas the total production capacity is 30,000 units per year. The production is well organized and thorough manufacturing process guarantees high product quality.

IBERNA's domestic market share is about 5%, however in the chest freezer sector it is much higher. Small amounts were exported by the company to Lybia and Russia. IBERNA aims at the high-quality, higher priced segment of the market. It has been on the market since 13 years. The servicing of appliances is implemented by four company service centres equipped with 3 service cars.

The compressors are imported from ZANUSSI, DANFOSS, NECCHI, UNIDAD, VERDICHTER, whereas evaporators and condensers are partially manufactured domestically.

The production equipment of the refrigeration cycle assembly were installed 13 years ago, but shows high standard. Two low-pressure foaming machines are in use. A high number of moulds and fixtures are in use to produce the many different models. Thorough handling and maintenance of the manufacturing equipment ensures high product quality.

Some most basic quality control instruments are available to carry out limited refrigeration tests. Extension of these equipments will enable IBERNA to implement tests required for model redesign. The know-how available at the company will guarantee the success of the conversion to cyclopentane foaming technology and the conversion of the use of CFC-12 to HFC-134a. The use of isobutane as a valid alternative is also being considered by IBERNA's technical staff. Plans have already been developed to build an extension to the existing buildings where a part of the new technology can be accommodated.

iv. *El Nasr Company for Electrical and Electronic Apparatus* (trade name: *Philips*) is situated near Alexandria. This public enterprise is manufacturing four different refrigerator and two freezer models. The production is based on a valid Philips - Whirlpool license. 240 workers are manufacturing in one shift annually 15,500 units (1993 figure), while the total production capacity is 60,000 appliances in two shifts. On a parallel assembly line washing machines are produced.

The main product is a two door 460 l refrigerator/freezer, it represents 60% of the production. The company has been on the market for 11 years during which it has produced already 232,000 units almost exclusively for the domestic sale. 200 workers in 28 service shops licensed and supported by the company are carrying out the servicing of all Philips refrigeration appliances (including the imported ones) all around Egypt. The service centres have 8 service cars equipped with charging boards for on site repairs.

The production flow, equipment available and the product quality are in accordance with European standards. A well equipped and staffed quality control laboratory enables to maintain product quality on a constant high standard. The vacuum pumps, leak-detectors and charging stations are well maintained and of good quality. The foaming machine installed in 1983 is still reliable and properly functioning. The company regularly uses 10 jigs for the cabinets and six jigs for the doors.

All parts of the refrigeration cycle are produced outside of the factory and a part of them is imported.

In order to convert the refrigerant and the foam to CFC-free substances the company has to cooperate with the original licensor in order to ensure compliance. It was agreed upon to use cyclopentane as foam propellant, and HFC-134a as refrigerant. The application of isobutane as an alternative would be possible as well. In any case the foaming machine, charging equipment and leak-detectors have to be replaced, the jigs and plugs have to be modified and proper test equipment for model redefinition has to be put into operation..

v. *Islamic Company for Industrialization* (trade name: *SILTAL*) is a private company situated in 10-th of Ramadan City, near Cairo. It is manufacturing 9 refrigerator and 2 different freezer models based on a valid license from SILTAL, Italy. The company has already been on the market for 9 years manufacturing annually 22,000 units on one production line, while the designed capacity is 40,000 appliances yearly. Their market share in Egypt is about 8 percent.

274 workers are involved in the manufacturing process, 23 in servicing at the 6 service stations of the company.

Refrigerators and freezers have a net volume between 60 and 430 l. The product quality is good.

Compressors are imported from DANFOSS, MATSUSHITA, ZANUSSI, UNIDAD and L'UNITÉ HERMETIQUE. Evaporators and condensers are partially produced locally, partially imported.

Equipment for drying the refrigeration cycle, testing the tightness, charging the refrigerant are from the mid and end eighties. A low pressure foaming machine from the year 1984 is used for both the doors and the cabinets. There are 3 jigs and 25 plugs for the refrigerators and one jig for the chest freezers in use. Most of these equipments need replacement and the fixtures modifications to enable conversion of the company to cyclopentane blowing agent and HFC-134a refrigerant. New test equipment will be required to enable model redesign to be performed by the company.

vi. *Super Bosh Factory* in Abu Rawash, near Cairo was set up in 1982 to manufacture refrigerators and freezers under the license of MONDIALE, Italy. Today 30 people are employed by this private enterprise, from which 20 are involved in the production process and two in the servicing of equipment. 4 different refrigerator and 10 deep-freezer models respectively are manufactured. The annual production is about 10,000 appliances. Since 1982 106,000 units were produced. The company is aiming at the low cost range of the market.

Refrigeration compressors and condensers are imported, evaporators are produced in the company itself.

The company has three low-pressure foaming machines, the newest one was put into operation in 1988. In order to manufacture the different models 20 jigs for cabinets and doors are available.

The level of maintenance and technology is the lowest among all Egyptian refrigerator plants. The know-how originated from MONDIALE, Italy, however, the agreement has been terminated and the know-how has not been followed. Quality tests are performed by means of simple running tests measuring the electrical power consumption and inside temperature. Apart from the mentioned simple quality control instruments the company has no test equipment whatsoever.

It was agreed with the owner of the company, that immediate actions will be taken by him to increase the level of technological discipline, plant safety and cleanliness with intensive technical assistance from the side of local manufacturers and consultants. This is a precondition without which Super Bosh might face serious difficulties in the application of HFC-134a refrigerant replacing CFC-12 and cyclopentane as a replacement of CFC-11.

All aforementioned domestic refrigerator producers have 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.

II. 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/freezers and in the refrigeration service at six Egyptian domestic refrigerator producers through conversion to the use of HFC-134a as refrigerant for the cooling system and cyclopentane as blowing agent for the polyurethane insulation foam.

III. PROJECT DESCRIPTION

The selected companies covered by the project are 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, all companies has chosen to replace CFC-12 by HFC-134a, because the new type compressors will be available, and the technology is mature and commercially applied outside Egypt.

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

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*

- In order to correspond to the strict requirments regarding cleanliness and dryness of a refrigeration cycle working with HFC-134a the vacuum control has to be improved.

- 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 according to the latest experience of large refrigeration companies have to be replaced.

- To optimize the cooling system for the application of HFC-134a and new specification for components used, performance tests for each model of refrigerator in an air-conditioned test room are needed. Therefore, a minimum specification of refrigeration test equipment needs to be provided (see Annex I: "Preliminary Specification of Refrigeration Test Equipment"). In the case of those companies, where some adequate testing facilities are already available only the necessary extension is taken into account. It is understood, that foam testing facilities cannot be financed by MFMP, as stated in the forthcoming para B: Foam System.

- 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 cyclopentane for the foam, it is necessary to optimize the cooling system as well as the energy consumption to keep an acceptable TEWI (Total Equivalent Warming Impact) 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 % non-condensable gases.

- The capillary tube has to be optimized for the actual pressure difference between condenser and evaporator pressures (increased resistance at low evaporating temperatures of the new refrigerant).

- It will be necessary to train manufacturing and service 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 the technical staff.

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. The polyol part of the machines have to be made explosion proof and encapsulated.

  Adaptation of the currently used low pressure foaming machines for cyclopentane would require substantial modifications to be carried out at the machine supplier's premises. Apart from the substantial adaptation costs, a further burden would be the several weeks interruption of production for decommissioning, rebuilding, transportation and recommissioning of the machinery. Thus, the only economically viable solution is to replace the low pressure foaming machines with suitable high pressure ones.

  According to our information collected in Egypt, there is no domestic market for the second hand low pressure foaming machines, since not only the refrigerator plants, but also the foam manufacturers are replacing their low pressure foaming machines with high pressure machines. Thus, similarly to the previously approved by the MFMP foam sector projects the high pressure machines are budgeted at their full cost.

- Since cyclopentane and polyol cannot be delivered premixed in drums or tanks (like CFC-11 and polyol), it will be necessary to provide mixing stations.

- It is necessary to provide one tank for polyol, one for cyclopentane and one for isocyanite to automatically deliver the components to the mixing stations.

- For work safety when using the highly flammable and explosive cyclopentane 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.

- The provision and installation of an exhaust 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 machinery and equipment which may come in contact with cyclopentane or the mix of polyol and cyclopentane must be encapsulated and explosion-proof;

- To make the foaming jigs explosion-proof, it is necessary to replace the electric heating elements by copper tubes in which hot water can circulate. (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 companies are ready to absorb 50% of the calculated costs of the modification of jigs and plugs. The foaming inner mould plugs have to be partially replaced/rebuilt using aluminium sheets to guarantee a constant temperature at the inner foam plug. The electric valves and microswitches to be used in connection with the foaming jigs need to be explosion-proof.

- Before foaming the work pieces have to be flushed with nitrogen to avoid generation of explosive mixture of cyclopentane vapors and air.

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

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

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

C. *Refrigeration Service*

- For refrigeration service simple mobile recovery units for CFC-12 (one third for each of the service cars currently used, plus additional units to be exchanged with the Central Collection Station) 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 Collection Station and sent for reclamation.)

- New mobile evacuation and charging boards for HFC-134a as well as leak detectors for service will also be provided (one each for the service centre and service cars currently used).

- Service personnel will be trained in using HFC-134a and hydrocarbons alternetively, as well as in CFC-12 recovery and recycling.

D. *Justification for Selection of Alternative Technologies*

As new refrigerant for domestic refrigerators and freezers most of the major manufacturers of compressors have chosen HFC-134a as replacement for CFC-12. The same refrigerant was selected by the compressor company under construction in Egypt with the assistance of the MFMP. New alternatives, however, based on hydrocarbons have been recently introduced in Europe. At the time of formulating this project the most feasible option for the Egyptian manufacturers seems to be HFC-134a.

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

Blowing agent	HCFC-141b	HCFC-142b	HCFC-142b + HCFC-22	HFC-134a	Cyclopentane
ODP	0.11	0.065	0.06	0	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 cyclopentane. Therefore, EEAA recommends that the Egyptian manufacturers should introduce an ultimate solution as blowing agent and should not use any transitional substances.

HFC-134a, which could be the other alternative, is too expensive, so it is very unlikely that it may become the ultimate blowing agent for polyurethane foam.

IV. INPUTS

1. *Capital Goods Replacement*

The equipment to be replaced, rebuilt, as well as new equipment are shown plant by plant in the Annex A.

2. *Conversion/Training*

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

- redesign and reconstruction of refrigerators and freezers;
- 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 the plants, technical staff under the supervision of the Chief Technical Advisor and specialized international consultants for this project.

As a financially most appropriate practice, modifications of the production lines will be carried out during evenings and off-days or line by line and, therefore, it will not cause further costs under this project.

V. PROJECT IMPLEMENTATION

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

Purchase of know-how is not considered in the project budget. However, to substantively assist and supervise the technical aspects of the conversion process, to perform troubleshooting and to provide assistance in product redesign work a Chief Technical Advisor and specialized consultants will be appointed and fielded by UNIDO. The respective job descriptions will be prepared upon approval of the project.

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

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

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

The permission from the local authorities for the introduction of the new technologies under this project will have to be obtained by the recipient plants. The plants 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, the companies will be committed to provide the following inputs:

- All activities and costs related to the 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 and paid for by the respective plants 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 of the project 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 in <u>Annex H</u>.

