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Executive Committee of
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Implementation of the Montreal Protocol

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PROJECT PROPOSAL: SYRIAN ARAB REPUBLIC

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

(a) Investment Project for Phasing out of CFCs at BARADA (UNIDO)

(b) Investment Project for Phasing out of CFCs at PENGUIN (UNIDO)

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Syrian Arab Republic
PROJECT TITLE:	Investment Project for Phasing out of CFCs at: (a) BARADA (b) PENGUIN
BUDGET:	(a) BARADA: Capital Costs: US $749,650 Operating Costs: US $435,000 (b) PENGUIN: Capital Costs: US $1,597,000 Operating Costs: US $ 345,000
INCREMENTAL COSTS:	(a) BARADA: US $1,184,650 (b) PENGUIN: US $1,942,000
ODS PHASE-OUT:	Total for two companies: 190 mt/y CFC-11 and CFC-12
COST EFFECTIVENESS:	US $16.46 per kg ODP saved
PROJECT DURATION:	18 months
IMPLEMENTING AGENCY:	UNIDO
NATIONAL COORDINATING AGENCY:	General Commission for Environmental Affairs
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. Two project proposals are submitted to phase out 191 mt/year of CFC-11 and CFC-12 in two large domestic refrigerators enterprises, BARADA (State owned) and PENGUIN (privately owned). The two proposals in addition to the project approved by the Committee at its Thirteenth Meeting cover all the major domestic refrigerator producers in Syria.

2. The two enterprises, BARADA and PENGUIN are converting to HFC-134a in the refrigeration system. Conversion of the refrigeration system involves replacement of existing evacuating and charging boards, modification of evacuating systems, acquisition of HFC-134a leak detectors, test equipment and prototyping. The refrigeration servicing will provide recovery and recycling equipment for both CFC-12 and HFC-134a.

3. The two enterprises are choosing two different foam blowing agent. BARADA will use HCFC-141b, a transitional chemical with residual ODP; PENGUIN will use cyclopentane.

4. The foam system conversion entails replacement of low pressure foam machines with high pressure machines, modification of fixtures, as well as safety equipment for the cyclopentane system in PENGUIN. It is to be noted that converting from HCFC-141b to zero-ODP chemicals would require some modification in the foam dispensing system.

5. 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.

6. Incremental operating costs for the refrigeration and foam systems are calculated for six months. The incremental operating costs of PENGUIN are comparable with those in approved projects. However, the incremental operating costs of BARADA are much higher because of the expensive innerliner required in HCFC-141b systems.

7. Incremental operating costs were recalculated by the Secretariat based on the actual number of units being currently produced and not on the basis of installed capacity or expected growth.

SECRETARIAT'S RECOMMENDATION

8. The Fund Secretariat recommends final approval of the projects and approval of funding as follows:

(a)	BARADA:	Capital Costs:	US $ 749,650
		Operating Costs:	US $ 240,000
(b)	PENGUIN:	Capital Costs:	US $1,405,800
		Operating Costs:	US $ 314,100

TECHNICAL REVIEW

1.	**Country of Origin:**	**SYRIA**
2.	**Project Title:**	Investment Project for phasing out CFC's at Penguin (Syrian Batric Co.)
3.	**Sector/Sub-sector:**	Domestic Refrigeration (Rigid Foams and Refrigerant), commercial and Industrial Refrigeration / Service.
4.	**Relationship to Country Programme:**	The project was prepared in line with Syrian Country Programme Document UNEP/OZI/EE/COM/11/22.

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5. **Technology**

a) Cyclopentane foaming is inherently more hazardous than other available alternatives. However, the project proposal includes relevant safety features (Technological and Procedural) necessary for thistype of plant.

(i) Cyclopentane will be stored under ground outside the factory building.

(ii) Premixing of polyol and Cyclopentane is done outside the factory building.

(iii) Local safety regulations have been taken into account.

b) The Technology involved is not Transitional. Cyclopentane has a zero ODP. HCFC 134a has a zero ODP.

c)
(i) There is no Technology transfer agreement at present.

(ii) There is no licensing agreement.

(iii) Alternative foaming Technology was considered but the company has decided to avoid the application of any transitional substance and to introduce the Cyclopentane as ultimate solution.

enable the plant to be converted without loss of product quality.

6. ENVIRONMENTAL IMPACT

a) (I) HFC 134a has a zero ODP.

(ii) Cyclopentane has a zero ODP and a very low GWP.

b) The appropriate measures to minimise Health and Safety impact are dealt with in the project.

7. PROJECT COSTS

a) (i) The low pressure foaming machines cannot be modified. Therefore they must be replaced with high pressure foaming machines and related equipment. Systems necessary for Cyclopentane based foaming Technology should also be provided.

(ii) Some of the cost elements could be reduced by selecting alternative suppliers but overall costs seem appropriate.

(iii) Some of the cost elements seem to be underpriced particularly for production leak detection, we would recommend production to use Helium detection stations. Because Leak detection on HFC 134a systems is much more critical than CFC12 systems and Helium has a smaller structure than HFC 134a, it is a better leak detection medium and therefore more suitable for production purposes, although a realistic costing for this would be US $25,000 each

(iv) We would doubt the reliability of using recovery bags for CFC12. we consider it advisable to equip the service modules with small portable recovery units which can be emptied at each service centre into recovery bottles for transportation to reclaim plant or back to original suppliers.

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

c) **COST OF EQUIPMENT**

(I) The baseline cost of existing equipment has not been addressed.

(ii) Not all baseline equipment will be replaced. Some such as vacuum pumps will be modified.

(iii) All requests for additional equipment can be justified. Any equipment requested as additional to the project is to be provided by the counterpart (Penguin).

