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

Tenth Meeting
Montreal, 28–30 June 1993

PROJECT PROPOSALS: EGYPT

GENERAL COMMENTS

1. The foam sector in Egypt consumes 722 tonnes of CFCs. The Executive Committee has already approved five projects in the foam sector for Egypt, which will result in the elimination of 329 tonnes of CFCs.

2. The Government of Egypt has prepared three new investment project proposals in the foam sector in co-operation with UNDP and UNIDO. These project proposals are submitted for consideration of the Executive Committee. They are:

- Elimination of CFC-11 in the Manufacture of Molded Flexible Polyurethane Foam at Modern Building Carpentry Co (Mobica)

- Elimination of CFC-11 in the Manufacture of Molded Rigid Polyurethane Foam at Cairo Light Industries Co (Olympic Electric)

- Phase-out of the use of CFC-12 in the Manufacture of Extruded Polystyrene Foam at Advanced Chemical Engineering Systems (Advechem).

3. The Fund Secretariat reviewed these project proposals in consultation with UNDP, UNIDO and their consultants as well as with the Government of Egypt.

4. The implementation of these projects will result in the elimination of 291 tonnes ODP bringing the total elimination in this sector to 620 tonnes ODP.

5. A total of US $2,395,520 is recommended for approval in the foam sector as follows:

- Mobica Co. (US $434,000);
- Olympic Electric Co. (US $940,000);
- Advechem (US $ 1,021,520). This figure includes 13% for support costs.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Egypt
PROJECT TITLE:	Elimination of CFC-11 in the manufacture of Molded Rigid Polyurethane Foam at Cairo Light Industries Co ("Olympic Electric")
BUDGET:	US $940,000 (Fixed Project Costs)
INCREMENTAL COSTS:	US $940,000 (Fixed Project Costs)
COST EFFECTIVENESS[1]:	US $12.53/Kg. ODP
PROJECT DURATION:	18 months for implementation of 100% CFC free technology; 10-year project life.
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	Egyptian Environment Affairs Agency (EEAA)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. A technical review was provided by UNDP after the project document was submitted by the Government of Egypt.

2. The incremental costs are those related to costs of investment and technical assistance. There is no net material costs included in the incremental costs. The company will absorb the expected increase in material prices and the additional preventive maintenance costs.

3. The project will result in an estimated annual phase-out of 75 tons of CFC-11.

4. The two-phase conversion to CFC-free technology was chosen by Olympic Electric. In the first phase, 50 percent of CFC-11 will be replaced by carbon dioxide. In the second phase, the remaining CFC will be replaced by HCFC-141b. The project can be compared with similar HCFC-141b conversion projects submitted by the World Bank for Thailand. The Cost effectiveness determined as the ratio of incremental costs to the estimated annual saving of ODP

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

is US $12.53/Kg ODP in the case of Egypt. The cost effectiveness in four HCFC-141b conversion projects with similar amount of ODS phased out in the refrigeration sector for Thailand ranges from US $17.4 to 50.7 per Kg ODP phased out. This comparison is in favour of the project for Egypt.

SECRETARIAT'S RECOMMENDATION

5. The project is recommended for final approval of funding in the amount of US $940,000.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Egypt
PROJECT TITLE:	Elimination of CFC-11 in the manufacture of Molded Flexible Polyurethane Foam at Modern Building Carpentry Co (Mobica)
BUDGET:	US $434,000 (Fixed Project Costs)
INCREMENTAL COSTS:	US $434,000 (Fixed Project Costs)
COST EFFECTIVENESS[1]:	US $21.70/Kg. ODP saved
PROJECT DURATION:	18 months, 10-year project life.
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	Egyptian Environment Affairs Agency (EEAA)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. A technical review was provided following the submission of the project document.

2. The all water blowing system will be applied to eliminate 20 tonnes of CFC-11 used in the manufacture of molded flexible polyurethane foams at Mobica Company.

3. The incremental costs cover costs of investments and related activities. Although operational costs are not requested, the project document indicates that an increase in material costs and additional higher maintenance costs of about US $60,000 per year are expected which accounts for the absence of cost savings. The company will absorb these costs.

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

4. This project is similar to those approved by the Executive Committee for other Egyptian molded foam manufacturers (Taki-Vita and Technopol); it is not as cost effective (Taki-Vita: US $5.88/Kg ODP saved and Technopol: US $11.72/Kg ODP saved). The low cost effectiveness of Mobica Co. may be explained by the fact that the project covers conversion to non CFC technology at two production lines manufacturing two different products at two different locations.

SECRETARIAT'S RECOMMENDATION

5. The project is recommended for final approval of funding in the amount of US $434,000 as an amendment to the 1993 UNDP Work Programme.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Egypt
PROJECT TITLE:	Phase-Out of the Use of CFC-12 in the Manufacture of Extruded Polystyrene Foam in Advance Chemical Engineering System (ADVECHEM)
BUDGET:	US $398,300 (Fixed Project Costs) US $1,425,000 (Operating Cost for Three Years) US $1,021,520 (Total Request including contingency fund and 13% overhead)
INCREMENTAL COSTS:	US $1,021,520 (Project Costs)
COST EFFECTIVENESS[1]:	US $3.09/Kg. ODP saved
PROJECT DURATION:	11 months
IMPLEMENTING AGENCY:	UNIDO
NATIONAL COORDINATING AGENCY:	Egyptian Environment Affairs Agency (EEAA)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. This project was first submitted to be considered by the Executive Committee at its Ninth Meeting. However it was agreed with UNIDO during the Fourth Co-ordination Meeting held on 4-5 February 1993, that the project should be revised by UNIDO and that funds for preparing the project would be requested. US $100,000 was approved by the Executive Committee for UNIDO to prepare this and three other investment projects in the foam sector in Egypt.