VI. PROJECT COSTS

I. INCREMENTAL OPERATING COSTS

The currently produced models will require modifications exhibited plant by plant in Annexes C, D and E based on an average European price level.

The figures in the Annexes C, D and E are showing the difference between the component prices for CFC-11 and CFC-12 versus component prices for HFC-134a and cyclopentane.

The price increase will be caused by:

- 8 % to 10 % compressor price increase for the new HFC-134a compressor and plus about 10 % for a one size bigger compressor (to cope with the lower capacity at low evaporating temperature, but no heavy duty compressor, coping with significant voltage fluctuations), totalling to an average of about US$ 5.0 per compressor);

- capillary tube average 1 m longer;

- evaporator/condenser 2 m longer;

- HFC-134a filling average about 10 % less compared with CFC-12;

- cyclopentane at US$ 1.55/kg will be used in a lower quantity as CFC-11 resulting in savings;

- for polyurethane foaming at least 15 % more of the complete mix needs to be charged due to the higher foam density in the initial test period of about 1 year of foam production using cyclopentane (see also Annex G: "Technical Information Sheet of BASF"). This results in incremental cost for the foam system;

- the currently used innerliner material is HIPS, type KR 2710 from BASF. According to our latest information this material could be used with cyclopentane blown foams as well. Thus, ther are no incremental costs for this.

Based on calculations shown in the Annexes C, D and E the total incremental operating costs for all six companies for **one year of operation** will be as follows:

US$ 1,067,012

For six months of operation the total incremental operating cost will amount to:

US$ 1,067,012 x 0.5 = **US$ 533,506**

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 staff are calculated separately.

II. CONTINGENCY FUND

A contingency fund (10 percent of the total investment cost) was calculated. The MFMP is proposed to cover unforeseen expenses which might be incu rred during the project implementation, e.g. purchase of small testing instruments, which might be required during the conversion process, miscellaneous expenses, price escalation, 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"), consultancy services for modifications (see Annex E: "Project Budget").
- 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 E: "Project Budget".
- For the calculation of the unit abatement cost see Annex F: "Unit Abatement Cost".
- Requested funding by the MFMP: **US$ 6,211,352**

Annex H. Implementation Schedule

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 layouts		X																
FOAM																		
5. Selection of equipment, bidding		X	X	X														
6. Training							X				X							
7. Rebuild jigs + plugs				X	X	X	X	X	X	X	X							
8. Purchase, installation, commissioning				X	X	X	X	X	X	X	X							
9. Prototyping and testing											X	X						
10. Start production with cyclopentane												X	X	X	X	X	X	X
REFRIGERANT																		
11. Redesign of models, training		X	X	X														
12. Selection of equipment, bidding		X	X															
13. Purchase, installation and commissioning			X	X	X	X	X	X	X									
14. Prototyping and testing							X	X	X	X	X	X	X	X	X	X		
15. Start production with HFC 134a											X	X	X	X	X	X	X	X
REFRIGERATION SERVICE																		
16. Selection of equipment, bidding			X	X														
17. Purchase and training				X	X													

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

Annex I: Preliminary Specification of Refrigeration Test Equipment

A. *To be supplied by the company:*

1 pc. Thermoinsulated test room: W x L x H: 2,500 x 3,000 x 2,800 mm, walls consisting of min. 80 mm thick polyurethane insulated panels covered with 0.6 mm electrogalvanized PVC coated steel plates.

B. *To be financed by MFMP:*

3 pcs. fan motors (ventilators)
2 pcs. heating elements
1 pc. cooling element
1 pc. ice-bank cooling system, complete
1 pc. electronic thermostat
1 pc. voltage stabiliser
1 set fluorescent light and plugs for test room
1 set terminal box for test room for connection of electricity, pressure and temperature
1 pc. terminal box outside test room for regulation equipment
2 pcs. amp. (current) converters
2 pcs. power converters
2 pcs. pressure converters
1 pc. 5 volt DC converter
1 pc. 24 volt DC converter
2 pcs. S-system/thermostat converter
1 pc. current transformer + cables, etc.
2 pcs. input card STBTC for measuring temperatures
1 pc. software Labtech notebook for analyzing signals
1 pc. A/D card RTI 820 for PC
1 pc. Hard disk colour system/PC
1 pc. matrix printer colour system
1 pc. overhead operator control panel
1 pc. Vario transformer
1 pc. frequency meter, digital
1 pc. voltage meter, digital
1 pc. thermometer, digital
1 pc. temperature regulator
1 pc. amperemeter
1 pc. HFI protection relay
1 pc. regulator for fan motors
1 pc. current transformer
1 set relay, cables, clamps etc.
350 kg tylose test packages 200 x 100 x 50 mm
150 kg tylose test packages 100 x 100 x 50 mm
50 kg tylose test packages with thermocouples, 200 x 100 x 50 mm
50 kg tylose test packages with thermocouples 100 x 100 x 50 mm
1,000 m Cu-Constantan thermocouples
2 pcs. Pressure transducers
1 set Software for testing according to ISO 5155.2

SUMMARY

Main plant data

Name	ALASKA	HELWAN	IBERNA	PHILIPS	SILTAL	Super Bosh	*Total*
Employees	250	200	35	240	274	20	1019
Actual production	52,000	9,000	16,000	15,500	22,000	10,000	124,500
Refrigerator models	4	2	3	4	9	4	26
Freezer models	8	2	7	2	2	10	31
CFC-11, t	44	5	14	18	20	10	111
CFC-12, t	11	2.5	5	4	6	3	32
Proposed refrigerant	cyclopentane	cyclopentane	cyclopentane	cyclopentane	cyclopentane	cyclopentane	cyclopentane
Proposed propellent	HFC-134a	HFC-134a	HFC-134a	HFC-134a	HFC-134a	HFC-134a	HFC-134a
Incremental operating cost, US$	220,767	37,945	67,928	68,377	93,495	44,994	533,506
Investment cost, US$	1,662,063	742,820	1,029,468	1,101,541	940,003	764,627	6,240,522
Abatement cost, US$/kg	9.01	21.17	12.39	11.00	9.48	13,03	10,83

SUMMARY

Annex E: Project Budget
(SUMMARY)

Budget line	Duration, work months	Cost, US$
11-01 Chief technical advisor	3.0	39,000
11-50 International Consultants	12.0	150,000
21-01 Subcontract		4,323,060
51-00 Miscellaneous:		
10% contingency fund on capital cost		451,206
Incremental operating cost		533,506
Total miscellaneous cost		984,721
99-99 Subtotal		5,496,772
Implementing Agency Overhead, 13%		714,580
PROJECT TOTAL		**6,211,352**

SUMMARY

Annex F: Calculation of Unit Abatement Cost
(SUMMARY)

A	*ODS Phase out*	Unit	*Total Project*
A1	Average use of CFC 11 per year	mt	111
A2	ODP of CFC 11		1
A3	ODP-weighted CFC 11 phase out (A1*A2)	mt	111
A4	Average use of CFC 12 per year	mt	32
A5	ODP of CFC 12		1
A6	ODP-weighted CFC 12 phase out (A4*A5)	mt	32
A7	Total ODP weighted phase out (A3+A6)	mt	143
B	*Annualized capital cost*	Unit	*Total Project*
B1	Total investment cost		
	(model redefinition + production conversion)	US$	4,963,266
B2	Equipment life	year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	807,523
C	*Annual incremental operating cost*	US$	533,506
D	*Unit abatement cost*	Unit	*Total Project*
D1	Annualized capital cost per kg ODS phased out (B4/A7/1000)	US$/kg	5.65
D2	Annual incremental operating cost per kg ODS phased out (C/A7/1000)	US$/kg	3.73
D3	Unit abatement cost (D1+D2)	US$/kg	**9.38**

ALASKA

Annex A: Equipment Specification and Cost Breakdown

	Quantity	Unit cost, *US$*	Total cost, *US$*
Refrigeration system			
Charging boards for production	2	31,300	62,600
Vacuum pumps	16	160	2,560
HFC 134a leak detectors	2	9,000	18,000
HFC 134a leak detector, back-up	1	1,000	1,000
Testing equipment	1	50,000	50,000
Foaming system			
High pressure foaming machine, 2 heads	2	160,000	320,000
Mixing station	2	60,000	120,000
Water heater system	2	15,000	30,000
Gas detecting system	2	50,000	100,000
Exhaust and ventilation	2	45,000	90,000
Foaming jigs, rebuild. (50% cost sharing)	20	5,000	50,000
Foaming plugs, rebuild. (50% cost sharing)	20	5,000	50,000
Antistatic floor			5,000
Pipe installation	2	15,000	30,000
Cyclopentane tank, pumps, detectors	1	30,000	30,000
Fire protection system	2	30,000	60,000
Pumps and pipes from tank to mixer	1	45,000	45,000
Water chiller	1	11,000	11,000
Refrigeration service			
Evacuation and charging board	3	3,000	9,000
CFC-12 recovery unit for service cars	6	30	180
CFC-12 collection station	1	2,500	2,500
Leak detector for HFC 134a	4	160	640
			54,374
Commissioning/start-up services			
Total			**1,141,854**

ALASKA

Annex B: Refrigerant cost increase

Refrigerant	Filling average	Price,	Cost,	Incremental cost,
	kg	*US$/kg*	*US$*	*US$*
CFC 12	0.2	1.88	0.376	
HFC 134a	0.18	7.07	1.273	**0.90**

Annex C: Foam cost increase

	R-11 system			Cyclopentane system		
Chemical	*wt-%*	*Price $/kg*	*Cost $*	*wt-%*	*Price $/kg*	*Cost $*
Polyol + MDI	86	1.60	1.38	94	1.70	1.60
R 11/Cyclopentane	14	3.30	0.46	6	1.73	0.10
PU-cost			**1.84**			**1.70**
Consumption kg/unit			6.00			6.90
Total cost, US$/unit			**11.03**			**11.74**
Incremental cost difference, US$/unit						**0.71**

Annex D: Incremental operating cost

Modification	*Incremental operating cost*
HFC 134a compressor	5.00
Capillary tube	0.20
Evaporator/Condenser	1.65
Drier 3AA	0.03
HFC 134a refrigerant	0.90
Foam	0.71
Total	8.49
Annual Production in 1993	52,000
6 month production rate	26,000
6 month reimbursement	**220,767**

ALASKA

Annex E: Project Budget

Budget line	Duration, work months	Cost, US$
11-01 Chief technical advisor	1.0	13,000
11-50 International Consultants	2.0	25,000
21-01 Subcontract		1,141,854
51-00 Miscellaneous:		
10% contingency fund on capital cost		117,985
Incremental operating cost		220,767
Total miscellaneous cost		338,752
99-99 Subtotal		1,518,606
Implementing Agency Overhead, 13%		197,419
PROJECT TOTAL		**1,716,025**