(iv) Some baseline equipment can be modified to perform functions needed in the conversion. This has been addressed in the project.
(v) The fate of scrapped equipment has not been addressed.

(iv) There is no calculation of salvage value of scrapped equipment.

(vii) The modification of the existing equipment within the scope of the project will not increase the production capacity.

d) **STARTUP / COMMISSIONING COSTS**

(i) The level of the training costs and Technology familiarisation costs both abroad and on site seems appropriate.

(ii) There could be some redundant production costs but these could be kept to an absolute minimum.

e) **OPERATING COSTS**

(i) The operating cost components are appropriate.

(ii) No transitional period is required.

(iii) There are no operational cost savings.

f) **OTHER COSTS**

(i) Consultancy costs and implementing agency overhead costs are deemed reasonable.

(ii) A contingency fund of (10% of the total budget) is included in the project, this is appropriate and justifiable.

g) **COST EFFECTIVENESS**

(i) The unit abatement cost for overall project according to calculation is 10.61 $ Kg. The ratio from overall cost to ODS (in ODP tonnes) is 39.45 $ Kg (B1 ÷ A7). The annual 1/3 incremental recurrent cost per Kg ODP phased out is 4.19 $ Kg. This indicates a relatively good level of cost effectiveness over the lifetime of the project but is a relatively high investment per ODP tonne phased out.

(ii) The project is cost effective.

h) **IMPLEMENTATION TIME**

(i) The proposed implementation time frame is feasible but we would question the length of time allowed for the manufacturing of the equipment, installation and commissioning (Page 13 item 7) given at 6 - 7 months, currently in our opinion this should be between 9 - 12 months.

RECOMMENDATIONS

(i) Approval as proposed.

(ii) Cost of new equipment should be reviewed, costs could be reduced in our opinion by selection of alternative equipment suppliers, subject to the compatibility of the existing equipment.

C. Wainwright M Inst R.

D. Ponsford.

PROJECT SUMMARY

This project is designed to phase out 100% of CFC 11 as blowing agent and CFC 12 as cooling agent in the production of domestic refrigerators at Barada Co., Damascus, Syria.

The chosen replacement alternatives are HCFC 141b as foam blowing agent and **HFC 134a** as refrigerant. The project will include the redesign of the refrigeration system for all currently produced models and the conversion of the plant.

The redesign of the models covers activities like prototyping, performance testing, trial manufacturing and adaptation as well as reliability tests. The conversion of the production facilities covers the refrigeration system, insulation foam blowing system and the refrigeration service sector of the company.

BACKGROUND

Sector Background

The subsector for domestic refrigerators and freezers in Syria consists meanwhile of 3 larger manufacturers (namely Al Hafez Co., Penguin and Barada), medium size companies (such as Krayem) and many small-scale manufacturers: 79 for domestic refrigerators, 49 for domestic freezers and also many for industrial and commercial refrigeration.

Syria does not produce CFCs. The total consumption of CFCs in the production of polyurethane foam was about 450 MT in 1991. The total consumption of CFC 12 was 759 MT in 1991. Approximately 60% of all ODS consumed in Syria in 1991 was used in the commercial and domestic refrigeration production and the air-conditioning subsectors. The demand of ODS, at the moment, is stagnant, but it is estimated that it will increase in the future unless plants are converted.

Based on a more than 15 years life expectancy for refrigerators and freezers, a total of 2,300.000 refrigerators, approximately 230.000 freezers and 36.500 industrial and commercial refrigeration systems were operating in 1991. Approximately 7% will be annually re-charged with about 62 MT of new CFC 12 during refrigeration service. Due to lack of equipment for the service sector, service staff often use CFC 12 for washing/flushing the cooling systems, instead of using vacuum pumps and charging boards. This causes up to 100% higher than necessary CFC 12 consumption in the service sector.

Apart from the refrigeration equipment BARADA is producing table top gas ovens, gas cookers with oven and gas oil heaters.

Background Information

BARADA General Company was founded 35 years ago and is, since then, the only state-controlled company operating in manufacture, sale and service of commercial and domestic refrigeration in Syria and shares 30% of the local market.

It employs 1180 staff from which 700 are working at the refrigerator factory. Its installed annual capacity is about 125.000 refrigerators. The capacity in the foaming section is per shift approx. 40.000-45.000 units per year.

PROJECT COVER

Country/Region:	Syria
Project title:	Investment Project for Phasing out CFCs at BARADA, General Company for Metallic Industry.
Sector covered:	In Syria the total consumption of CFC 11 is 493 MT and of CFC 12 is 795 MT
Project impact:	Phase out of annual consumption of 90 MT of CFC 11, 17 MT of CFC 12 for production and 1,9 MT for service (Total ODP= 108,9 MT)
Project duration:	18 months
Project economic lifetime:	10 years
Total proposed project cost:	US$ 1,338,650.00
Project investment cost:	US$ 749,650.00
Implementing Agency's overheads:	US$ 154,000.00
Incremental Operating Cost: (One year operational costs)	US$ 435,000.00
Proposed MF financing:	US$ 1.338,650.00
Cost effectiveness:	See Annex C: Unit Abatement cost
Counterpart enterprise:	BARADA, General Company for Metallic Industry, Syria
Implementing Agency:	UNIDO
Coordinating Ministry:	General Commission for Environmental Affairs

From 1.1.93 to 31.12.93, the actual production was only 75.000 refrigerator units. An increase of 10% per year is intended for the next four years; but it cannot be guaranteed that it will be reached since the Government cut the exchange rate privileges for state-controlled companies and obliged them to compete with the private sector.