2. A revised proposal was developed by UNIDO and submitted by the Government of Egypt.

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[1] Determined as the ratio of incremental costs to the estimated annual saving of ODP ($/ODP$_{Kg}$). For CFC-12, ODS = ODP

3. The objective of the project is to replace CFC-12/HCFC-22 blend with an HCFC-142b/HCFC-22 blend in the production of extruded polystyrene insulation foam boards.

4. The project will result in an estimated phase-out of 196 tonnes of CFC-12.

5. In its review of the project proposal, the Secretariat raised several issues related to the eligibility and/or cost of some of the project components and communicated its views to UNIDO.

6. An independent technical review of the proposal was prepared for the Secretariat. The review has also questioned the cost of some project components. After discussions with UNIDO and the Government of Egypt, all outstanding issues have been resolved. The project proposal has been revised accordingly.

SECRETARIAT'S RECOMMENDATION

7. The project is recommended for final approval and for funding in the amount of US $1,021,520.

PROJECT COVER SHEET

COUNTRY:	Egypt
PROJECT TITLE:	Elimination of CFC-11 in the manufacture of molded flexible polyurethane foam at Modern Building Carpentry Co. (Mobica)
SECTOR COVERED:	Foamed Plastics
ODS USE IN SECTOR:	722 tons CFCs (722 tons ODS) in 1991
PROJECT IMPACT:	20 tons CFC-11 per year, based on 1993 consumption
PROPOSED BUDGET:	USD 434,000
IMPLEMENTING AGENCY:	UNDP
COORDINATING AGENCY:	Egyptian Environment Affairs Agency (EEAA)

PROJECT SUMMARY

Mobica is a leading manufacturer of home furniture, office furniture and complete automotive seats in Egypt.

The company produces a substantial part of the polyurethane foam it needs for its product in house on four production lines. CFCs are currently used in this process. Under this project, Mobica will phaseout the use of CFCs in the production of molded flexible polyurethane foams. It will be replaced by an all water blown system, requiring replacement of the foam lines, the (epoxy) molds and the installation of thermal conditioning equipment.

The replacement of CFCs will increase the cost of raw materials, resulting in 10-15% higher operational costs. The company will not request reimbursement of these costs, but absorb these if compensation through the market proves to be impossible.

PROJECT OF THE GOVERNMENT OF EGYPT

ELIMINATION OF CFCS IN THE MANUFACTURE OF MOLDED FLEXIBLE POLYURETHANE FOAM AT MOBICA

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of molded flexible polyurethane foam (PUF) at Modern Building Carpentry Co. (Mobica).

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. ENTERPRIZE BACKGROUND

Mobica is a private sector partnership company, established in 1976. It is one of Egypt's major manufacturers of institutional and commercial furniture. Products include:

- Office furniture
- Home furniture
- Kitchen cabinets
- Hotel furniture
- School furniture
- Laboratories
- Car seats (complete)

Mobica is the only supplier of complete seats to the automotive industry.

The company operates 7 factories and employs 1100 workers. More information is included in annex A.

4. PROJECT DESCRIPTION

One of Mobica's main activities is the production of seats for offices, cars and busses, utilizing cold cured foam technology. The company has four low pressure foaming units in place: two for the production of (semi rigid) integral skin foams (ISF) and two for the production of (flexible) foam seats.

The company is committed to phaseout the use of CFCs. It has prioritized the phaseout in flexible foam, as this process uses the majority of the CFCs (20 t/y versus only 7.5 t/y in ISF), and replacement technology is readily available. The intention is to employ full water blown formulations.

The existing low pressure machines are not suited to handle the higher viscosities that are associated with the new process, and will need to be replaced. Also, the company feels that the existing molds, made from epoxy resin, need to be replaced. Finally, temperature conditioning systems are needed.

The new raw materials will induce a 10-15% increase in operating costs. The company will absorb these costs, or, if possible compensate the effect through higher product prices.

5. TECHNOLOGY

5.1 SELECTION

The standard replacement technology for CFCs in molded flexible PUF is an all water blown system. Virtually all manufacturers in the USA have made this shift in previous years, and the trend is--although somewhat delayed--the same in Europe and Japan. Other Egyptian manufacturers are already in the process to do the same (MISR Foam, Taki-Vita, Technopol) with the help of the IMLF. Mobica wants to follow this trend.

5.2 PROCESS MODIFICATIONS

the existing two low pressure metering systems for flexible PUF have to be replaced by high pressure units.

Boilers for mold heating and an oven for resin conditioning are needed.

The existing epoxy molds are considered to be insufficient for the new system and need to be replaced.

Personnel has to be instructed in the new technology.

6. PROJECT COSTS

6.1 TOTAL PROJECT COSTS

The following is a summary of the expected costs of investment and related activities (the numerical values are for UNDP budgeting purposes):

ITEM	DESCRIPTION		SUBTOTAL (USD)	TOTAL (USD)
2109	2 High pressure foaming units (80 kg/hr).....each		150,000	300,000
2109	2 chillers	each	10,000	20,000
2109	Temperature conditioning system consisting of			
	o Two boilers	each	13,750	
	o one barrel oven		35,000	62,500
3309	Training, Start-up			12,000
5306	Contingency and Rounding			39,500
	GRAND TOTAL			**434,000**

Supporting documentation is provided in annex B.
Exchange rate: 1 USD = 1.60 DM.

6.2 OPERATING COSTS

The company expects an increase of 10-15% or USD 25,000-37,500 in raw material costs related to the conversion to a non CFC system. In addition higher maintenance costs are expected related to the new equipment (about USD 25,000-35,000). Overall, incremental operating costs of about

USD 60,000

are expected. As mentioned before, the company will absorb these costs.