ALASKA

Annex F: Calculation of Unit Abatement Cost

A	***ODS Phase out***	*Unit*	*Total Project*
A1	Average use of CFC 11 per year	mt	44
A2	ODP of CFC 11		1
A3	ODP-weighted CFC 11 phase out (A1*A2)	mt	44
A4	Average use of CFC 12 per year	mt	11
A5	ODP of CFC 12		1
A6	ODP-weighted CFC 12 phase out (A4*A5)	mt	11
A7	Total ODP weighted phase out (A3+A6)	mt	55
B	***Annualized capital cost***	Unit	*Total Project*
B1	Total investment cost		
	(model redefinition + production conversion)	US$	1,297,839
B2	Equipment life	year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	211,158
C	***Annual incremental operating cost***	US$	220,767
D	***Unit abatement cost***	Unit	*Total Project*
D1	Annualized capital cost per kg ODS phased out (B4/A7/1000)	US$/kg	3.87
D2	Annual incremental operating cost per kg ODS phased out (C/A7/1000)	US$/kg	4.05
D3	Unit abatement cost (D1+D2)	US$/kg	**7.93**

HELWAN

Annex A: Equipment Specification and Cost Breakdown

	Quantity	Unit cost, US$	Total cost, US$
Refrigeration system			
Charging boards for production	1	31,300	31,300
Charging boards for production	1	20,000	20,000
Vacuum pumps	10	2,000	20,000
HFC 134a leak detectors	1	9,000	9,000
HFC 134a leak detectors, back-up	4	1,000	4,000
Test equipment,	1	50,000	50,000
Foaming system			
High pressure foaming machine modification	1	50,000	50,000
Mixing station	1	60,000	60,000
Water heater system	1	15,000	15,000
Gas detecting system	1	50,000	50,000
Exhaust and ventilation	1	45,000	45,000
Foaming jigs, rebuild. (50% cost sharing)	10	5,000	25,000
Foaming plugs, rebuild. (50% cost sharing)	4	5,000	10,000
Antistatic floor			3,000
Pipe installation	1	15,000	15,000
Cyclopentane tank, pumps, detectors	1	10,000	10,000
Fire protection system	1	30,000	30,000
Pumps and pipes from tank to mixer	1	45,000	45,000
Refrigeration service			
Evacuation and charging board	2	3,000	6,000
CFC-12 collection station	1	2,500	2,500
Leak detector for HFC 134a	2	160	320
Commissioning/start-up services			25,056
Total			**526,176**

HELWAN

Annex B: Refrigerant cost increase

Refrigerant	Filling average	Price,	Cost,	Incremental cost,
	kg	*US$/kg*	*US$*	*US$*
CFC 12	0.24	1.88	0.45	
HFC 134a	0.216	7.07	1.53	**1.08**

Annex C: Foam cost increase

	R-11 system			Cyclopentane system		
Chemical	*wt-%*	*Price $/kg*	*Cost $*	*wt-%*	*Price $/kg*	*Cost $*
Polyol + MDI	86	1.60	1.38	94	1.70	1.60
R 11/Cyclopentane	14	3.30	0.46	6	1.73	0.10
PU-cost			**1.84**			**1.70**
Consumption kg/unit			4.00			4.60
Total cost, US$/unit			**7.35**			**7.83**
Incremental cost difference, US$/unit						**0.48**

Annex D: Incremental operating cost

Modification	*Incremental operating cost*
HFC 134a compressor	5.00
Capillary tube	0.20
Evaporator/Condenser	1.65
Drier 3AA	0.03
HFC 134a refrigerant	1.08
Foam	0.48
Total	**8.43**
Annual Production in 1993	9,000
6 month production rate	4,500
6 month reimbursement	**37,945**

HELWAN

Annex E: Project Budget

Budget line	Duration, work months	Cost, US$
11-50 International Consultants	2.0	25,000
21-01 Subcontract		526,176
51-00 Miscellaneous:		
10% contingency fund on capital cost		55,118
Incremental operating cost		37,945
Total miscellaneous cost		93,063
99-99 Subtotal		644,239
Implementing Agency Overhead, 13%		83,751
PROJECT TOTAL		**727,990**

HELWAN

Annex F: Calculation of Unit Abatement Cost

A	*ODS Phase out*	*Unit*	*Total Project*
A1	Average use of CFC 11 per year	mt	5
A2	ODP of CFC 11		1
A3	ODP-weighted CFC 11 phase out (A1*A2)	mt	5
A4	Average use of CFC 12 per year	mt	2.5
A5	ODP of CFC 12		1
A6	ODP-weighted CFC 12 phase out (A4*A5)	mt	2.5
A7	Total ODP weighted phase out (A3+A6)	mt	7.5
B	***Annualized capital cost***	*Unit*	*Total Project*
B1	Total investment cost (model redefinition + production conversion)	US$	606,294
B2	Equipment life	year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	98,644
C	***Annual incremental operating cost***	US$	37,945
D	***Unit abatement cost***	*Unit*	*Total Project*
D1	Annualized capital cost per kg ODS phased out (B4/A7/1000)	US$/kg	13.15
D2	Annual incremental operating cost per kg ODS phased out (C/A7/1000)	US$/kg	5.06
D3	Unit abatement cost (D1+D2)	US$/kg	**18.21**

IBERNA

Annex A: Equipment Specification and Cost Breakdown

	Quantity	Unit cost, US$	Total cost, US$
Refrigeration system			
Charging boards for production	1	31,300	31,300
Charging boards for production	1	20,000	20,000
Vacuum pumps	16	160	2,560
HFC 134a leak detectors	2	9,000	18,000
Test equipment, extension	1	40,000	40,000
Foaming system			
High pressure foaming machine, 2 heads	1	160,000	160,000
Mixing station	1	60,000	60,000
Water heater system	1	15,000	15,000
Gas detecting system	1	50,000	50,000
Exhaust and ventilation	1	45,000	45,000
Foaming jigs, rebuild. (50% cost sharing)	17	5,000	42,500
Foaming plugs, rebuild. (50% cost sharing)	18	5,000	45,000
Antistatic floor			3,000
Pipe installation	1	15,000	15,000
Cyclopentane tank, pumps, detectors	1	10,000	10,000
Fire protection system	1	30,000	30,000
Pumps and pipes from tank to mixer	1	45,000	45,000
Water chiller	1	11,000	11,000
Refrigeration service			
Evacuation and charging board	3	3,000	9,000
CFC-12 recovery unit for service cars	6	30	180
CFC-12 collection station	1	2,500	2,500
Leak detector for HFC 134a	4	160	640
Commissioning/start-up services			32,784
Total			**688,464**

IBERNA

Annex B: Refrigerant cost increase

Refrigerant	Filling average	Price,	Cost,	Incremental cost,
	kg	*US$/kg*	*US$*	*US$*
CFC 12	0.2	1.88	0.38	
HFC 134a	0.18	7.07	1.27	**0.90**

Annex C: Foam cost increase

	R-11 system			Cyclopentane system		
Chemical	*wt-%*	*Price $/kg*	*Cost $*	*wt-%*	*Price $/kg*	*Cost $*
Polyol + MDI	86	1.60	1.38	94.00	1.70	1.60
R 11	14	3.30	0.46	6.00	1.73	0.10
PU-cost			1.84			1.70
Consumption kg/unit			6.00			6.90
Total cost, US$/unit			**11.03**			**11.74**
Incremental cost difference, US$/unit						**0.71**

Annex D: Incremental operating cost

Modification	*Incremental operating cost*
HFC 134a compressor	5.00
Capillary tube	0.20
Evaporator/Condenser	1.65
Drier 3AA	0.03
HFC 134a refrigerant	0.90
Foam	0.71
Total	**8.49**
Annual Production in 1993	16,000
6 month production rate	8,000
6 month reimbursement	**67,928**

IBERNA

Annex E: Project Budget

Budget line	Duration, work months	Cost, US$
11-50 International Consultants	2.0	25,000
21-01 Subcontract		688,464
51-00 Miscellaneous:		
10% contingency fund on capital cost		71,346
Incremental operating cost		67,928
Total miscellaneous cost		139,275
99-99 Subtotal		852,739
Implementing Agency Overhead, 13%		110,856
PROJECT TOTAL		**963,595**

IBERNA

Annex F: Calculation of Unit Abatement Cost

A	***ODS Phase out***	Unit	*Total Project*
A1	Average use of CFC 11 per year	mt	14
A2	ODP of CFC 11		1
A3	ODP-weighted CFC 11 phase out (A1*A2)	mt	14
A4	Average use of CFC 12 per year	mt	5
A5	ODP of CFC 12		1
A6	ODP-weighted CFC 12 phase out (A4*A5)	mt	5
A7	Total ODP weighted phase out (A3+A6)	mt	19
B	***Annualized capital cost***	Unit	*Total Project*
B1	Total investment cost		
	(model redefinition + production conversion)	US$	784,810
B2	Equipment life	year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	127,689
C	***Annual incremental operating cost***	US$	67,928
D	***Unit abatement cost***	Unit	*Total Project*
D1	Annualized capital cost per kg ODS phased out (B4/A7/1000)	US$/kg	6.72
D2	Annual incremental operating cost per kg ODS phased out (C/A7/1000)	US$/kg	3.58
D3	Unit abatement cost (D1+D2)	US$/kg	**10.30**

EL NASR

Annex A: Equipment Specification and Cost Breakdown

	Quantity	Unit cost, *US$*	Total cost *US$*
Refrigeration system			
Charging boards for production	1	31,300	31,300
Charging boards for production	1	20,000	20,000
Vacuum pumps	8	160	1,280
HFC 134a leak detectors, back-up	8	1,000	8,000
HFC 134a leak detectors	2	9,000	18,000
Test equipment, extension	1	25,000	25,000
Foaming system			
High pressure foaming machine, 2 heads	1	160,000	160,000
Mixing station	1	60,000	60,000
Water heater system	1	15,000	15,000
Gas detecting system	1	50,000	50,000
Exhaust and ventilation	1	45,000	45,000
Foaming jigs, rebuild. (50% cost sharing)	16	5,000	40,000
Foaming plugs, rebuild. (50% cost sharing)	10	5,000	25,000
Antistatic floor			3,000
Pipe installation	1	15,000	15,000
Cyclopentane tank, pumps, detectors	1	10,000	10,000
Fire protection system	1	30,000	30,000
Pumps and pipes from tank to mixer	1	45,000	45,000
Water chiller	1	11,000	11,000
Refrigeration service			
Evacuation and charging board	9	3,000	27,000
CFC-12 recovery unit for service cars	20	30	600
CFC-12 collection station	1	2,500	2,500
Leak detector for HFC 134a	12	160	1,920
Commissioning /start-up services			32,230
Total			676,830

EL NASR

Annex B: Refrigerant cost increase

Refrigerant	Filling average	Price,	Cost,	Incremental cost,
	kg	*US$/kg*	*US$*	*US$*
CFC 12	0.22	1.88	0.41	
HFC 134a	0.198	7.07	1.40	**0.99**

Annex C: Foam cost increase

	R-11 system			Cyclopentane system		
Chemical	*wt-%*	*Price $/kg*	*Cost $*	*wt-%*	*Price $/kg*	*Cost $*
Polyol + MDI	86	1.60	1.38	94	1.70	1.60
R 11/Cyclopentane	14	3.30	0.46	6	1.73	0.10
PU-cost			**1.84**			**1.70**
Consumption kg/unit			8.00			9.20
Total cost, US$/unit			**14.70**			**15.66**
Incremental cost difference, US$/unit						**0.95**