They produce the following models:

- 8 cu.ft. 1 door refrigerator model with freezer compartment,
- 11 cu.ft. 1 door refrigerator model with freezer compartment,
- 13 cu.ft. 1 door refrigerator model with freezer compartment,
- 14 cu.ft. 2 door refrigerator and freezer model, and
- 15 cu.ft. 1 door refrigerator model with freezer compartment.

Currently, Barada is not producing refrigerators with low energy consumption. The insulation thickness is only 30mm which is less than the international standard of 35mm.

BARADA has the following lines in the refrigerator section:

- Steel sheet processing lines for cabinets and doors,
- Two-stage painting line,
- Thermoforming lines, THERMOFORMING, Italy,
- Polyurethane foaming lines, CANON, Italy, 1986, locally made,
- Plastics sheet extrusion lines, COVEMA, Italy,
- Profile extrusion lines for tubes, door gaskets, COLINES, Italy,
- Plastics mould injection line, COLINES, Italy,
- Pre-assembly, assembly, evacuation, charging and testing lines.

At both production sections, which are subject to conversion, the following equipment is available:

- 4 low pressure foaming machines for cabinets and doors (one from Cannon and 3 made at Barada); each with 1 mixhead;
- 4 pneumatic and manual jigs with unheated wooden cores in bath position for refrigerators; the side plates are heated;
- 3 double fixtures and 2 single fixtures mechanically closed for refrigerator doors;
- 1 CFC 12 recovery unit is ordered to be switched to HFC 134a.

The jigs are stationary in the foaming places. The premixing of polyol and CFC 11 is done by an own made mixer.

All the fixtures for foaming of cabinets and doors are made of aluminium and steel plates and are heated. The plugs are wooden and not heated. The cabinet jigs are pneumatically operated and use the bath position.

BARADA is using standard polyurethane foam without CFC reduction with a free rising density of 30-31 kg/m3.

In the evacuation, charging and testing section, there are 2 lines with the following equipment:

- 22 pcs. vacuum pumps (20 on a carousel, 2 as single units);
- 3 pcs. vacuum and charging stations, (1 unit is new, 2 are very old);
- 5 pcs. production electronic leak detectors from Leybold.

Presently, BARADA does not have its own performance test laboratory. However, in order to optimize the R134a cooling system and to ensure the quality, they have to build up a separate test room and laboratory.

BARADA'S Refrigeration Service

BARADA has its own network of service shops in Syria including 5 service centers of their own and many distributors' service shops. Each of the service shops is equipped with a service evacuation and charging board and a service leak detector and adequate tools. To date no CFC 12 reclaiming equipment exists in Syria. Therefore, a project concept for establishment of a national system for CFC 12 recovery, reclaiming, stock-piling and distribution for services is under discussion at the Ministry of Environment.

BARADA provides, through their service shops, service for about 5000 units per year using approximately 20,5 MT of CFC 12.

During the last 15 years, equal to the average lifetime for refrigerators and freezers, BARADA has manufactured about 930.000 refrigerators of which 10% will need service each year. It means that about 93.000 units need service every year from which only 5.000 units are serviced at BARADA's own service shops.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of CFC 11 and CFC 12 in the production of domestic refrigerators at BARADA through conversion to the use of HFC 134a as refrigerant and HCFC 141b as blowing agent for the polyurethane insulation foam.

PROJECT DESCRIPTION

BARADA is prepared to phase out ODS in the refrigeration section as soon as the new technology has been acquired, the necessary machinery and equipment installed and the technical staff trained.

Among the technological options currently available on a commercial basis, BARADA has chosen to replace CFC 12 by HFC 134a, because the new compressors are available, the technology is mature and commercially applied.

As for replacement of CFC 11 by an alternative blowing agent, two technological options have been considered and analyzed: cyclopentane and HCFC 141b. Finally HCFC 141b was accepted although it is a transitional solution for a period of 20 to 25 years.

This technology was selected taking into consideration two major arguments:

a) location of the building and layout of the main production lines and sections in the building which make it impossible to situate a cyclopentane storage tank, related systems and polyol-pentane pre-mixing station in a safe way. A total reconstruction of the factory would be required if cyclopentane technology were to be selected, and

b) the company is not prepared to operate with inflammable and explosive materials. Their industrial safety, alarm, monitoring and training system has been established in accordance with the relevant requirements of the existing production programme.

The factory managers are also well aware of their technical, financial and other responsibilities caused by the conversion, which are as follows:

- HFC 134a as a refrigerant is sensitive and can react with water, a number of chemical substances, oils and even dust-like particles. High viscosity products (polymers, resins, etc.) of these reactions can easily block the cooling system. Therefore, special arrangements are to be made aimed at increasing technological discipline, skill and responsibility of technical personnel, etc.

- Since the present innerliner made at BARADA by extrusion of the regular or modified grade of PS and double sided covered by a HDPE film, is not resistant to HCFC 141b, it should be replaced by imported special plastics sheets available on the market. However, the existing extrusion line can be modified for co-extrusion of multilayer ABS or HIPS sheets covered by EVOH film (DUPONT) - if possible, since the sheet extrusion line is 20 years old - or monolayer sheets made of special compounds which might be available on the market in the future.

- Since parameters of the thermoforming process of new plastics sheets are different than for regular/modified PS sheets, the existing thermoforming machines have to be adjusted to a new technology to ensure quality of final products and reduce quantity of rejects.

- All stages of the foaming process require a high accuracy and exactness in maintaining the required ratio of components of foam formulation and the parameters of the mixing process.