6.3 UNIT ABATEMENT COSTS

a)	ODS reduction project costs	USD 434,000
b)	Annual incremental operating costs	USD 60,000
c)	project useful life	10 years
d)	ODS reduction/y	kg 20,000

Unit Abatement Costs [(a/c + b)/d] **USD/kg/y 5.17**

(discount rate: 10)

7. FINANCING PLAN

Mobica is requesting full reimbursement of the project costs of USD 434,000. The company itself will absorb the incremental operating costs.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP-OPS will oversee the successful implementation of this project. The project will be carried out at the companies facilities in Desert Road Cairo-Alexandria. UNDP-ENR will provide technical assistance during project execution.

8.2 PROCUREMENT

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

8.3 SCHEDULE

TASK	TIME 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	xx						
o Purchase order(s)	x						
Arrival equipment, Customs clearing			xx				
Installation of equipment			x				
Training				xx			

Total implementation time: 12 months.

9. PROJECT IMPACT

This project will eliminate the use of 20 tons of CFCs (1993 base) in the first and subsequent years of implementation.

10. ANNEXES

Annex A: Company Information

Annex B: Equipment Quotations

PROJECT COVER SHEET

COUNTRY:	Egypt
PROJECT TITLE:	Elimination of CFC-11 in the manufacture of molded rigid polyurethane foam at Cairo Light Industries Co. ("Olympic Electric")
SECTOR COVERED:	Foamed Plastics
ODS USE IN SECTOR:	722 tons CFCs (722 tons ODS) in 1991
PROJECT IMPACT:	75 tons CFC-11 per year, based on 1993 consumption
PROPOSED BUDGET:	USD 940,000
IMPLEMENTING AGENCY:	UNDP
COORDINATING AGENCY:	Egyptian Environment Affairs Agency (EEAA)

PROJECT SUMMARY

Cairo Light Industries Co., better known under its brand name "Olympic Electric", is one of Egypt's major manufacturers of water heaters, cool boxes and solar panels. It is a member of the Olympic Group, an Egyptian owned private sector enterprize.

The company utilizes rigid PUF to insulate the above mentioned products. CFC-11 is currently used in this process. Under this project, Olympic will phaseout the use of CFCs in two phases. In the first phase 50% of the CFCs will be replaced by carbon dioxide. In the second phase the remaining CFC will initially be replaced by HCFC-141b and ultimately be replaced by HFCs or carbon dioxide.

The replacement of CFCs will increase the operating costs of the process, at least initially (HCFC-141b is about 50% more expensive than CFC-11). The company is not requesting reimbursement of these costs, but will attempt to find compensation through the market.

PROJECT OF THE GOVERNMENT OF EGYPT

ELIMINATION OF CFCS IN THE MANUFACTURE OF RIGID POLYURETHANE FOAM AT OLYMPIC ELECTRIC

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of rigid polyurethane foam at Cairo Light Industries Co. ("Olympic Electric").

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. ENTERPRIZE BACKGROUND

The Olympic Group is a family owned enterprize, employing in excess of 5000 workers. The company was founded in 1960 . It currently produces waterheaters, solar panels, ice coolers, vacuum cleaners and more.

Cairo Light Industry Co., a fully owned subsidiary, opened five years ago a modern, state of the art plant on property in 10 Ramadan City. An older plant in Cairo is still in use. The company is highly "vertically" integrated, i.e. it produces virtually all parts of its products in house. House keeping, and modern labor relations are in 10 Ramadan a priority, and have resulted in a productivity that is unique in the Egyptian industry.

4. PROJECT DESCRIPTION

Cairo Light Industries Co.(Olympic) currently utilizes about 75 metric tons of CFC-11 to produce rigid polyurethane foam for the

insulation of water heaters, cool boxes and solar panels.

Two foaming units are used for the insulation of water heaters and the panels in a modern facility in 10 Ramadan City. Two other foaming units are used in a facility in Cairo, where cool boxes for ice and food are manufactured. Water heaters is the major production.

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

The higher viscosity of the raw materials requires the replacement of the existing foaming units. In addition, separate introduction of physical blowing agents requires the installation of blending units.

The new raw material systems are expected to be somewhar more expensive, leading to higher operating costs for Olympic. In time, higher expected costs for CFCs and more competitive chemical pricing may reduce or eliminate this difference. Olympic will not request any subsidizing of incremental operational costs. The company will absorb these costs or, if possible, compensate the effect through price increases.

5. TECHNOLOGY

5.1 SELECTION

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

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

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

The first solution--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. One potential solution is HFC-356, but full water blown foam with improved cell structure remains an option, specifically in "lesser demanding" systems such as water heaters, were dimensional changes--although costly-- are possible.

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

Cyclopentane technology is lately commercial introduced in Germany. Its flammable character requires safety conditions and limits its use. Only two companie offer currently cyclopentane packeges, including equipoment Bayer/Hennecke and BASF/Elastogran). In Olympic's case, the use of cyclopentane would be cost prohibitive from a safety standpoint.

Olympic has decided for the water/HCFC-141b solution with most likely subsequent replacement of the HCFC by a fully water blown system. Such systems are already introduced for water heaters. The main reason for this choice is the flexibility that this option provides. With three distinctly different applications, Olympic may well end up with different end solutions for these applications. This route will allow for this without additional investments.

5.2 PROCESS MODIFICATIONS

The existing equipment at Olympic 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 four (4) units in place is therefore required.

Minimizing the CFC content--and subsequently the HCFC content--requires the possibility of separate and individual blending. This is the more needed, because in the future, many system suppliers will not deliver blends that include CFCs or HCFCs.

In addition, readjustments of the product line are expected, which may include increase of the insulation thickness and modifications to provide for suitable filling of the molds with the higher viscisity mixture. This means change of the outer dimensions (plastic) or inner dimensions (steel or plastic), and consequently changes in dies and molds. On the other side, novel foaming technologies currently in development may substantially improve the insulation capabilities of the HCFC-foams and mitigate the need of at least some of the changes.