Annex D: Incremental operating cost

Modification	*Incremental operating cost*
HFC 134a compressor	5.00
Capillary tube	0.20
Evaporator/Condenser	1.65
Drier 3AA	0.03
HFC 134a refrigerant	0.99
Foam	0.95
Total	**8.82**
Annual Production in 1993	15,507
6 month production rate	7,754
6 month reimbursement	**68,377**

EL NASR

Annex E: Project Budget

Budget line	Duration, work months	Cost, US$
11-01 Chief technical advisor	1.0	13,000
11-50 International Consultants	2.0	25,000
21-01 Subcontract		676,830
51-00 Miscellaneous:		
10% contingency fund on capital cost		71,483
Incremental operating cost		68,377
Total miscellaneous cost		139,860
99-99 Subtotal		854,690
Implementing Agency Overhead, 13%		111,110
PROJECT TOTAL		**965,799**

EL NASR

Annex F: Calculation of Unit Abatement Cost

A	***ODS Phase out***	*Unit*	*Total Project*
A1	Average use of CFC 11 per year	mt	18
A2	ODP of CFC 11		1
A3	ODP-weighted CFC 11 phase out (A1*A2)	mt	18
A4	Average use of CFC 12 per year	mt	4.5
A5	ODP of CFC 12		1
A6	ODP-weighted CFC 12 phase out (A4*A5)	mt	4.5
A7	Total ODP weighted phase out (A3+A6)	mt	22.5
B	***Annualized capital cost***	*Unit*	*Total Project*
B1	Total investment cost (model redefinition + production conversion)	US$	786,313
B2	Equipment life	year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	127,933
C	***Annual incremental operating cost***	US$	68,377
D	***Unit abatement cost***	*Unit*	*Total Project*
D1	Annualized capital cost per kg ODS phased out (B4/A7/1000)	US$/kg	5.69
D2	Annual incremental operating cost per kg ODS phased out (C/A7/1000)	US$/kg	3.04
D3	Unit abatement cost (D1+D2)	US$/kg	8.72

SILTAL

Annex A: Equipment Specification and Cost Breakdown

	Quantity	Unit cost, US$	Total cost, US$
Refrigeration system			
Charging boards for production	1	31,300	31,300
Charging boards for production	1	20,000	20,000
Vacuum pumps	10	160	1,600
HFC 134a leak detectors	2	9,000	18,000
Extention of existing testing equipment	1	25,000	25,000
Foaming system			
High pressure foaming machine, 3 heads for doors and cabinets	1	180,000	180,000
Mixing station	1	60,000	60,000
Water heater system	1	15,000	15,000
Gas detecting system	1	50,000	50,000
Exhaust and ventilation	1	45,000	45,000
Foaming jigs, rebuild. (50% cost sharing)	4	5,000	10,000
Foaming plugs, rebuild. (50% cost sharing)	20	5,000	50,000
Antistatic floor			3,000
Pipe installation	1	15,000	25,000
Cyclopentane station, pumps, detectors	1	10,000	10,000
Fire protection system	1	30,000	30,000
Pumps and pipes from tank to mixer	1	45,000	45,000
Water chiller	1	11,000	11,000
Refrigeration service			
Evacuation and charging board	3	3,000	9,000
CFC 12 recovery unit for service cars	6	30	180
R12 collection station	1	2,500	2,500
Leak detector for HFC 134a	9	160	1,440
Commissioning/start-up services			112,636
Total			**664,671**

SILTAL

Annex B: Refrigerant cost increase

Refrigerant	Filling average	Price	Cost	Incremental cost
	kg	*US$/kg*	*US$*	*US$*
CFC 12	0.20	1.88	0.376	
HFC 134a	0.18	7.07	1.2726	**0.90**

Annex C: Foam cost increase

	R-11 system			Cyclo-pentane system		
Chemical	*wt-%*	*Price $/kg*	*Cost $*	*wt-%*	*Price $/kg*	*Cost $*
Polyol + MDI	86	1.60	1.38	94.00	1.70	1.60
R 11/Cyclopentane	14	3.30	0.46	6.00	1.73	0.10
PU-cost			**1.84**			**1.70**
Consumption kg/unit			6.00			6.90
Total cost, US$/unit			**11.03**			**11.74**
Incremental cost difference, US$/unit						**0.71**

Annex D: Incremental operating cost

Modification	Incremental operating cost
HFC 134a compressor	5.00
Capillary tube	0.20
Evaporator/Condenser	1.65
Drier 3AA	0.03
HFC 134a refrigerant	0.90
Foam	0.71
Total	8.49
Annual Production in 1993	22,022
6 month production rate	11,011
6 month reimbursement	93,495

SILTAL

Annex E: Project Budget

Budget line	Duration, work months	Cost, US$
11-01 Chief technical advisor	1.0	13,000
11-50 International Consultants	2.0	25,000
21-01 Subcontract		664,671
51-00 Miscellaneous:		
15% contingency fund on capital cost		70,267
Incremental operating cost		93,495
Total miscellaneous cost		163,762
99-99 Subtotal		866,433
Implementing Agency Overhead, 13%		112,636
PROJECT TOTAL		**979,069**

SILTAL

Annex F: Calculation of Unit Abatement Cost

A	***ODS Phase out***	Unit	*Total Project*
A1	Average use of CFC 11 per year	mt	20
A2	ODP of CFC 11		1
A3	ODP-weighted CFC 11 phase out (A1*A2)	mt	20
A4	Average use of CFC 12 per year	mt	6
A5	ODP of CFC 12		1
A6	ODP-weighted CFC 12 phase out (A4*A5)	mt	6
A7	Total ODP weighted phase out (A3+A6)	mt	26
B	***Annualized capital cost***	Unit	*Total Project*
B1	Total investment cost		
	(model redefinition + production conversion)	US$	772,938
B2	Equipment life	year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	125,757
C	***Annual incremental operating cost***	US$	93,495
D	***Unit abatement cost***	Unit	*Total Project*
D1	Annualized capital cost per kg ODS phased out (B4/A7/1000)	US$/kg	4.84
D2	Annual incremental operating cost per kg ODS phased out (C/A7/1000)	US$/kg	3.60
D3	Unit abatement cost (D1+D2)	US$/kg	**8.43**

SUPER BOSH

Annex A: Equipment Specification and Cost Breakdown

	Quantity	Unit cost, *US$*	Total cost, *US$*
Refrigeration system			
Charging boards for production	1	31,300	31,300
Vacuum pumps	2	2,000	4,000
HFC 134a leak detector, back-up	1	1,000	1,000
HFC 134a leak detectors	1	9,000	9,000
Test equipment	1	50,000	50,000
Foaming system			
High pressure foaming machine, 2 heads	1	160,000	160,000
Mixing station	1	60,000	60,000
Water heater system	1	15,000	15,000
Gas detecting system	1	50,000	50,000
Exhaust and ventilation	1	45,000	45,000
Foaming jigs, rebuild. (50% cost sharing)	10	5,000	25,000
Foaming plugs, rebuild. (50% cost sharing)	10	5,000	25,000
Antistatic floor			3,000
Pipe installation	1	15,000	15,000
Cyclopentane tank, pumps, detectors	1	10,000	10,000
Fire protection system	1	30,000	30,000
Pumps and pipes from tank to mixer	1	45,000	45,000
Water chiller	1	11,000	11,000
Refrigeration service			
Evacuation and charging board	1	3,000	3,000
CFC 12 recovery unit for service cars	6	30	180
R12 collection station	1	2,500	2,500
Leak detector for HFC 134a	2	160	320
Commissining/start-up services			29,765
Total			**625,065**

SUPER BOSH

Annex B: Refrigerant cost increase

Refrigerant	Filling average	Price,	Cost,	Incremental cost,
	kg	*US$/kg*	*US$*	*US$*
CFC 12	0.3	1.88	0.56	
HFC 134a	0.27	7.07	1.91	**1.34**

Annex C: Foam cost increase

	R-11 system			Cyclopentane system		
Chemical	*wt-%*	*Price $/kg*	*Cost $*	*wt-%*	*Price $/kg*	*Cost $*
Polyol + MDI	86	1.60	1.38	94	1.70	1.60
R 11/Cyclopentane	14	3.30	0.46	6	1.73	0.10
PU-cost			1.84			1.70
Consumption kg/unit			6.50			7.48
Total cost, US$/unit			**11.95**			**12.72**
Incremental cost difference, US$/unit						**0.77**

Annex D: Incremental operating cost

Modification	*Incremental operating cost*
HFC 134a compressor	5.00
Capillary tube	0.20
Evaporator/Condenser	1.65
Drier 3AA	0.03
HFC 134a refrigerant	1.34
Foam	0.77
Total	**9.00**
Annual Production in 1993	10,000
6 month production rate	5,000
6 month reimbursement	**44,994**

SUPER BOSH

Annex E: Project Budget

Budget line	Duration, work months	Cost, US$
11-50 International Consultants	2.0	25,000
21-01 Subcontract		625,065
51-00 Miscellaneous:		
10% contingency fund on capital cost		65,007
Incremental operating cost		44,994
Total miscellaneous cost		110,001
99-99 Subtotal		760,066
Implementing Agency Overhead, 13%		98,809
PROJECT TOTAL		**858,874**

SUPER BOSH

Annex F: Calculation of Unit Abatement Cost

A	*ODS Phase out*	Unit	*Total Project*
A1	Average use of CFC 11 per year	mt	10
A2	ODP of CFC 11		1
A3	ODP-weighted CFC 11 phase out (A1*A2)	mt	10
A4	Average use of CFC 12 per year	mt	3
A5	ODP of CFC 12		1
A6	ODP-weighted CFC 12 phase out (A4*A5)	mt	3
A7	Total ODP weighted phase out (A3+A6)	mt	13
B	***Annualized capital cost***	Unit	*Total Project*
B1	Total investment cost		
	(model redefinition + production conversion)	US$	715,072
B2	Equipment life	year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	116,342
C	***Annual incremental operating cost***	US$	44,994
D	***Unit abatement cost***	Unit	*Total Project*
D1	Annualized capital cost per kg ODS phased out (B4/A7/1000)	US$/kg	8.95
D2	Annual incremental operating cost per kg ODS phased out (C/A7/1000)	US$/kg	3.46
D3	Unit abatement cost (D1+D2)	US$/kg	**12.41**

WS Atkins Consultants Limited
Technical Review - Foam Project

1. Country of Origin : Egypt

2. Project Title : Phasing out ODS at the ALASKA, Helwan Company for metallic Appliances, IBERNA, EL Nasr Company for Electrical and Electronic Apparatus, SILTAL and SUPER BOSH domestic refrigerator plants.

3. Sector / sub-sector Domestic Refrigeration / Rigid Foam

4. Relationship to Country Programme

a) The Country Programme has not been seen.

b) It is not clear if this project is part of a sectoral/sub-sectoral strategy.

5. Technology

a) Cyclopentane foaming is inherently more hazardous than other available alternatives. The project document makes reference to some relevant safety features under the heading III Project Description, B Foam System on pages 8,9 and 10. The following points should also be included.

cyclopentane will be stored outside the factory building

local safety regulations should be cited.

b) The technology involved is not transitional cyclopentane has a zero ODP.

c) (i) Technology transfer will come from POLYFA Trading AS, who are designated as the main contractor Copenhagen but no formal agreement is referenced. Some description of this relationship in terms of technology transfer should be included.