Assistance, through the project, is sought for:

a. Procurement of new machinery and equipment;

b. Modernization and partial replacement of existing equipment;

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

d. Installation and commissioning of equipment, training of national personnel abroad and on-the-job training, trial operation and start-up of converted production lines, etc.

e. To provide each of the 5 refrigerator service centres of Barada with one set of equipment for servicing of HFC 134a based refrigeration systems as well as with one CFC 12 recovery unit and recovery bags.

The following machinery and equipment needs to be rebuilt, replaced or added and relevant expertise and know-how to be applied:

A. Refrigeration System

- The 2 charging boards at 2 refrigerator lines and 1 board for the service/repair shop have to be replaced by new boards suitable for HFC 134a.

- The 5 existing leak detectors ((Leybold Inficon) two for each production line and one for the service/repair shop) need to be replaced by special leak detectors for R134a.

- The existing 24 vacuum pumps, after having applied a special cleaning technology (described in Annex D) can be re-used.

- The cooling system of current models of refrigerators and freezers should be re-designed or optimized due to replacement of CFC 12 by HFC 134a.

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

- The drier for HFC 134a has to be with a desiccant with 3AA pores or a desiccant XH7 (Union Carbide).

- The cooling system must not contain chlorine and max. 1% non-condensable gases. Therefore, a new cleaning liquid has to be used.

- The capillary tube has to be optimized for an increased resistance at low evaporating temperatures because the volume flow with HFC 134a is about 80% of the volume flow with CFC 12.

B. Foam system

- With the existing low pressure foaming machines (one from CANON, 1986, three made at BARADA's workshop), BARADA cannot foam refrigerators in an optimal way necessary to compensate for the 5% higher thermal conductivity of HCFC 141b blown foam in comparison to CFC 12. In general, the design of these machines cannot meet special requirements of HCFC 141b based technology related, in particular, to maintaining the ratio of foam components with high precision and mixing parameters of the components.

- Instead of adjusting the 4 low-pressure PUR machines, it is recommended to replace them with only one high-pressure machine with 2 mixheads and to request BARADA to change their layout to have only 1 larger high-pressure PUR line with cabinets and door jigs instead of 2 small ones. In order to use the machine to foam cabinets and doors, a second foaming place is needed.

- Through this, BARADA will also stop using large amounts (25t per year) of tetrachlorethylene for cleaning the mixheads, because the high-pressure machines have self cleaning mixheads.

- To reduce the energy consumption of the refrigerators, it is recommended that Barada uses the opportunity of conversion to increase the thickness of the insulation foam from 30mm to 35mm according to standard and climate requirements. The necessary moulds, tooling and other costs for the increase are not part of the project and should therefore be borne by BARADA.

- The existing cabinet foaming jigs can be used except that the plug has to be heated to be able to use HCFC 141b. Therefore, a heating fan per cabinet jig has to be added and the existing 4 wooden cabinet plugs have to be replaced by aluminium plugs to be able to reach the needed temperature for the HCFC 141b reaction at the necessary speed.

- Furthermore, BARADA has to provide a pre-heating oven.

- The 5 door jigs have to be modified by adding electric resistance heating elements on the plates.

- The final specification of HCFC 141b to be used will be defined after having carried out a market review in Syria and an assessment of its availability. The current price level is about US$ 3,42/kg plus packaging and transport.

There are no manufacturers of HCFC 141b in Syria.

BARADA's technicians have to be trained by the consultants in new foaming technology as well as in design/ calculation and performance test and calculation/design of cooling systems.

During the installation and start up of the new machinery and equipment, the supplier's engineers have to train BARADA's technical staff in all aspects of the refrigeration and foaming sections operation. The shift to R134a should be made model after model to avoid interruptions in the production process.

If necessary, some additional consultancy service for the production management, process and quality control has to be introduced to master this new technology.

C. Refrigeration Service

BARADA has, at each of their 5 service centers 1 set of service equipment for R12. In order to cover the requested service in the future, each center should get 1 pc. of R134a mobile charging board, 1 pc. of electronic leak detector for R134a and 10 sets of recovery bags for R12. Furthermore, each center should collect the R12 from the recovery bags by a recovery unit to send the R12 for reclaiming.

D. Justification for Selection of Alternative Technologies

1. HFC 134a as an alternative refrigerant to CFC 12 is recognized and accepted by all major manufacturers of domestic refrigerators and freezers as well as by the manufacturers of compressors and relevant production and testing equipment.

The necessary expertise, services, technical documentation, equipment, machinery and instrumentation as well as the raw materials are available on the market.

The counterpart (BARADA Co.) is also sufficiently technically equipped to convert their refrigeration section from CFC 12 to HFC 134a. The necessary consultancy and other services (apart from the equipment as incremental capital cost) will be provided under the project.

2. Although HCFC 141b chosen as an alternative to CFC 11 blowing agent for the PU insulation foam is a transitional solution, it can only be recommended for the real conditions of BARADA. More justification for this selection is given under "Project Description" above.

The company, being equipped with a modern high-pressure foaming machine, can replace HCFC 141b by a hydrocarbon as blowing agent at a later stage. By that time, the company should be able to modify the building according to the respective safety requirements and to change the layout of the production section. Minor adjustment/modifications of the foaming equipment will also be required.

3. The following three alternatives for replacement of the innerliner were considered:

a) Import of co-extruded plastics sheets resistant to HCFC 141b. These products have been developed by BASF and DOW and are available on the market at a cost of US$ 3.5-4.0/kg;

b) Modernization of the existing sheet extrusion line to enable BARADA to produce co-extruded sheets with the required performance parameters; in this case, a package of the following engineering services related to modernization of the extrusion line is needed: two additional small non-standard extruders should be built in, a new extrusion die should be designed and fabricated and the technology should be transferred.

c) Adjustment and minor modification of the existing extrusion line for extrusion of ABS or HIPS sheets covered by a special polymer film.