The modifications have to be complemented by training, the

installation of some (minor) leak detection equipment and some lay-out adjustments.

6 PROJECT COSTS

6.1 TOTAL PROJECT COSTS

The following is a summary of the expected costs of investment and related activities (the numerical identification system originates from UNDP-OPS, and facilitates later procurement):

ITEM	DESCRIPTION	SUBTOTAL (USD)	TOTAL (USD)
2108	4 High pressure foaming units, incl. blenders	each 190,000	760,000
4208	2 leak detectors	each 2,500	5,000
5108	Process adjustments and trials		80,000
3308	Training		10,000
5306	Contingency		85,000
9908	GRAND TOTAL		940,000

Supporting documentation is provided as annex.
Exchange rate: 1 USD = 1.60 DM

6.2 OPERATING COSTS

An minimal increase in material prices is expected of USD 40,000/y. Also, the new equipment is more complicated and will require additional preventive maintenance (USD 26,000).
Total incremental operating costs are expected to amount to

USD 66,000

As mentioned before, the company will absorb these costs.

6.3 UNIT ABATEMENT COST

a)	ODS Reduction Project Costs	USD	940,000
b)	Annual Incremental Operating Costs	USD	66,000
c)	Project Useful Life		10 years
d)	ODS reduction/y		kg 75,000
	Unit Abatement Costs [(a/c + b)/d]	**USD/kg/y**	**2.13**
	(discount rate: 10)		

7. FINANCING PLAN

Olympic is requesting reimbursement to the amount of the full project costs of USD 940,000. The company itself will absorb the incremental operating costs.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP-OPS will oversee the successful implementation of this project. The project will be carried out at the companies facilities in 10 Ramadan City and Cairo. UNDP-ENR will provide technical assistance during project execution.

8.2 PROCUREMENT

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

8.3 SCHEDULE

TASK	TIME FOR COMPLETION Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Procurement preparations								
o Project management	x							
o Design, specifications	x							
o Preparation bid lists	x							
o Tenders, selection of contractors	xx							
o Purchase order(s)	x							
Arrival equipment, Customs clearing			x	x				
Installation of equipment				x				
Training					xx			
Implementation of 50% CFC technology						xxx	xxx	
Implementation of 100% CFC free technology								xxx xxx

Total implementation time: 18 months.

9. PROJECT IMPACT

This project will eliminate the use of 37.5 tons of CFCs (1993 base) in the first year of implementation, growing to 75 t/y (1993 base) for subsequent years.

10. ANNEX

Equipment quotation

Olympic/UNEG0319.CLI
5-31-93 Rev 02

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

PROJECT DOCUMENT

PROJECT COVER SHEET

Country/Region:	EGYPT
Project Title:	Phase-out of the Use of CFC-12 in the Manufacture of Extruded Polystyrene Foam at ADVECHEMS
Sector Covered:	Foamed plastics
ODS Consumption in this Sector:	722 MT of CFC in 1991
Project Impact (ODS reduction):	196 MT CFC 12/year
Project Duration:	11 months - couversion phase - 10 years project life
Proposed Budget:	US$ 398.300 - one off capital cost US$ 425.000 - 3 years incremental cost
Proposed ODS Grant:	US$ 1,021,520 (incl. contingency fund and 13% overheads)
Cost Effectiveness:	0,49 US$/Kg of ODS/Year (over 10 year period)
Implementing Agency:	UNIDO
National Co-ordination Agency:	Egyptian Environment Affairs Agency
Appraisal date:	

PROJECT TITLE: Phase-out of the Use of CFC-12 in the Manufacture of Extruded Polystyrene Foam at ADVECHEMS

Sector Information

Egypt ratified the Montreal Protocol in 1988 and started to reduce ODS consumption that time through a Government ban of the use of CFCs in aerosols.

In accordance with the Country Programme of Egypt (UNEP/Ozl.Pzo/ExCom/8/14) related to ODS phase-out, the total consumption of CFCs in Egypt in 1991 was 2170 MT, distributed as follows:

- manufacture and servicing of refrigerators and airconditioners	29 %
- plastics foams (cushions, furniture, insulation and packaging)	29 %
- fire extinguishing equipment (halons)	35 %
- aerosol sector	4 %
- solvent sector	3 %

Although Egypt has quite a modern petrochemical industry the country does not produce ODS. These products are being imported.

In Egypt, both, the private and the public sector of these industries use ODSs.

In frame of the Country Programme for phase-out of ozone depleting substances in various sectors of industry there are several respective ongoing projects which are under implementation by the specialized international agencies. In accordance with the decision of the Executive Committee of the Montreal Protocol some projects will be implemented by UNIDO in the field of refrigeration and foams manufacturing.

The major types of foamed plastics being produced in Egypt are polyurethane foam (PUF) for insulation, cushioning, packing and automotive applications, and polystyrene foams for insulation and food packaging.

In 1991 an estimated quantity of 722 MT of CFC's were used for manufacture of these two kind of foams. This project will reduce CFC-12 use by 196 tons per year; total CFC's reduction under this project would amount to approximately 27 % of 1991 usage in foams.

PROJECT BACKGROUND AND JUSTIFICATION

ADVECHEMS was established in 1987 and started their production in April 1989. The company has paid a capital of Egyptian Lbs. 2,700,000. The cost of production line is approximately US$ 1,000.000.

ADVECHEMS is a manufacturer of extruded polystyrene foam boards for thermal insulation. The company's head office is situated in Cairo; the factory itself is located in Sadat City, 90 km outside from Cairo on the Cairo-Alexandria desert road. The number of employees is 100. The company uses a mixture of freon gas CFC 12/HCFC 22 (70/30%) as a blowing agent summing up to 280 tons/year. It is expected that this project will reduce the use of CFC 12 by 196 tons per year.