(ii) All of the companies involved in this project have licensing agreements with European or American companies.

(iii) Alternative foaming technology using HCFC 141b and other transitional solutions was considered.

(iv) The technology selected is the most cost effective available non-transitional solution.

6. Environmental Impact

a) Cyclopentane has a zero ODP

b) The proposal details some measures to minimize health and safety impact, this should be expanded as recommended.

7. Project Costs

a) The cost elements detailed in the budget appear to be necessary for the conversion. More detail should be added to support and justify the cost elements in Annex A.

The participating companies are contributing 50% of the cost of modification of jigs and plugs.

b) The principal cost elements detailed would not be expected to be present prior to the conversion of the plant.

Cost of Equipment

c) The existing CFC 11 foaming equipment is low pressure machinery and must be replaced in 5 of the 6 factories. One company will be able to convert existing equipment. No reference is made to the baseline cost of existing equipment.

The fate of scrapped equipment has been addressed. The equipment has no residual value.

A production increase is planned at only one site, IBERNA, where production of an Isobutane refrigerator is being considered. It should be made clear that the cost of this will not form part of the incremental costs which constitute the grant application.

d) Training and technology familiarisation is essential particularly safety training. Technology training costs are indicated in Annex F as study tours. Further detail should be given, probably in Annexes B and F, for on site technology training, particularly safety training .

There will be some redundant production costs but these have not been included.

e) (i) The incremental operating costs seem appropriate. A figure of 15% increase in PU is given due to density changes, although 10% is more normal this figure does not seem unreasonable. Savings occur through the cost differential between cyclopentane and CFC-11.

(ii) No transitional period is required.

Other Costs

f. Consultancy costs, and Implementing Agency Overhead costs are reasonable

A contingency of 15% has been included to ensure adequate funding of project capital costs, this is appropriate but should be reviewed once equipment costs have been finalised.

Cost Effectiveness

g) The unit abatement cost for the cyclopentane foaming part of the overall project is 7.85 \$/kg including contingency on capital, this indicates a good level of cost effectiveness.

The ratio of net incremental costs to immediate ODP phase out is 44.1 \$/kg based on the level of funding requested

The project is environmentally cost effective

Implementation Time

h) The proposed implementation time frame is feasible.

Recommendations

i) Approval after modification as follows :

More detail should be added to support and justify the cost elements in Annex A. The capital cost elements are equal for all sites regardless of production size, is this really the appropriate.

More detail is needed to describe how the layout and process design of the plant will ensure maximum safety, for example the Cyclopentane tank should be located outside and remote from the main working area.

A safety annex should be added to detail how safety will be ensured and maintained, this should include a mechanism for safety audits of the plant once it is in operation and describe the role of the technology partners.

Training and technology familiarisation is essential particularly safety training. Technology training costs are indicated in Annex F as study tours. Further detail should be given, probably in Annexes B and F, for on site technology training, particularly safety training .

ii) Other comments :

Pre-filling of foam cavities with nitrogen is not commonly done although it is an additional safety feature. .

PROJECT COVER SHEET

COUNTRY	Egypt
PROJECT TITLE	Elimination of CFCs in the manufacture of Commercial Refrigeration Equipment (tw) enterprises)
SECTOR COVERED	Refrigeration and Foams
ODS USE IN SECTORS	Refrig: 1,040 t CFCs (870t ODS) 1991 Foams: 722t CFCs (722t ODS) 1991
PROJECT IMPACT	Phaseout of 28.2 tons/year CFC-11, 3.1 t/y CFC-12 and 1.1 t/y R-502 (base 1993) (32.3 t/y ODS)
PROJECT DURATION	One year
PROJECT ECONOMIC LIFE	10 years
TOTAL PROJECT COST	USD1,023,000 Incremental Capital Cost
PROPOSED MLF GRANT	USD1,023,000
COST EFFECTIVENESS	USD5.15 kg/yr (Unit Abatement Cost)
COORDINATING NATIONAL BODY	Egyptian Environmental Affairs Agency (EEAA)
IMPLEMENTING AGENCY	UNDP
APPRAISAL DATE	April/June/October 1994

PROJECT SUMMARY

This project is the second group of manufacturers of commercial refrigeration equipment in Egypt. There are two more companies identified that will become the core of a third project group that should complete the ODS phaseout plan in the commercial refrigeration portion of the foam sector. This project includes the replacement of CFC-11 in the production of rigid PUF insulation (commercial and institutional refrigerators, freezers, and cold storage panels), and the charging of CFC-12 and R-502 in refrigeration units in the assembly operations. Many of the remote servicing operations are independently owned so they are not included. There will be a group project prepared for the reclaim/recycling of CFC-12/R-502 from servicing operations.

Prepared by: Jerry S. Pool, Stuart W. Kelly, UNDP Consultants
Reviewed by: Bert Veenendaal, UNDP Foam Sector Expert

PROJECT OF THE GOVERNMENT OF EGYPT

ELIMINATION OF CFCs IN THE MANUFACTURE OF COMMERCIAL REFRIGERATION EQUIPMENT

1. PROJECT OBJECTIVE

The objective of this project is to eliminate CFCs used by Port Said Metal Work Co. and Royal Engineering Co., manufacturers of unitary and non-unitary commercial refrigeration equipment.

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 MLF 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

3.1 PORT SAID METAL WORK CO.

Port Said Metal Work Co. (MOG) is a 100% Egyptian, privately owned enterprise. The production facilities are located in 10th, Ramadan City, with a showroom in Nasr City. The enterprise started operations in sheet metal fabrication and expanded to include refrigeration equipment. MOG manufactures currently a wide range of catering equipment for the commercial and institutional sector, including refrigerated food storage and display systems. The refrigeration products include unitary chiller and freezer cabinets, as well as "walk-in" cold rooms. The company also has a service net that includes five regional service centres. In 1993 all production was sold in the Egyptian market.

CFC-11 is used as a blowing agent in the manufacture of rigid PUR insulation foam. CFC-12 and R-502 are used in both equipment manufacturing and in servicing operations. In 1993, ODS consumption was as follows:

CFC-11 for insulation foam	:	10.20 tons
CFC-12 for new equipment	:	1.30 tons
CFC-12 for servicing	:	0.30 tons
R-502 for new equipment	:	0.20 tons
R-502 for servicing	:	0.05 tons

The ODS consumption for manufacturing operations served the production of 500 refrigeration cabinets, 50 chiller rooms, 50 cabinet freezers and 5 freezer rooms. The consumption of ODS through MOG's service net in 1993 was as follows:

SERVICE CENTER LOCATION		ODS CONSUMPTION (1993; kg) CFC-12	R-502
1.	Nasr City	90.0	15.0
2.	10th of Ramadan	75.0	12.5
3.	Alexandria	30.0	5.0
4.	Tanta	30.0	5.0
5.	El Kardaka	75.0	12.5
	Totals	**300.0**	**50.0**

All major refrigeration equipment components are imported. Small, hermetic compressors are sourced from Danfoss and Tecumseh, whilst the larger semi-hermetic compressors used for the "walk-in" chiller and freezer rooms are obtained from Copeland. All unitary equipment is manufactured on the same production line and existing refrigerant charging equipment consists solely of vacuum pumps (2), manifold gauge sets (2) and a hand-held refrigerant leak detector.

Insulation foams are produced on a low pressure OMS dispenser with an output of up to 60 kg/min. The usage of foam chemicals in 1993 was about 70t, from which about 10t CFC-11.

3.2 **ROYAL ENGINEERING CO.**

Royal Engineering Co. ("Royal") is a fully Egyptian owned enterprise with production facilities in Giza. It manufactures a range of unitary and non-unitary commercial refrigeration equipment consisting of 14 different models of both chillers and freezers. The company also operates a service system with centres in Cairo and Alexandria. In addition, Royal represents the Swiss compressor manufacturer Sulzer and installs and services Sulzer based commercial and industrial air-conditioning equipment. In 1993, about 90% of the production was sold in the Egyptian market, with the balance exported to other Middle East markets.

Royal uses CFC-11 as blowing agency in the manufacture of rigid PUR insulation foam. CFC-12 and R-502 is used in the manufacture of refrigeration equipment as well in the servicing of such equipment. In 1993, ODS consumption was as follows:

CFC-11 for insulation foam	:	18.00 tons
CFC-12 for new equipment	:	1.96 tons
CFC-12 for servicing	:	0.48 tons
R-502 for new equipment	:	0.84 tons
R-502 for servicing	:	0.26 tons

All major refrigeration equipment components are imported. Small, hermetic compressors are sourced from Danfoss, whilst the larger semi-hermetic compressors used for non-unitary supermarket storage and display systems are obtained from Copeland. All unitary equipment is manufactured on the same production line. Royal uses Galileo refrigerant charging equipment for both CFC-12 and R-502 as well as vacuum pumps and leak detection equipment. More information on existing equipment is provided in para 5.2.3.

Insulation foams are produced on a low pressure foam dispenser with an output of up to 80 kg/min. The usage of foam chemicals in 1993 was about 120t, from which about 18t CFC-11.

4. PROJECT DESCRIPTION

Under this project, MOG and Royal will phase out the use of ozone depleting substances in their manufacturing operations through the use of cyclopentane to replace CFC-11, HFC-134a to replace CFC-12 and 502R to replace R-502. In addition, the project includes the recycle/reuse of ODSs that otherwise would be emitted at the service operations. Based on 1993 operations, the amount of ODS eliminated appears in the following table:

ENTERPRISE	CFC-11 (tons)	CFC-12 (tons)	R-502 (tons)	TOTAL ODP (TONS) ELIMINATED
MOG	10.2	1.40	0.20	11.67
ROYAL	18.0	2.29	1.02	20.63
TOTAL	**28.2**	**3.69**	**1.22**	**32.30**

Notes:
- ODP of R-502; 0.334.
- MOG will eliminate 100 kg/y CFC-11 by recovery/recycling. Quantities recovered from R-502 are minor and not included.
- Royal will eliminate an estimated 330kg/y CFC-12and 180kg/y R-502 through recovery and recycling.

1 The designation 502R refers to zero ODP replacements for R-502, such as R-404A, R-407A, etc. The actual choice of replacement will be made in cooperation with and depending on the compressor supplier.

The project includes incremental capital costs to cover equipment substitution, safety devices, technology transfer, trials and training. The companies do not request disbursement of incremental recurrent costs.

5. TECHNOLOGY

5.1 INSULATION FOAM

5.1.1 OVERVIEW

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

- ° CFC-11 > partial water/HCFC-1411b>?
- ° CFC-11 > partial water/HCFC-22, 142b> HFC-134a, 152a

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 -- also called the "liquid solution" -- employs technology that is closely related to the existing one. The final step in this process is not yet decided. A potential solution is the use of liquid HFCs currently under development (HFC-356 and -245 isomers), but full water blown foam with improved cell structure remains an option, specifically in "lesser demanding" systems such as water heaters, pipe insulation and spray foams where insulation values are less critical or where dimensional changes are possible.

The second one -- also called the "gas" solution -- utilizes a gaseous mixture of physical blowing agents, requires always high pressure equipment, and extensive adjustments to avoid -- or to deal with -- frothing. The final step in this process is seen as the introduction of (gaseous) HFC's such as HFC-134a.