After having evaluated the above mentioned alternatives, it was found that the third alternative is the most cost-effective, technically justified and acceptable solution for BARADA. It is suggested that, immediately after the project approval and allocation of funds, a minor part of the incremental operating cost (approx. US$ 10,000) will be used for:

- purchase of new raw plastics materials in quantities sufficient to carry out the necessary technological tests;

- short-term advisory and technical assistance related to possible extrusion of new plastic sheets resistant to HCFC 141b using existing extrusion line;

- processing (thermoforming) and performance (resistance to HCFC 141b) tests of the new plastic sheets.

Practical experience accumulated by some refrigeration companies shows that such innerliners are compatible and resistant to HCFC 141b blown PU-foam, if the foaming process itself is properly organized.

In case the quality of these innerliners is not in accordance with the required quality, the co-extruded sheets should be imported. Initially the incremental operating cost portion of the project funds will be utilized for purchase of new plastic sheets. Further needs of BARADA's production programme in innerliners will be the responsibility of the company.

In view of the above, the incremental operating cost of the project is calculated based on the concept that BARADA will import ABS or HIPS of required grade in granules at US$ 1.5-2.0 as raw material for sheet extrusion.

INPUTS

1. Capital Goods Replacement, Rebuilding and Modification

A. Refrigeration System

The following equipment needs to be modified, rebuilt or replaced as well as additional equipment to be provided as specified below:

A.1 3 pcs. HFC 134a production charging boards with vacuum pump, refrigerant supply pump and vacuum check (two for production lines, one for service/repair workshop);

A.2 Cleaning of the existing 24 pcs. vacuum pumps with ester oil according to Annex D.

A.3 3 pcs. HFC 134a production leak detectors (two for production lines, 1 for service/repair workshop);

A.4 1 set of test equipment and materials for prototyping and testing of converted models.

A.5 24 pcs. vacuum control for existing vacuum pumps, which can be cleaned to be used for R134a;

B. Foam System

B.1 1 pc. high pressure foaming machine designed to operate with HCFC 141b;

B.2 2 pcs self cleaning mixheads of two sizes for filling of cabinets and doors;

B.3 second foaming place in order to use the machine to foam cabinets and doors, using, at the same time, two different mixheads;

B.4 1 pc. premixing station for polyol and HCFC 141b;

B.5 1 set foam test equipment;

B.6 Modification of 4 pcs. foaming jigs for all refrigerator cabinets to enter a heater for the plugs;

B.7 Modification of 5 pcs foaming jigs for all refrigerator doors to enter electrical resistance wire heaters;

B.8 4 pcs. new refrigerator foaming fixed aluminium plugs for the jigs;

B.9 1 pc. water chiller (it is needed for the high-pressure PU-foaming line).

2 pcs. pre-heating ovens (to be provided by BARADA at their cost).

C. Refrigeration Service

C.1 5 pcs. HFC 134a charging boards for 5 refrigeration service centers;

C.2 50 pcs. recovery bags for CFC 12 (10 for each center);

C.3 5 pcs. recovery units for CFC 12, one at each center;

C.4 5 pcs. electronic leak detectors for R134a, one for each service center.

2. Conversion/ Training

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

- management and production control in the PUR section, charging and testing lines;
- 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 of material for the PUR lines and for the refrigeration system, compressors, evaporators, condensers, dryers, capillary tubes, etc.;
- clean operation of the charging and closing of the cooling system.
- servicing of the converted refrigeration equipment.

3. Model Redesign

It is foreseen that for all current models of refrigerators, redesign or modification is required, followed by the manufacture of some prototypes and refrigeration performance tests. The cost for these activities is only partially included in the training component for technical staff, as well as in the international expert component, but it should mainly be absorbed by BARADA.

As a common practice, modifications of the production lines will be carried out during evenings and off-days and should therefore not cause negative impact on the regular production. It is not necessary to stop the production (except for a few days) to switch the production from the old to the new equipment.

PROJECT IMPLEMENTATION

The project will be implemented by UNIDO in close cooperation with the General Commission for Environmental Affairs. The local coordination will be carried out by BARADA.

Any construction work needed to accommodate the equipment for the new foaming technology and the necessary change of layout to have 1 PUR foaming line, which has to be carried out by BARADA, is not reflected in the project budget. The specification of construction work will be elaborated after project approval.

The counterpart is also responsible for provision of all additional supporting equipment, machinery, instrumentation, materials and related services which are not specified in the project document but are necessary for the conversion of the production programme.

The proposed tentative work plan for the project implementation is as follows:

ACTIVITIES	Months: 1 2 3 4 5 6 7 8 9 10 11 12 14 16 18
General:	
1. Project approval, receipt of funds	X
2. Preparation of det. work plan	X
3. Initial training of management	X
FOAM:	
4. Selection of equipment	XXXXXXX
5. Purchase authorization	XXXXXXX
6. Training	X XX
7. Manufacturing of equipment, installation, commissioning	XXXXXXXXXXXXXXXX
8. Start up of production	XXXXXXX
REFRIGERATION:	
9. Redesign of models, training	XXXXXXXX
10. Selection of equipment	XX
11. Purchase, installation and commissioning	XXXXXXX
12. Prototyping and testing	XXXXXXXXXXXXXXXXXXXXXXX
13. Start up of production with HFC 134a	XXXXXX
Refrigeration Service:	
14. Selection of equipment	XXXXXX
15. Purchase, installation	X XX

PROJECT COST

I. INCREMENTAL INVESTMENT COST

The investment cost will cover incremental capital investment cost for modification of manufacturing facilities, new machinery, materials, testing equipment, training, installation and consultancy services for modifications. Incremental capital investment cost break down is shown in Annex A.