This project by facilitating the reduction of CFC- 12 in the manufacture of extruded polystyrene foam will assist Egypt to meet its ODS phase-out targets under the provisions of the Montreal Protocol thereby contributing to the global reduction of ODS.

In view of the complexity of various techno-economic problems to be solved and in order to achieve the goal, preparatory assistance was provided by UNIDO in order to:

a) determine the actual needs of the counterpart;

b) advise on alternative optional technology and blowing agent which is most appropriate in the conditions of Egypt;

c) estimate costs of required assistance including capital cost covering the production of equipment modifications, technology transfer, additional operation cost, etc. and

d) formulate a detail full-scale project document.

The blowing agent (HCFC142b/HCFC22) proposed for ADVECHEMS is widely used by European polystyrene insulation board manufacturers and accepted by the Montreal convention and is an acceptable alternative according to the UNEP technical committee.

The following alternatives*) to the proposal for the HCFC 142b as a replacement of CFC- 12 have been considered.

a) Inert gases (eg. CO2, N2) ODP NIL, full or partial replacement;
b) HCFC 22, ODP 0.055 (100 % replacement);
c) HCFC 142b, ODP 0.065 (100 % replacement);
d) HCFC 142b/22 blend (60/40) ODP 0.06 (100 % replacement);
e) HCFC 134a, ODP NIL (100 % replacement);
f) Hydrocarbons (Pentane, Butane) OPDP NIL; and
g) Other HCFC alternatives.

The requirements of the product are however:

- minimum fire standard;
- economically competitive specific insulation value;
- have closed cell, to trap the blowing agent, which in itself must have a low coefficient of thermal conductivity; and
- dimensionally and cosmetically acceptable in the market.

*) ANNEX A: Specific HCFC blowing agents properties.

Therefore the alternative blowing agent should have the following properties:

a) good specific insulation value;

b) form a closed cell foam;

c) be able to form a non-flammable product, with appropriate flame retardant, achieve all European fire resistance standards for building materials (typically DIN 4102 Class B 1);

d) economically available in the manufacturing country;

e) diffusion rate out of the foam to ensure the insulation value, imparted by the gas, is not lost over time;

f) high latent heat of evaporation to ensure the foam structure formed at the die is frozen;

g) has a factor of plasticization of polystyrene, within controlled limits, to prevent loss of die head pressure and consequent pre-foaming of material prior to exit from the die. Also required to prevent collapse of the cell walls due to softening by residual blowing agent quantities;

h) has solubility factor within controlled limits to ensure that:
   - sufficient blowing agent will dissolve in the polystyrene in the extruder, and
   - be released in a controlled manner on exit from the die.

The summary of the comparative analysis of the potential options is shown in Annex C.

Substitution of the blowing agent requires usually modification and replacement of certain units of the extrusion line.

Taking into consideration that the existing production equipment at ADVECHEMS supplied by the LMP IMPIANTI, Italy, is in good working condition and the supplier has already converted their extrusion lines using CFC-free technologies, it was justified to contact the original supplier regarding its potential participation in conversion of ADVECHEMS. It is obvious that in this case the project cost related to the equipment modification or replacement will be at minimal level.

The preliminary quotation of LMP IMPIANTI was received and subsequently discussed in more detail in terms of their scope of supply and relevant costs (see Annex B).

ADVECHEMS is willing to absorb a significant proportion of the cost over a period of ten years.

The ongoing cost is mainly due to the higher cost of the alternative (HCFC 142b/22 blend) blowing agent, along with the anticipated increase in flame retardant.

ADVECHEMS agree to be funded under this project by the Multilateral Fund for only three years of the operation cost difference and are ready to absorb these cots after this period.

I. PROJECT OBJECTIVE

To eliminate the use of CFC- 12 in the production of extruded polystyrene foam boards at ADVECHEMS, this would amount to 196 MT/year of reduced CFC- 12 usage for current production at the factory in 1994.

The project, if successfully implemented at ADVECHEMS will ensure the replacement of CFC-12/HCFC 22 blend 70/30 with HCFC 142b/HCFC 22 blend 60/40 without significant deterioration of the products' properties at minimum additional cost.

OUTPUTS

The transitional technology transferred and adopted at ADVECHEMS using modernized equipment, technical and managerial personnel trained and the products are accepted/absorbed by the market.

PROJECT BUDGET

The project budget consists of the following components:

a) Additional capital costs related to:

- replacement of existing 16.5 tonnes ISO container by establishment of 20 tonnes on-site gas storage tank;
- existing equipment modification or replacement and technology/ know-how transfer by LMP IMPIANTY under subcontract basis, and
- start up and recommissioning cost.

b) Additional three years incremental operating costs related to:

- supply and use of the more expensive alternative blow agent;
- supply of increased level of a fire retardant since the blend HCFC 1426/HCFC 22 at certain conditions has a higher flammability than the conventional blend. This however will require add. tests; and

c) Contingency and project management fund.

Some cost savings may occur from an anticipated reduction in consumption of blowing agent due to the use of a lower molecular weight blend (280 tonnes/year down to 240 tonnes). However these savings can only partially compensate the additional costs of the more expensive blend.

Since the polystyrene foam scrap or rejects accumulated during start-up of the converted process can easily be recycled, the loss of raw materials will be only the new blowing agent.