(Cyclo)pentane technology is being used commercially in Europe. Its flammable character requires safety considerations and limits its use to factories that can be adapted to meet those requirements and can be trusted to maintain the operation in a safe way.

5.1.2 SELECTION

The company has selected the use of cyclopentane to replace CFC-11. Cyclopentane has no ODP and a very low GWP. HCFCs have been considered but constitute transitional technologies. The company has decided to use directly non-ODS technology in analogy to its neighbouring markets in Europe.

5.1.3 REQUIRED MODIFICATIONS

The use of cyclopentane (CP) will require substantial changes in the production and storage facilities based on the highly flammable/explosive character of the substance. The adherence to the strictest safety standards available, such as EN, NFPA or other internationally recognized standards is required for UNDP implemented projects. These standards classify explosive zones ("EX areas") generally in three categories:

Zone 0 **Where a constant amount of highly flammable/explosive liquids or gases can be expected. Areas inside CP pipes and tanks are Zone 0 (level, pressure and temperature controls). Materials used have to be explosion proof (EX) and grounded.**

Zone 1 **Where from time to time highly flammable liquids or gases can be expected; Areas in and around molds and fixtures are Zone 1. and grounded. Zone-1 can generally be reclassified to Zone 2 by applying sufficient ventilation.**

Zone 2 **Where only by accident or scheduled maintenance highly flammable/explosive gases can be expected. Tank storage areas, premix stations and foam dispensers are generally Zone 2. Materials required are Ex-n or with IP54 sealing. Grounding to avoid spark building triggered by differences in electrical potential, is required.**

Other requirements related to the use of CP are:

- **The installation of containment around CP storage tanks;**
- **Installation of premix equipment -- CP cannot be purchased pre-blended;**
- **Antistatic clothing and shoes in Zone 0/1 areas;**
- **Installation of CP gas sensors in all EX areas, connected to a central panel and an automatic recorder/printer;**
- **A portable gas detector to monitor CP concentrations throughout the plant according to an approved monitoring plan;**
- **An approved preventive maintenance system and emergency response plan;**
- **Training for production and maintenance personnel in the safe handling of CP;**
- **Process Safety Audits (PSAs) by a UNDP appointed independent contractor prior, during and after implementation.**

In line with the above-mentioned modifications on equipment and safety requirements, process adjustments are required to cope with the lower insulation value, higher core temperatures and longer aging times related to the use of CP.

THE USE OF CYCLOPENTANE MUST CONFORM TO THE SAFETY REQUIREMENTS OF RELEVANT LOCAL AND STATE AUTHORITIES

5.2 REFRIGERANT

5.2.1 OVERVIEW

HFC-134A is universally accepted as a replacement for CFC-12 in the manufacture of domestic and commercial refrigeration equipment using both hermetic and semi-hermetic compressors. HFC-134A is widely available and the technology is mature, having already been introduced in many of the Developed countries.

A number of zero-ODP replacements for R-502 are commercially available from refrigerant suppliers, including R-404A and R-407A. Different compressor manufacturers have tested and adapted to different alternatives and thus have specific recommendations for their own compressor.

While hydrocarbon refrigerants are being used on a limited base in at least one developed country. The use of a flammable substance triggers safety issues that have to be dealt with on manufactures level as well on users level. No transfer of this technology to a developing country has been taken place so far.

HFC-12a might be considered as another candidate for CFC-12 replacement in unitary commercial refrigeration equipment. The substance is also flammable, is not yet commercially offered and some questions around the stability in refrigerator systems remain.

5.2.2. SELECTION

The selected technology for CFC-12 replacement is HFC-134a. The selection of a replacement for R-502 will be decided in consultation with the compressor supplier(s). The CFC-12/R-502 technology used by both MOG and Royal was developed "in house" with support of refrigerant, compressor and lubricant suppliers. The replacement technology will in analogy be developed with assistance of compressor manufacturers.

5.2.3 REQUIRED MODIFICATIONS

Commercially available R-502 rreplacements are based on HFC-134a blended with other components to give the required lower temperature performance. These blends are non-flammable and have very low toxicity. For the purpose of this project proposal, therefore, the following comments relating to HFC-134a can also generally be ascribed to the commercially available R-502 replacements.

HFC-134a, like CFC-12, is non flammable. HFC-134a has also been the subject of extensive toxicological testing and is considered safe in industrial applications provided the suppliers recommended occupational exposure limits are not exceeded. At the present time, this means ensuring that exposure levels do not exceed 1,000 ppm on an 8-hour time weighted average basis (TWA). This is identical to the allowed threshold limits for CFC-12 and thus no changes from current practices are required.

There will be an approximately 10% reduction in the mass charge of HFC-134a compared with CFC-12 for a refrigerator system of the same capacity.

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

Because system cleanliness and moisture content are paramount to the successful manufacture of hermetic compressor based HFC-134a refrigeration systems, both MOG and Royal will need to carefully re-assess production procedures and re-train production personnel.

The conversion from CFC-12 to HFC-134a will take place on a model by model basis, so that the enterprises will be producing both CFC-12 and HFC-134a equipment during the implementation phase of the project. This is feasible, given the configuration of the production facilities. This means that there is a requirement for new system evacuation equipment and refrigerant charging equipment at both enterprises.

Leak detection of the refrigeration system is an integral part of the manufacturing process and the use of HFC-134a requires that new leak detection equipment be employed.

The relevant existing equipment that will be impacted by the change in technology is as follows:

MOG	-	1 Ritchie model 9302 vacuum pump (7.5 cfm capacity)
	-	1 FastVac dual stage vacuum pump (2.5 cfm capacity)
	-	1 GE H-10B hand-held electronic leak detector
ROYAL	-	1 Galileo R-12 refrigerant charging unit
	-	1 Galileo R502 refrigerant charging unit
	-	1 Galileo vacuum pump (8 m/hr capacity)
	-	1 Galileo vacuum pump (3 m/hr capacity)
	-	2 Yokogawa hand-held halogen refrigerant leak detectors

All the vacuum pumps are in operation. Retrofit of the existing vacuum pumps is not considered feasible given the phased nature of the change from CFC-12 to HFC-134a technology.

6. PROJECT COSTS

6.1 INCREMENTAL CAPITAL COSTS

6.1.1 MOG

INSULATION FOAM

Pentane Foam Dispenser	USD	160,000
Blowing Agent Blending Machine	USD	60,000
Pentane Storage System	USD	30,000
Fire Safety, Exhaust, Detection, Safe Electricals	USD	80,000
Technology, Transfer & Training	USD	15,000
Foam Trials	USD	5,000
Contingency	USD	35,000
Subtotal	**USD**	**385,000**

REFRIGERATION SYSTEM

CFC-12 manifold gauge set & hoses	USD	200
R-502 manifold gauge set & hoses	USD	200
New vacuum pumps	USD	3,400
Leak detection equipment	USD	1,000
Training	USD	5,000
Re-design, prototyping, testing pilot scale production and reliability test trials	USD	50,000
Technology transfer, technical assistance	USD	20,000
CFC-12 recovery & recycling machine	USD	5,000
R-502 recovery & recycling machine	USD	5,000
Contingency	USD	9,200
Subtotal	**USD**	**99,000**
TOTAL INCREMENTAL COSTS MOG	**USD**	**484,000**

6.1.2 ROYAL

INSULATION FOAM

Pentane Foam Dispenser	USD	160,000
Blowing Agent Blending Machine	USD	60,000
Pentane Storage System	USD	30,000
Fire Safety, Exhaust, Detection Safe Electricals	USD	80,000
Technology Transfer & Training	USD	15,000
Foam Trials	USD	5,000
Contingency	USD	35,000
Subtotal	USD	385,000

REFRIGERATION SYSTEM

Refrigerant charging unit for HFC-134a	USD	25,000
Refrigerant charging unit for R-502	USD	25,000
New vacuum pumps	USD	3,400
Leak detection equipment	USD	1,000
Training	USD	5,000
Re-design, prototyping, testing, pilot scale Production and reliability test trials	USD	50,000
Technology transfer, technical assistance	USD	20,000
CFC-12 recovery and recycling machine	USD	5,000
R-502 recovery and recycling machine	USD	5,000
Contingency	USD	14,600
Subtotal	**USD**	**154,000**
TOTAL INCREMENTAL CAPITAL COSTS ROYAL	**USD**	**539,000**

6.1.3 SUMMARY

MOG	**USD**	**484,000**
ROYAL	**USD**	**539,000**
TOTAL INCREMENTAL CAPITAL COST	**USD**	**1,023,000**

6.2 OPERATING COSTS

Consistent with previous projects in the commercial refrigeration sector in Egypt, the companies will not seek disbursement of incremental recurrent costs.

6.3 UNIT ABATEMENT COST

C	=	Project costs for ODS reduction	USD	1,023,000
F	=	Capital Recovery Factor (10y; 10%)		0.16275
OC	=	Incremental Operating Costs	USD	0.00
OS/R	=	Incremental Operating Savings/Revenue	USD	0.00
ODP	=	ODP Reduction in first year, kilograms		32,300

Unit Abatement Costs $\frac{C(F) + (OC-OS/R)}{ODP}$ **USD/kg/y**

7. FINANCING PLAN

The companies request financing in the amount of the full project costs of

USD1,023,000

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP will oversee the successful implementation of this project and provide technical assistance during project execution. The project will be carried out at the companies facilities in 6th of October and 10th of Ramadan.

8.2 PROCUREMENT

UNDP will oversee the procurement activities under this project and will provide technical and procedural assistance.

8.3 **SCHEDULE**

TASK	TIME TO COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Presentation						
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	xxx	xxx	xx
Certification						x

9. **PROJECT IMPACT**

This project will eliminate theuse of 32.3 t/y ODP (1993 base).

ANNEX: TECHNICAL REVIEW

PROJECT COVER SHEET

COUNTRY:	Egypt
PROJECT TITLE:	Conversion to CFC-free Technology in the Manufacturing of Rigid PU Foam (seven enterprises)
SECTOR COVERED:	Foamed Plastics
ODS USE IN SECTOR:	722 tons CFCs (722 tons ODS) in 1991
PROJECT IMPACT:	Phaseout of the use of 68.8 tons/year CFC-11 (1993) in the manufacturing of rigid polyurethane foam for insulation.
PROJECT DURATION:	One year
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	USD 780,000 Incremental Capital Cost
PROPOSED MLF GRANT:	USD 780,000
COST EFFECTIVENESS:	USD 1.85 /kg/y (Unit Abatement Cost)
COORDINATING NATIONAL BODY:	Egyptian Environmental Affairs Agency (EEAA)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	Oct. 18, 1994

PROJECT SUMMARY

Under this project, Egypt will substantially complete the phaseout of CFCs in the manufacture of hot water heaters, solar panels, thermos bottles, construction panels, and spray applications of rigid polyurethane foams, leading to an annual reduction of 68.8 tons ODS/year. There are other rigid panel manufacturers who specialize in cold storage applications. They have selected the pentane solution and are covered by another project.

Six companies involved will install high pressure foam dispensing equipment allowing the use of CFC-free systems. The phaseout strategy will be water based systems. The project is a demonstration project for the Global strategy for small ODS-users in the foam industry, to show the cost savings from the combination of small users in one project. The seventh company has 2 high pressure machines and will need only technical aid.