Cost of CIF transportation and insurance of equipment provided by the suppliers is included in the budget.

II. INCREMENTAL OPERATING COSTS

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

	Modification		Incremental cost (US$)
-	HFC 134a compressor		5,00
-	Capillary tube modification		0,13
-	Condenser modification		0,90
-	Evaporator modification		1,60
-	3 AA drier		0,15
-	HFC 134a refrigerant		0,39
	Extra cost for foam with HCFC 141b due to density increase to 36kg (+15%)		2,16
-	material for innerliner		5,08
	Total	USD	15,41

The above mentioned figures show the difference between the respective component prices for CFC 11 and CFC 12 based refrigerators versus component prices for HFC 134a and HCFC 141b based ones.

(All above mentioned amounts do not include customs and value added tax).

The increase in cost is caused by:

- purchase of a new HFC 134a compressor (to cope with the lower capacity at low evaporating temperature, but no heavy duty compressor, coping with significant voltage fluctuations), averaging to 10%; US$ 5,00;

- capillary tubes prolongation and changes; average US$ 0,13;

- increase of evaporator and condenser surfaces up to 10% which will cause subsequent cost increase of the condenser on an average of US$ 0,90 and for the evaporators on an average of US$ 1,60.

- HFC 134a charging level is about 10% less than CFC 12; the average charge of CFC 12 is 0,18 kg at US$ 3,00/kg; a current price for HFC 134a at US$ 5,75/kg, excluded any customs tax: (0,162 kg x 5,75) - (0,18 x 3,0) = 0,39/kg;

Comparative cost analysis of foam system:

R11 system				HCFC 141b system			
chemicals	weight %	price $/kg	cost US$	chemicals	weight %	price $/kg	costUS$
Polyol + MDI	86	1,60	1,376	Polyol + MDI	94	1,60	1,598
R11	14	3,30	0,462	R 141b	6	3,42	0,205
		Total:	1,838			Total:	1,803

PU cost US$/kg	1,838	PU costs US$/kg:	1,803
Kg per unit:	9,200	Kg per unit:	10,580
Total costs US$/ unit:	16,910	Total costs US$/ unit:	19,075

Incremental cost difference: US$ 2,16.

BARADA is presently using modified PS granules for local manufacture of innerliners at a price of US$ 0,99/kg. On the average, the cost of PS innerliner material per set foodliner and doorliner is US$ 11,24. By switching, for example, to ABS or HIPS polymers produced by BASF and DOW for these particular applications with an average market price of US$ 1.50-2.0/kg, the cost of a new set of innerliner will increase by 60 %. However, the thickness of new sheets can be reduced from 6.0 mm to 4.5 mm which is recommended by the suppliers. That is why total cost of the new innerliner material will increase by 45 % only and will be on average US$ 5,08 per unit.

The total incremental operating cost for the annual production programme of BARADA (75.000 units) will be US$ 1.155,750 (US$ 15,41 x 75.000).

It is relevant to mention that in case the existing sheets extrusion line cannot be used for manufacturing of the new sheets resistant to HCFC 141b, the company will be forced to import new expensive sheets instead of the necessary raw materials which were the basis for the estimation of the above mentioned incremental operating cost.

In order to ensure smooth conversion of the factory and its operation at the initial period, it is suggested that the incremental operating cost for one year is be provided through this project.

III CONTINGENCY FUND

A contingency fund (10% of the total budget) proposed to cover unforeseen expenses which might incur during the project implementation is also foreseen.

IV. TOTAL COSTS

- Incremental investment cost see Annex A: "Equipment Specification and Cost Breakdown". $ 749.650
- Incremental operating cost (as above). $ 435.000
- Executing agency's overhead cost (13% of total project budget). $ 154.000
- Regarding project cost breakdown see Annex B: "Project Budget"
- Regarding calculation of the unit abatement cost see Annex C: "Unit Abatement Cost".
- Requested funding from the MFIMP:

US$ 1,338.650

Technical Review

1. **Country of Origin:** **Syria**
2. **Project Title:** Investment Project for phasing out CFC's at Barada, General Company for Metallic Industry.
3. **Sector Covered:** Domestic Refrigeration/Rigid Foam Installation/Service
4. **Relationship to Country Programme:** The Project was prepared in line with Syria Country Programme Document UNEP/OZT PRO/EE/COM/11/22

* * * * *

5. **Technology:**

a) The chosen alternatives of HCFC 141b as foam blowing agent and HFC 134a as refrigerant are the safest and environmentally sound for this Project.

b) The foaming technology is transitional as blowing agent HCFC 141b is a transitional substance for an expected period of 20 - 25 years.

c) (I) There is no technological transfer agreement at present that we know of.

(ii) There is no Licensing Agreement.

(iii) Alternative foaming technology Cyclopentane was considered but due to the location of the building and layout of main production lines, which make siting of Cyclopentane tank, related systems and premixing stations plus extensive re building of the factory, it was not deemed economically, or safety, viable. Also, the company is not prepared to operate with inflammable and explosive materials.

(iv) The technology selected will enable the factory to be converted without reduction in product quality while being cost effective.

6 Environmental Impact

a) (I) HFC 134a has a zero ODP

(ii) HCFC 141b has a minimal ODP but is considered necessary in view of the circumstances.

b) The appropriate measures to minimise Health and Safety impact are dealt with in the Project.

Cont/........

7 Project Costs

a) (i) The low pressure foaming machines cannot be modified. I... considered good engineering practice to replace with a high pressure foa... machine which will utilise less spares and be compatible to modification at a later date to accommodate Cyclopentane.