- provision of necessary technical and administrative support;

- provision of raw materials, equipment and spare parts other than those to be provided by the project, maintenance and quality control/testing services;

- absorbtion of additional operational cost during subsequent seven years after three years of project life when this cost is covered by the project, and

- logistic support of project implementation.

b) **Multilateral Fund Input through UNIDO**
(see attached Project Budget)

		Duration	US $
BL 11-51	Consultant in extrudered polysterene form production and commercial management	2 weeks	8,000
BL 21-00	Subcontract with LMP Impianti for provision (C+F) of:	5 months	243,000 (including:)
	- set of screw elements and barrel		69,000
	- static homonizer		42,000
	- gas injection system incl. mass flow meter and injection valve		56,000
	- gravimetric flow meter		11,000
	- teflon-coated die lip set		18,000
	- set of spare parts for PAG pump		2,000
	- technology/know-how transfer (licence)		30,000
	- equipment installation and commissioning, training of ADVECHEM operational personnel in Egypt (two IMP specialists)	10 days	15,000 (incl. travel DSA & salary)
BL 32-00	Study tour of three managers of ADVECHEMS to LMP Impianti, Italy for technical inspection and training purposes	5 days (incl. travel and DSA)	7,000
BL 41-00	Start up of modified equipment and technology conversion/transfer	10 days	20,000
BL 41-00	Incremental operating cost resulting from the technology conversion		425,000 (including 200,500 - I yr; 112,250 - II yr; 112,250 - III yr)
BL 42-00	Purchase and installation of on-site storage tank for the alternative blowing agent		120,300
BL 51-00	Contingency fund (appr. 10% of estimated project costs) related in particular to use of retardant (when it is proven), engineering and construction works of on-site storage tank, miscellaneous, etc.		80,700
	Total		904,000

Project Budget Analysis

(a) Summary of one off capital costs	US $
- consultant-economist to advise the ADVECHEMS of the contractors scope of supply, financial and market consequences caused by the conversion	8,000
- subcontractor's (LMP Impianti) package service incl. C+F provision of equipment and accessories, installation, commissioning, technology transfer and training of ADVECHEM personnel (see Annex B)	243,000
- purchase and installation of on-side storage tank for new blowing blend (see Annex D)	120,000
- study tour of three managerial staff of ADVECHEMS to Italy for technical inspection and training purposes (5 days)	7,000
- start up of modified equipment using new blowing agent (see Annex E)	20,000
Total one off capital costs	398,300

(b) Incremental operating costs

It is proposed that the incremental cost will be compensated to ADVECHEMS by the Multilateral Fund during the first three years of the converted plant operation. An increase of the operating cost is mainly because of the higher price of the new blowing agent. Due to the difference of molecular weights of present CFC-based blend and the new proposed one the consumption of it can be theoretically reduced from 18% in current production to 15% in the proposed process. The HCFC-142b solubility in the polymer will be higher than CFC-12 reducing its efficiency as a blowing agent and actual experience will be needed to determine the optimal level.

Therefore it is considered as justified that during the first year of the converted plant operation the level of the blowing agent can be estimated as 16.5% and then to be reduced to 15.3% through process optimisation by more experienced staff.

The following methodology used for the incremental cost calculation:

Working days

- 1 year - 52 weeks
- public holidays = 13 days (2 weeks)
- line maintenance = 5 weeks
- working weeks = 45 weeks
- working hrs/day = 24 hrs.

Raw materials consumption:

- Polysterene compound
  205 kg/hr x 24 hrs x 7 days x 45 weeks = 1,549,800 kg

- present blowing agent
  content in mixture - 18% weight.

  price, US $/kg - 3,64
  annual consumption
  1549800 kg x 0.18 = 278964 kg
  annual cost
  278964 kg x 3.64 = US $1.015.429

- new blowing agent
  content in mixture - 16.5% I year
  - 15.3% II+III year

  Price, IS $/kg - 4,755
  annual consumption
  (a) I year consumption
  1549800 x 16.5 = 255717 kg

  I year cost
  255717 kg x 4.755 = US $1.215.934

  (b) II + III year consumption
  1549800 x 15.3 = 237119 kg

  II + III year cost
  237119 kg x 4,755 = US $ 1.127.500

Overall difference for I year
1.215.934 - 1.015.429 = US $ 200.505

Overall difference for the consequent II and III year
1.127.500 - 1.015.429 = US $ 112.071/ year

Total incremental three years cost US $ 425.000

(c) Other costs — US $

- Contingency fund (appr. 10% of the total project budget) — 80,700
  The fund is proposed to cover unforeseen expenses which might be occurred during the project implementation, like purchase of retardant if its use will be proven, engineering support for establishment of on-site gas storage facilities, purchase of small testing and safety instruments whose needs will be caused by the converted process, miscellaneous expenses etc.

Cost effectiveness calculation

Calculation of the cost effectiveness of this project of 10 years life time period.

One off capital cost	= 388,300 = 425,000
Incremental operating cost for 3 years	= 200,500 I year = 112,250 II year = 112,500 III year
Other costs	= 80,700
Hence total proposed cost	= 910,000
Effective reduction in ODS	= 183,300 kg/year
Project life time	= 10 years
Unit cost	= 910,000/(183,300 x 10)
Cost efficiency	= US $ 0.49/kg ODS

Project Timeframe

Total project duration is 11 months starting from the fund allocation.

The schedule of the project implementation is as follows:

Activities	Months										
	1	2	3	4	5	6	7	8	9	10	11
1. Fielding of consultant for plant process verification, preparation of detailed terms of reference for subcontract and for advising on changes in commercial activities of the company.	--										
2. Contract award and execution by LMP Impianti, Italy		----------	----------	----------	----------	----------					
3. Purchase and installation of on-site storage tank		----------	----------	----------	----------						
4. Study tour of ADVECHEMS managerial staff to Italy						---					
5. Purchase of new blowing agent		----------	----------	----------	----------	----------					
6. Equipment installation, process start-up and training at operational personnel, process optimization							---	- -	- -	- -	- -

Implementation Arrangements

The project will be implemented by UNIDO in cooperation with the national Egyptian coordinating agency EEAA. UNIDO as executing agency has necessary experience and capabilities for the successful implementation of projects on the enterprise level. UNIDO has an effective mechanism and procedures of projects substantive and financial management, control, evaluation and reporting.