Prepared by: Mr. Jerry Pool, UNDP Process Consultant
Reviewed by: Mr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF EGYPT

ELIMINATION OF CFCS IN THE MANUFACTURE OF RIGID POLYURETHANE FOAM AT SEVEN (7) FACTORIES

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of rigid polyurethane foam at seven companies in Egypt. One company (Petrojet) manufacturers insulated pipe for the transport of hot oil and chemicals. The other companies produce hot water heaters, solar energy systems, thermos bottles of various sizes, limited custom products, or laminated insulation panels for walls and roofs of industrial and commercial buildings.

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. ENTERPRISES' BACKGROUND

3.1 GMC, EGYPTIAN SHARING COMPANY

GMC is a privately owned, 100% Egyptian company located in 6th Of October City. They manufacture and market household appliances, such as gas cookers, washing machines, dishwashers, electric room heaters, water heaters, fans, etc. They also import and assemble domestic refrigerators. (Compressors are all ready installed).
The company has an invested capital of USD 26,000,000 in a facility of 76,500 m^2. They are presently constructing an addition of 38,000 m^2, with plans to add that much more in the next 2 years. Current employment is 1,500 and current sales are USD 19,690,000.

The CFC usage is in rigid urethane insulation for the water heaters. They manufacture 20 to 80 liter units and fill the cavity between the inner and outer shell with foam in place urethane using an OMS Impianti (12 kilo) low pressure foam machine . They currently use 60 tons of urethane chemicals per year (10 tons of CFC-11) and expect that to double over the next 3 years.

3.2 PETROJET

Petrojet is a 100% state owned company with branches in Alexandria (2), Suez, Giza, and Cairo. The head office is also in Cairo. There are approximately 15,000 employees. Petrojet functions as a general contractor in large scale marine and industrial construction. Its pipe factory supplies coated and/or insulated pipe to the petroleum and chemical industries. There are 120 employees in the factory and 7 to 10 field crews with 10 to 12 people in each crew. There are 3 Binks spray foam machines located on the factory production line and "about 7 machines in the field" at various locations. Production at the pipe factory varies from year to year as a function of the contracted work. Foam usage from 1983 through 1993 was 1,500 tons or an average of 150 tons per year. That is an average of 25.5 tons of CFC per year.

3.3 MODERN PRODUCTS

Modern Products is a 100% Egyptian, privately-owned company that was founded in 1990 by the family of Dr. Mohamed Tarek Elewa, who teaches electrical engineering at the university. The company manufactures 10 liter thermos containers for food and liquids and assembles plastic end caps and liner to a metal exterior that are manufactured by other companies to Modern's design and specification. Once assembled, Modern fills the cavity between the interior liner and the exterior metal shell with rigid urethane foam for insulation and strength. The completed units are then packaged and shipped directly to retail stores for sale to the public. The company directly employs 8 people in the assembly, foaming, and packaging operation. It has a GRACO foam machine from France with a fixed 1/1 ratio capable of 14 kilos per minute throughput. Their 1993 chemical consumption was 25 tons containing 3.8 tons of CFC-11.

3.4 CAIRO GENERAL CONTRACTORS COMPANY

Cairo General is a 100% state owned company located in Heickstep outside Cairo, Egypt. It was founded in 1981 and functions as a general contractor in smaller scale military and civilian construction projects. They employ 75 people of which 8 are involved in the rigid urethane foam production. The production of foam is connected with the manufacturing of the "W-Panel", a unique laminated foam/concrete construction panel licensed from CS & M Incorporated of Chino, California USA. The panel consists of a three dimensional 14 gauge wire frame. Each surface of the wire has a 2 inch square welded mesh pattern of longitudinal and transverse wires. Individually welded spreader wires, designed to maintain the surfaces wires at the required distance apart, extend between the two panel faces and hold them approximately 2 inches apart. The wire frames are placed on a solid belt conveyor covered with 1/2 inch of sand. With the bottom face of the wire grid buried in the sand, the panel is passed under a traversing spray gun for the rigid foam application. The chemical lay-down rate is designed to produce a foamed layer approximately 1 inch thick located in the center between the two wire grid surfaces. At the end of the conveyor, the layer of sand drops away for recycling, and the panel is allowed to cure before being shipped to a construction site.

At the site the panels are wired together to form walls, ceilings, beams, etc. as required to frame the building. The panels are then coated with a 7/8 inch layer of cement by various means (plastering, spraying, etc.) and when cured, offer a strong, lighter weight, insulated, water resistant means of rapid construction. The rigid foam spray equipment is a Binks, model 101 that came as part of the foam panel line when it was purchased in 1981 at the time the company was founded. It operates at a capacity of 2.25 kilos per minute. Since Cairo General works on a contract basis, production will vary considerably. However, over the last 13 years, they have used 1,000 metric tons of chemicals containing 150 tons of CFC-11 for an average usage of 11.5 tons per year.

3.5 EGYPTIAN SOLAR ENERGY COMPANY

Egyptian Solar is a 100% Egyptian, privately owned company, founded in 1988, located in 6th of October City. The company manufactures solar panels and hot water storage tanks. The panels are in sizes up to 2.5 meters long and 0.9 meters wide. The hot water tanks are in sizes of 180, 360, 500, and up to 5,000 liters capacity. The company employs 25 people of which 5 are in the rigid foam operation. The foam is used as insulation around the sides and bottom of the solar panels and on the hot water tanks. For the water tanks, a metal shell is fabricated to cover the water tank, leaving a 75 to 80 mm thick cavity between the tank and the outer shell. Rigid urethane foam is used to fill the cavity and provides insulation to keep the water hot. Egyptian Solar has a Cannon foam machine (60 kg) manufactured in 1988. In 1993, its CFC-11 consumption was 4.5 tons. In 1994, the company has switched to a 50% reduced CFC-11 formulation which they import from Italy.

3.6 TAWFIKIA

Tawfikia Products is a 100% Egyptian, privately owned company that was founded in 1984. The company weaves brightly colored area rugs from polypropylene fiber that is extruded on sites, and uses the reground for producing strapping bands for commercial/industrial packaging. In 1987, Tawfikia began producing 600 cc and 1,000 cc thermos bottles insulated with rigid urethane. The polyethylene inner bottle and polypropylene exteriors are produced by another company in Tawfikia's molds. The thermoses are assembled, foamed, and packaged for distribution at the Tawfikia plant. In 1993, the company did contract filling of 10 liter thermoses for another company and is currently obtaining its own molds for 8 and 10 liter units to add to their product line.

Tawfikia employs 150 people, of which 15 are involved in the thermos manufacturing. Three of those operate the foam machine. The company has a low pressure Cannon machine, model C7 (7 kilo). In 1992, 30 tons of rigid foam chemicals were consumed. The 1994 contract for 10 liter thermoses, increased the usage to 50 tons which contained 7.5 tons of CFC-11.

3.7 HELWAN FOR DEVELOPED INDUSTRIES

Helwan is a 100% government owned company located in the district of Helwan outside Cairo. The company works by contract with both military and civilian agencies and has excellent engineering staff and good equipment. The company tends to do work that is specialized, complex, and of limited production. Among the military projects have been target drone planes of foam filled fiber glass and molded foam packaging for ordinance. Civilian projects have been foam filled fiber glass laboratory tables for educational institutions and prototype microcellular and RIM parts for the automotive industry

Because much of the work is military, projects and employment figures were not available. In the foam department, the company has 15 people and 2 engineers, although others are available as required. Future projects in the civilian area are integral skin, energy absorbing back filled pads for transportation vehicles, RIM, and possibly, flexible molded bus seats.

Helwan has 2 foam machines. The small one is a high pressure Cannon, model H-40 (24 kilo) and the large one is a piston type, high pressure Cannon, model HE-360 (210 kilo) capable of RIM production. It will not require machine replacements for the elimination of CFCs, but will need technical assistance in formulation and processing of the replacement chemical systems. If high insulation properties are needed in a future application, it would need to add a pentane blender and the associated safety equipment, but past production has not had "thermal insulation" as a criterion.

In 1993, 40 tons of rigid urethane chemicals containing 6 tons of CFC-11 were used. This is expected to increase in the 1994/95 period because of extension of some existing contracts and the pending contracts.

4. PROJECT DESCRIPTION

The seven participating companies in this project will phaseout the use of CFCs in their operations. Most of the companies involved qualify as "small" users and would not be able to propose an individual, cost-effective project.

By combination of procurement, technical support and training, the original costs of USD 1,049,500 could be reduced to USD 780,000, i.e., more than 25%! The project serves as an example how "upscaling" of project size, as mentioned as one of the impossible options in the Global Project to determine strategies for cost-effective phaseout strategies for small ODS users, can help to reduce project costs.

5. TECHNOLOGY

5.1 OPTIONS

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

- CFC-11 > partial water/HCFC-141b > 100% water blown
- 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, have limited availability or are 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, where dimensional changes are possible. Also, the differences in "K" Factors observed in "cold" applications (refrigerator/freezer) tend to disappear in "hot" applications.

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.

The third solution is used in Europe in domestic refrigeration. The pentane is flammable and requires extensive safety considerations.

5.2 SELECTION

The full water blown foams would be the best choice for all the applications. In all cases, the "contained" product is hot, so the "k" factor differences are of less concern and in the case of the spray foams, a flammable blowing agent would be hazardous in field applications where the working environment cannot be easily controlled.

5.3 PROCESS MODIFICATIONS

The existing equipment at six 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. Replacement of the spray units and the low pressure foam machines currently in place is required.

At Petrojet, because seven (7) spray units were scattered all over Egypt and could not be physically identified, it will be necessary to include in the implementation, a plan to replace and destroy the obsolete machines on a one by one basis. To that end, a supplementary transportation allowance is included in the budget for bringing each field based machine to a central location and returning a new machine to the field site.

6. PROJECT COSTS

6.1 TOTAL PROJECT COSTS

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

QUANTITY	DESCRIPTION	TOTAL (USD)
3	High pressure foaming unit @ USD 80,000	240,000
1	High pressure foaming unit.(Egypt. Solar)	100,000
10	Spray machine..(Petro-Jet) @ USD 27,800	278,000
1	High pressure spray machine (Cairo General)	32,000
-	Process adjustment and trials	20,000
-	Technology transfer	40,000
-	Contingency	80,000
	GRAND TOTAL	**780,000**

6.2 OPERATING COSTS

The elimination of CFCs will be offset by increased density of the foam to obtain the same physical properties. The 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

C	=	ODS Reduction Project Costs	USD 780,000
F	=	Capital Recovery Factor	0.16275
OC	=	Annual Incremental Operating Costs	USD 0.00
OS/R	=	Annual Incremental Savings or Revenue	USD 0.00
ODP	=	ODP Reduction in first year, kilograms	68,800

Unit Abatement Costs USD/kg/y 1.85
(discount rate: 10% per year over 10 year life)

$$A = \frac{C(F) + (OC/R)}{ODP}$$

7. FINANCING PLAN

The companies are requesting reimbursement to the amount of the full project costs of **USD 780,000**

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP-OPS will oversee the successful implementation of this project. The projects will be carried out at each facility on an individual basis and at the Petrojet pipe insulation facility near Suez. Representatives from Petrojet's field teams will come to the pipe insulation facility to train on the machines set up there. Training at the facilities by supplier technicians will be included in the bid requests. UNDP-MPU will provide technical assistance during project execution.