(ii) The cost of the 5 off Aluminium foam plugs (B8) is very high at US $40,000 each - a more realistic price would be approximately US $25,000 each. Furthermore, R141b generates a higher temperature than R11 and if the main reason for changing from wooden plugs to Aluminium plugs is dissipation of heat build-up due to high production output, then heating/cooling should be considered either by Hot/Cold air or Hot/Cold water. It should not be necessary to have both heated jigs/plugs and a pre heating oven.

(iii) Some of the cost elements could be reduced by selecting alternative suppliers, in particular the charging boards - A.1., foaming plugs - B.8., pre mixing station - B.4, Water Chiller - B.9., High pressure foaming machine - B.1., Self cleaning mixing heads - B.2. It is estimated that these items could be reduced from a total of US $580,000 to US $380,000 providing a reduction of US $200,000.

(iv) Some of the cost elements seem to be under priced, particularly for production leak detection; we would recommend production to use Helium leak detection stations which are better than HFC 134a leak detectors, which can be upset by background refrigerants (HCFC 141b), and as leak detection on HFC 134a systems has to be to a very high standard, we think Helium leak detection stations are more suitable, although a realistic costing for this would be US $25,000 each.

(v) We would doubt the reliability of using recovery bags for CFC12. We consider it advisable to equip the service modules with small portable recovery units which can be emptied at each service centre into recovery bottles for transportation to the reclaim plant or back to original suppliers.

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

c) **Cost of Equipment**

(I) The baseline cost of existing equipment has not been addressed.

(ii) Not all baseline equipment will be replaced, some such as vacuum pumps, will be modified.

(iii) There is no request for additional equipment - all equipment asked for is justifiable.

(iv) There is an error in the pricing A.5 Vacuum Control for existing pumps, total cost should read US $1,680 (not US $1,600)

(v) Some baseline equipment can be modified to perform functions in the conversion - this has been addressed in the Project.

(vi) The fate of scrapped equipment has not been addressed.

Cont/.......

(vii) There is no calculation of salvage value of scrapped equipment.

(viii) The modification of the existing equipment will not increase the production capacity.

d) **Start up/Commissioning costs**

(i) The level of the training costs and technology familiarisation costs both abroad and on site seems appropriate.

(ii) There could be some redundant production costs but these could be kept to absolute minimum.

e) **Operating Costs**

(i) The operative cost components are appropriate.

(ii) No transitional period is required.

(iii) There are no operational cost savings.

f) **Other Costs**

(i) Consultancy costs and implementing agency overhead costs are deemed reasonable.

(ii) A contingency of 10% of all equipment, services and incremental operative costs is included - this is appropriate and justifiable.

g) **Cost Effectiveness**

(i) The unit abatement cost for overall Project according to standard calculation is 12.12 $/kg . The net ratio from overall cost to ODS (in ODP tonnes) is 22.48 $/kg. The annual incremental recurrent cost is 10.61 $/kg. This indicates a relatively good level of cost effectiveness over lifetime of the Project, but is relatively high investment per ODP tonne phased out.

(ii) The Project is cost effective.

h) **Implementation Time**

(i) The proposed implementation time frame is feasible, but we would question the length of time allowed for manufacturing of equipment, installation and commissioning (Page 13: Item 7) given at 6 months, currently in our opinion this should be between 9 - 12 months.

Recommendations

Approved After Modification

Cost of new equipment should be reviewed, it is estimated that cost could be reduced by up to US $200,000 by selection of alternative equipment supplier, subject to the compatibility of the existing equipment.

CW/DP/TAM
21st October 1994

G. Whitney M.Inst.R. D. Parsfal

PROJECT COVER

Country/Region:	Syria
Project title:	Investment Project for Phasing out of CFCs at PENGUIN (Syrian Batric Co.)
Sector covered:	Domestic refrigeration (Rigid foams and Refrigerant) commercial and industrial refrigeration. In Syria the total ODS consumption of CFC 11 is 493 MT and of CFC 12 is 759 MT.
Project impact:	Phase out of annual consumption of 52,3 MT of CFC 11, 25 MT of CFC 12 for production and 5 MT for service (Total ODP = 82,3 MT).
Project duration:	18 months
Project economic lifetime:	10 years
Total proposed project cost:	US $ 2,212,500
Project investment cost:	US $ 1,597,000
Implementing Agency's overheads:	US $ 254,500
Incremental Operating Cost: (six months operational costs)	US $ 345,000
Proposed MF financing:	US $ 2,212,500
Cost effectiveness:	See Annex C: Unit Abatement cost
Counterpart enterprise:	PENGUIN (Syrian Batric Co.), Syria
Implementing Agency:	UNIDO
Coordinating Ministry:	General Commission for Environmental Affairs

PROJECT SUMMARY

This project has been designed to phase out 100% of the use of CFC 11 as blowing agent and CFC 12 as cooling agent from the production programme of domestic refrigerators at two factories of PENGUIN (Syrian Batric Co.) in Aleppo and Lattakia, Syria.

The chosen replacements are cyclopentane as foam blowing agent and HFC 134a as refrigerant. Apart from the replacement of some of the production equipment and related services, the project includes the redesign of the refrigeration system for all currently produced models and the conversion of the plant.

The redesign of the models covers activities like prototyping, performance testing, trial manufacturing and adaptation, as well as reliability tests.

The conversion of the production facilities covers the refrigeration system, insulation foam blowing system and the refrigeration service sector of the company.