Upon the project approval by the Multilateral Fund the project's fund to be transferred to UNIDO. Respective project allotment document will be then issued by UNIDO financial section to allow the project implementation. Any substantive and financial deviations are subjects for approval by the EEAA and the Executing Committee (if necessary.)

Substantive and financial reporting procedure will be in accordance with the Multilateral Fund requirements.

ANNEXES:

A Project Budget (UNIDO format)
B Provisional quotation of LMP IMPIANTI, Italy
C Comparative analysis of the potential options of alternative blowing agents
D Specification of on-site storage tank
E Analysis of Start up cost

UNIDO

PROJECT BUDGET/REVISION

3. COUNTRY	4. PROJECT NUMBER AND AMENDMENT	5. SPECIFIC ACTIVITY
EGYPT	..../EGY/93/.....	J 13420

10. PROJECT TITLE: Phase-out of the Use of CFC 12 in the Manufacture of Extruded Polystyrene Foam at ADVECHEMS

15. INTERNATIONAL EXPERTS (functional titles required except for line 11-50)	16. TOTAL		17. 1993		18. 1994		19.		20.	
	M/M	$	M/M	$	M/M	$	M/M	$	M/M	$
11-01										
02										
03										
04										
05										
06										
07										
08										
09										
10										
11										
12										
13										
14										
15										
16										
11-50 Short term consultants	0.5	8,000	0.5	8,000						
11-99 Sub-total-international experts **	0.5	8,000	0.5	8,000						

21. REMARKS

** If more than 16 experts required check here ☐ and attach continuation sheet 1A. This sub-total must include all experts.

Form/FS.03/Rev.6
(UNX61F 86-07-17)

UNIDO EDP SECTION

PROJECT BUDGET/REVISION

4. PROJECT NUMBER ..../EGY/93/....	16. TOTAL		17. 1993		18. 1994		19.		20.	
	M/M	$	M/M	$	M/M	$	M/M	$	M/M	$
OPAS EXPERTS (functional titles required)										
12-01										
12-02										
12-03										
12-99 Sub-total-OPAS experts **										
ADMINISTRATIVE SUPPORT PERSONNEL										
13-00 Clerks, secretaries, drivers										
13-50 Freelance interpreters (non-UNDP projects)										
13-99 Sub-total-administrative support personnel										
UN VOLUNTEERS (functional titles required)										
14-01										
14-02										
14-03										
14-04										
14-99 Sub-total-UN VOLUNTEERS **										
15-00 Project travel										
16-00 Other personnel costs (including UNIDO staff mission costs)										
NATIONAL EXPERTS (functional titles required)										
17-01										
17-02										
17-03										
17-04										
17-05										
17-99 Sub-total-National experts **										
18-00 Surrender prior years' obligations										
19-99 TOTAL-PERSONNEL COMPONENT	0.5	8,000	0.5	8,000						

** If additional individual budget lines are required, check here ☐ and attach continuation sheet 1A. These sub-totals must include budget lines listed on page 1A.

PROJECT BUDGET/REVISION

4. PROJECT NUMBER .../EGY/93/....	16. TOTAL		17. 1993		18. 1994		19.		20.	
	M/M	$	M/M	$	M/M	$	M/M	$	M/M	$
SUBCONTRACTS										
21-00 Subcontracts		243,000		243,000						
28-00 Surrender prior years' obligations										
29-00 TOTAL-SUBCONTRACTS		243,000		243,000						
TRAINING										
31-00 Individual fellowships										
32-00 Study tours; UNDP group training		7,000		7,000						
33-00 In-service training										
34-00 Non-UNDP group training										
35-00 Non-UNDP meetings										
38-00 Surrender prior years' obligations										
39-99 TOTAL-TRAINING COMPONENT		7,000		7,000						
EQUIPMENT										
41-00 Expendable equipment		445,000		220,500		224,500				
42-00 Non-expendable equipment		120,300		120,300						
43-00 Premises										
48-00 Surrender prior years' obligations										
49-99 TOTAL-EQUIPMENT COMPONENT		565,300		340,800		224,500				
MISCELLANEOUS										
51-00 Sundries		80,700		50,000		30,700				
55-00 Hospitality (non-UNDP projects)										
56-00 Support costs (CC and DC projects only)										
58-00 Surrender prior years' obligations										
59-99 TOTAL-MISCELLANEOUS COMPONENT		80,700		50,000		30,700				
99-99 PROJECT TOTAL	0.5	904,000	0.5	648,800		255,200				

+ 117,520 (13% overheads)

TOTAL 1.021,520

ANNEX B

LMP Impianti

C.so Piemonte 63
10099 S. Mauro To. - ITALY

phone nr. (11) 2256318/19/20
fax nr. (11) 2236794

Address fax nbr.: 0043 1 2309615 / 232156 **FAX message**

To:	V. Bysyuk/Tchekmaverian	Date:	22/06/93
Company:	UNIDO VIENNA	From:	Renato Crana
Message nbr.:	93/1P /abc		
Pages:	2		

Re.: Your fax dated 18 Jun. Msge nbr. 937957

SUBJECT: CFC PHASE-OUT FROM EXTRUDED POLYSTYRENE FOAMS AT ADVECHEMS EGYPT

FILE REF.: MONTREAL PROTOCOL

Dear Mr. Bysyuk,
further to your fax under reference. we are replying here below:

AAA) Breakdown of our offer:

- screw elements and barrel	US $	69,000
- static homoganizer	US $	42,000
- injection system	US $	56,000
- gravimetric flow meter	US $	11,000
- teflon coated lips	US $	18,000
- set of spare parts for pump.....	US $	2,000
- technical transfer of know-how	US $	30,000
- technical assistance for machine commissioning	US $	15,000
total	US $	243,000=

(twohundred-fortythreethousand)

As you can see from the above list, we excluded the Chiller equipment. as per your request.
Concerning the teflon coated die lips, we stress their importance because when using the new blowing agent, the the melt (molten plastic) si more viscous and to obtain a perfect foam, the customer need a different set of lips with a new profile.