8.2 PROCUREMENT

UNDP Office for Project Services (UNDP/OPS) will procure all the required equipment under bulk purchasing system and implement the sub-projects in tandem. 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 68.8 tons of CFCs (1993 base) in the first year of implementation.

10. ANNEXES

ANNEX A: CAPITAL COSTS
ANNEX B: TECHNICAL ASSESSMENT

ANNEX A (1)

EXPECTED COSTS OF INVESTMENT AND RELATED ACTIVITIES:

EQUIPMENT

COMPANY	DESCRIPTION	TOTAL (USD)
GMC	1 High Pressure Foaming Unit	80,000
PETROJECT	10 Spray Machine @ USD 27,800/Ea.	278,000
MODERN	1 High Pressure Foaming Unit	80,000
CAIRO GENERAL	1 High Pressure Spray Foaming Unit	32,000
SOLAR	1 High Pressure Foaming Unit	100,000
TAWFIKIA	1 High Pressure Foaming Unit	80,000
	Subtotal	650,000

RELATED ACTIVITIES

GMC, PETROJET, MODERN PRODUCTS, CAIRO GENERAL, EGYPTIAN SOLAR, TAWFIKIA:		
Process Adjustment and Trials	15,000	
Technology Transfer	30,000	
Contingency	68,000	113,000
HELWAN FOR DEVELOPED INDUSTRIES:		
Process Adjustment and Trials	5,000	
Technology Transfer	10,000	
Contingency	2,000	17,000
Subtotal		130,000
Grand Total		780,000

TECHNICAL REVIEW

PREPARED BY:	**Dr. Hubert Creyf** **UNDP Foam Sector Project Reviewer**
DATE:	**21 October 1994**

1.	**COUNTRY:**	**Egypt**
2.	**PROJECT TITLE:**	**Conversion to CFC-free Technology in the Manufacturing of Rigid PUF (seven enterprises)**
3.	**(SUB) SECTOR:**	**Foamed Plastics**
4.	**CP RELATIONSHIP:**	**In early 1993 EEAA, with technical assistance from UNDP, prepared a strategy for the foam sector that aims at reducing CFCs consumption beginning 1993 and completing the CFC phaseout in 1998. This project would complete CFC phaseout in the flexible slabstock sub-sector.**
5.	**TECHNOLOGY:**	**All seven enterprises will change from CFC blown foam to fully water blown formulationS. Since insulating capacity is not directly related to energy consumption (e.g. thermos containers for food and liquids), or the lesser insulating capacity can be compensated by a thicker layer (spray-foam, pipe insulation...) the nature of the gas inside the foam cells is of less importance. In this case water blown formulations resulting in cells filled with CO_2, are the best acceptable solution.**

6. **ENVIRONMENTAL** **No particular environmental impact is to be expected from water blown formulations.**

7. **PROJECT COST:** Costs as presented can be accepted. For Petrojet, it is important to ensure that the unidentified seven spray machines are physically destroyed before money is released for a new one.

The price for ODP-replacement is shown in the next table:

	TONS	COST USD	USD/Ton CFC
1. GMC	10	112,800	11,200
2. PETROJET	25.5	327,500	12,843
3. MODERN PRODUCTS	3.8	112,000	29,474
4. CAIRO GEN. CONSTR.	11.5	48,000	4,174
5. SOLAR	4.5	157,000	34,889
6. TAWFIKIA	7.5	112,000	14,933
7. HELWAN	6	17,000	2,833

8. **IMPLEMENTATION:** One year seems adequate.

9. **RECOMMENDATION:** It is recommended that the project be approved.

PROJECT COVER SHEET

COUNTRY:	Egypt
PROJECT TITLE:	Conversion to CFC-free technology in the Manufacture of Flexible Slabstock PUF at El-Tawil Manufacturing Company.
SECTOR COVERED:	Foamed Plastics
ODS USE IN SECTOR:	722 tons CFCs (722 tons ODS) in 1991
PROJECT IMPACT:	Phaseout of the use of 36 tons/year CFC-11 (1993) in the manufacture of flexible molded polyurethane foams
PROJECT DURATION:	One year
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	USD 121,000 Incremental Capital Cost
PROPOSED MLF GRANT:	USD 121,000
COST EFFECTIVENESS:	USD 0.55/kg/yr (Unit Abatement Cost)
COORDINATING NATIONAL BODY:	Egyptian Environment Affairs Agency (EEAA)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	October 1994

PROJECT SUMMARY

Under this project Egypt will substantially complete the phaseout of CFCs in the production of slabstock flexible polyurethane foams, leading to a reduction of about 36 tons of ODS per year.

El-Tawil is the remaining company in Egypt that manufactures flexible slabstock polyurethane foam. They mold single blocks of slabstock polyurethane foam that is used in its own manufacturing of mattresses and furniture. The phaseout strategy will be to replace the CFC-11 with methylene chloride in the same way that has been done in the plants producing continuous slabstock foams.

Prepared by: Mr. Jerry Pool, UNDP Process Consultant
Reviewed by: Mr. Hubert Creyf, UNDP Foam Sector Project Reviewer

PROJECT OF THE GOVERNMENT OF EGYPT

ELIMINATION OF CFCS IN THE MANUFACTURE OF FLEXIBLE SLABSTOCK POLYURETHANE FOAM AT EL-TAWIL

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of flexible slabstock polyurethane foam at El-Tawil Manufacturing.

2. SECTOR BACKGROUND

The CFC consumption in 1991 in the Egyptian foam sector--excluding foams for domestic and commercial appliances--was established at 722 tons, with an annual growth rate of 15-20% (Egyptian Country Program). It was also estimated that with uninhibited growth, CFC consumption would be 1,000 tons in 1993 and 2,050 tons in the year 2000. EEAA, with the 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

El-Tawil is a 100% Egyptian, privately owned company located in Cairo. They are the only manufacturer in Egypt using single block molding of flexible slabstock urethane. They have been in business since 1971 and produce foams primarily for their own fabrication of mattresses and upholstered furniture. They employ 55 people, of which 15 are in the foam pouring and fabrication operation. Annual company sales are USD 2,000,000. In 1993, they used 1,000 tons of chemicals including 36 tons of CFC-11. The foam machine is a model 500, Sistemas De Espumacao by Pampero, from Brazil. The company will need improved ventilation and a new transfer pump for the methylene chloride, as well as technical help on reformulation and pouring.

4. PROJECT DESCRIPTION

The single block molding operation will not need to change their manufacturing equipment, but will need improved ventilation in the pouring and curing areas to reduce exposure to the more toxic methylene chloride. Also, the system for transferring methylene chloride from drums at ground level to the storage tanks on the third floor will have to be upgraded to stainless steel. Wall-mounted fans for make-up and exhaust air will take care of the ventilation. A new pump will be needed for transferring the MC.

5. TECHNOLOGY

5.1 SELECTION

The standard replacement technology for CFCs in slabstock flexible PUF is the substitution of methylene chloride for the CFC-11. Virtually all manufacturers in the USA have made this shift in previous years and the trend, unless restricted by specific countries, is the same in Europe and Japan. With the help of the MLF, other Egyptian manufacturers have made the change or are in the process of doing so.

5.2 PROCESS MODIFICATIONS

The block molding process will require a new transfer pump for the methylene chloride and ventilation fans for the foaming and curing areas. Personnel will have to be trained in the formulation and process technology as well as safety practices associated with methylene chloride use.

6. PROJECT COSTS

6.1 TOTAL PROJECT COSTS

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

QUANTITY	DESCRIPTION	SUBTOTAL (USD)	TOTAL (USD)
6	Exhaust and make-up air fans @ $10,000		60,000
1	Methylene chloride pump and storage system		35,000
-	Technology transfer/safety training		10,000
-	Trials and process adjustment		5,000
-	Contingency and Rounding		8,000
	GRAND TOTAL		**121,000**

6.2 OPERATING COSTS

El-Tawil, in switching from CFC-11 to methylene chloride will initially experience lower production yields, but will see a slight reduction in chemical costs . The methylene chloride foams are more difficult to process and will require training of the personnel. With experience, the yields can reach those obtained on the CFC blown foams. It is expected that the poorer yields will offset the reduced chemical costs and the company will not seek incremental operating costs.

6.3 UNIT ABATEMENT COSTS

C	=	ODS reduction project costs	**USD 121,000**
F	=	Capital recovery factor	**0.16275**
OC	=	Incremental Operating Costs	**USD 0.00**
OS/R	=	Operating Savings or Revenue	**USD 0.00**
ODP	=	ODP reduction in first year, kilograms	**36,000**

Unit Abatement Costs **USD/kg/y 0.55**

(discount rate: 10% per year over 10 year life)

$$A = \frac{C(F) + (OC-OS/R)}{ODP}$$

7. FINANCING PLAN

The companies are requesting full reimbursement of the project costs of USD 121,000.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP-OPS will oversee the successful implementation of this project. UNDP-MPU will provide technical assistance during project execution.

8.2 PROCUREMENT

The procurement activities under the project will be carried out by UNDP Office for Project Services (UNDP/OPS). The UNDP/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 FOR COMPLETION						
	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Procurement preparations							
o Project management	x						
o Design, specifications	x						
o Preparation bid lists	x						
o Tenders, selection of contractors		x					
o Purchase order(s)		x					
Arrival equipment, Customs clearing			X				
Installation of equipment				X			
Training, Certification				X			

9. PROJECT IMPACT

This project will eliminate the use of 36 tons of CFCs (1993 base) in the first and subsequent years of implementation.

10. ANNEX

Annex A: Project Technical Review

TECHNICAL REVIEW

PREPARED BY: Dr. Hubert Creyf
UNDP Foam Sector Project Reviewer H Creyf

DATE: 20 October 1994

1.	**COUNTRY:**	Egypt
2.	**PROJECT TITLE:**	**EL-TAWIL MANUFACTURING COMPANY - Conversion to CFC-free Technology in the Manufacture of Flexible Slabstock PUF**
3.	**(SUB) SECTOR:**	Foamed Plastics
4.	**CP RELATIONSHIP:**	In early 1993 EEAA, with technical assistance from UNDP, prepared a strategy for the foam sector that aims at reducing CFCs consumption beginning 1993 and completing the CFC phaseout in 1998. This project would complete CFC phaseout in the flexible slabstock sub-sector.
5.	**TECHNOLOGY:**	The proposed technology, where by CFC 11 is replaced by methylene chloride is common. The main difficult points are - reformulation is necessary, and sometimes not easy - the concentration of MC in the work place must be monitored, and, when the TLV value is not met, ventilation has to be adapted. - the emission legislation in Egypt must be checked.
6.	**ENVIRONMENTAL IMPACT:**	The proposed technology has no important environmental impact. MC has neither ODP nor GWP.
7.	**PROJECT COST:**	No cost for stainless steel storage tanks or tubing is foreseen (30,000 USD).
8.	**IMPLEMENTATION:**	The presented period seems right
9.	**RECOMMENDATION:**	It is recommended to approve the project.