BBB) Breakdown of technical assistance for disassembling, re-assembling and start the line up again with the new product, training of the customer personnel, is covered by the item 'technical transfer of know-how), i.e. US $ 30,000-;
technical assistance has been calculated as follows:
daily tariff: 350 US $ (8 daily hours) x 2 men x 10 working days = US $ 7,000 plus
US $ 4,200 (board and lodge in Egypt 2 men x 14 days)
US $ 3,800 (air return tickets for 2 men)

total U$S 15,000=

ccc) FR agent (flame retardant) is necessary because it is used to reduce the risk of fire due to the fact the Polyatyrene resin itself is flammable.
Consequently, if the obtained product is used for building insulation, the FR agent needs to be included in the formulation.

Always at your disposal for any further information you may need and hoping to have cleared all points, we remain with best regards.

Yours sincerely,

L.M.P. IMPIANTI s.r.l.
RENATO ORANA
Managing Director

Summary Assessment of Options
Blowing Agent and Process Compatibility

Options	Safety	Commercial Availability	Cost Price*	Process Compatibility
CO2 / N2 Partial Replacement	OK	OK	OK	Some
CO2 / N2 Total Replacement	OK	OK	OK	Some (laboratory/ development) Not widely accepted
HCFC 22 100%	OK	OK	Increased cost over CFC12	Limited
HCFC 142b 100%	Flammable	OK	Increased cost over CFC12	OK
HCFC 142b/22 Blend (60/40)	OK	OK	Increased cost over CFC12	OK
HCFC 134a	OK	OK	Very expensive	Poor solubility in polystyrene
Hyrodcarbons (Pentane/ butane)	Flammable	OK	OK	Possible by development
Other HCFC option	OK	Variable	Variable	Mainly excluded by boiling point & availability

* Comparative to CFC 12.

Summary Assessment of Options
Known and Anticipated Product Properties

Options	Product Fire Standards	Product Density	Product Insulation*	Comments
CO2 / N2 Partial Replacement	OK	Fair	Reduced	Incomplete solution max. replacement 25% of CFC
CO2 / N2 Total Replacement	OK	Not economic	Reduced 73% down with CO2	Unproven process uneconomic solution with respect to density and insulation
HCFC 22 100%	OK	OK	OK 20 % down	Limited compatibility with process
HCFC 142b 100%	OK	OK	OK 30% down	Flammable, excluded on safety grounds
HCFC 142b/22 Blend (60/40)	OK	OK	OK 25% down	Widely used
HCFC 134a	OK	OK	OK 40% down	Concern over poor solubility
Hyrodcarbons (Pentane/ butane)	OK	OK	Reduced 60% down	Unable to achieve fire standards with current technology
Other HCFC option	Variable	Variable	Variable	Variable and unproven

* Based on comparison of gas conductivity values in vapour phase at 30oC compared to CFC 12. (See annex A).

THERMAL CONDUCTIVITY VALUES FOR COMMON BLOWING AGENTS

Chemical name	Symbol	Thermal Conductivity W/mK
Carbon dioxide	R 744	0.0168
Propane	R 290	0.0183
Butane	R 260	0.0160
Pentane		0.0152
Trichlorofuloromethane	R 11	0.008
Dichlorodifluoromethane	R 12	0.01
Chlorodifluoromethane	R 22	0.012
Chlorodifluoroethane	R 142B	0.013
Tetrafluoroethane	R 134A	0.014

Annex D

ON SITE GAS STORAGE CAPACITY

ADVECHEMS, is receiving the freon mixture CFC-12/HCFC 22 from the local market in tanks of 1 ton capacity. This material was always available to its needs, as both types were widely used in the Egyptian market.

The HCFC 142b/22 blend is not available locally or stored by others in Egypt. This blend will have to be imported in economic quantities by ADVECHEMS from either:

(1) Solvay - Germany
(2) ATOCHEM - France
(3) Rhone Poulenc - UK

The only economic import is in 16.5 tonne ISO containers which cannot be retained on site. This necessitates the on-site storage facility which must hold a minimum of 20 tonnes of blowing agent. The current cost estimates are based on a proposal for two 10 tonne tanks. This may be changed after evaluation to one 20 tonne tank facility with no anticipated cost change.

Cost calculation for gas tank installation

1.	Two 10 tonne tanks ex INTMEX (2 x 45,900)	-	US $ 91,800
2.	Two rotary pumps, valves + pipework	=	US $ 9,000
3.	Site preparation and foundation for tanks	=	US $ 15,000
4.	ISO container discharge pump	-	US $ 4,500
	Total	=	US $120,300

Note: Careful scheduling of deliveries will be required to ensure the timely arrival of new deliveries and further discussions need to be held with gas supplying companies to identify problem areas. Following these discussions ADVECHEMS may decide to go to one 30 tonne tank, but would absorb this additional cost themselves.

Annex E

START UP COST ANALYSIS

It is expected that 10 working days will be sufficient for start up and the process conversion. During this period up to 50 % of the product may have off-specification quality and to be considered as scrap. Taking into consideration that this scrap can easily be recycled on the spot only the loss of the blowing agent to be calculated as the start up cost.

Related variable manufacturing costs (labour, power, etc.) should be absorbed by ADVECHEMS.

Thus the calculation of the start up cost is as follows:

205 kg/hr (PS compared consumption) x 10 days x 24 hrs x 50 % scrap x 16.5 % (weight of blowing agent) = 4059kg of BA loss.

4-59 lg x US $ 4,755/kg of BA = 19,300.

TOTAL START UP COST US$ 19,300.