BACKGROUND

Sector Background

The subsector for domestic refrigerators and freezers in Syria consists of 3 larger manufacturers, namely AL HAFEZ Co., BARADA and PENGUIN, medium size companies (such as KRAYEM) and many small-scale manufacturers: 79 for domestic refrigerators, 49 for domestic freezers and also many for industrial and commercial refrigeration. In 1991 the total ODS consumption in Syria in the domestic refrigerator and freezer branch (without industrial and commercial refrigeration) was 165 MT.

Syria does not produce CFCs. The total consumption of CFCs in the production of polyurethane foam was about 450 MT in 1991. The total consumption of CFC 12 in 1991 was 759 MT. 60% of all ODS consumed in Syria in 1991 were used in the commercial and domestic refrigeration and the air-conditioning subsectors. The demand for ODS at the moment is stagnant, but it is estimated that it will increase in the future unless a conversion is made.

The total installed refrigerator production capacity at Penguin (Syrian Batric Co.) is 75,000 units per year. However, at the moment, the company produces only 60,000 units per year due to the market crisis in the Middle East.

PENGUIN, with their factories in Aleppo and Lattakia, covers about 20% of the refrigerator market and 30% of the refrigerator and freezer service in Syria.

Based on a more than 15-years life expectancy for refrigerators and freezers, a total of 2,300,000 refrigerators, approximately 230,000 freezers and 36,500 industrial and commercial refrigeration systems were operating in 1991. Approximately 7% will be re-charged annually with about 62 MT of new CFC 12 during refrigeration service in Syria.

Background Information

'Syrian Batric Co.', for which the trade name is PENGUIN, was established in 1975 and it is a 100% private company operating in the manufacture and sale of commercial and domestic refrigerations.

PENGUIN employs 250 staff with the following capacity:

	Lattakia factory	Aleppo factory	Total
Refrigerator and freezers	30,000	45,000	75,000

PENGUIN produces a wide range of refrigerators and freezers; 15 different models, starting from small cooling boxes of 75 l to 21 cu.ft. large NO FROST 2 door refrigerators with CFC 12 charging range from 175g to 400g per unit. Approximately 7% of their production programme is chest freezers. The major part of their production is the large 15 to 21 cu.ft., often NO FROST, refrigerators (4401 - 6101).

Currently, PENGUIN does not produce low energy consumption refrigerators. The insulation thickness reaches the standard of today's refrigerator technology with 35mm insulation of refrigerators and 50mm insulation of vertical freezers. Penguin follows the international standard and local Syrian standard S.N.S 1068/92 and 810/90.

In addition, PENGUIN produces:

- washing machines,
- gas cookers,
- dish washers, and
- microwave ovens.

The current production programme is composed of the following:

ONE DOOR REFRIGERATORS:

Model	Volume
UNO one door	260 l
BAR one door	75 l
TURBO PANORAMA, NO FROST one door	440 l
PRIMO one door	380 l
MAX, NO FROST one door	400 l

TWO DOOR REFRIGERATORS:

Model	Volume
JUMBO two doors	610 l
JUMBO, NO FROST two doors	610 l
PENGUIN two doors	440 l
BATRIC WIDE two doors	440 l

CHEST FREEZERS:

Model	Volume
Chest freezer	300 l
Chest freezer	400 l
Chest freezer	500 l

VERTICAL FREEZERS:

Model	Volume
UNO PENGUIN vertical freezer	380 l
PENGUIN PRIMO vertical freezer	400 l
UNO PENGUIN vertical freezer	280 l

The company PENGUIN is equipped with 3 low pressure PUR lines (2 at their factory in Aleppo and 1 at the factory in Lattakia), and a total of 14 fixtures for cabinets and 14 fixtures for doors (all in bell position). They have 14 plugs for the cabinets and chests and 14 moulds for doors for single fixtures. Each factory has its own production line consisting of:

- 2 steel sheet processing lines for cabinets and doors (1 in Aleppo and 1 in Lattakia),
- 3 plastic sheet thermoforming lines (2 in Aleppo and 1 in Lattakia)
- 3 pre-assembly lines for cabinets, chests, doors and small items (2 in Aleppo and 1 in Lattakia),
- PUR lines (1 pc. PUR machine with 1 mixhead and 5 cabinet and 5 door fixtures at Lattakia and 2 pcs. PUR machines with 2 mixheads and 9 cabinet and 9 door fixtures at Aleppo),
- 3 assembly lines (2 in Aleppo, 1 in Lattakia)
- 3 evacuation and charging lines (2 in Aleppo, 1 in Lattakia),
- 2 repair lines
- 2 testing lines
- 2 packing lines.

PENGUIN uses standard polyurethane foam without CFC reduction with a density of 32 kg/m^3). Its equipment for foaming and refrigerator charging is 5 to 10 years old and in good condition.

The foaming lines consist of the following:

- 3 pcs. low pressure foaming machines for cabinet, doors and chests (1 in Lattakia and 2 in Aleppo);

- 14 pcs. automatic fixtures, electrically heated with 14 plugs in bell position for refrigerators and freezers, 3 of them are expandable for chest freezers;

- 14 door fixtures with profile moulds to support the doorliner.

The fixtures are electrically heated, but PENGUIN does not use pre-heating ovens.

PENGUIN uses the polyol component and CFC 11 already pre-mixed.

The charging and testing sections consist of 3 lines and 2 repair lines.

Following equipment is available at the evacuation, charging and testing sections:

- 7 pcs. vacuum pumps of which only 5 can be cleaned and used for R134a and 2 have to be replaced because of low vacuum speed (less than 8m^3/h) as needed for R134a to avoid reduction of capacity;
- 3 pcs. automatic vacuum and charging Galileo stations (2 in Aleppo, 1 in Lattakia);
- 2 production electronic leak detectors;
- 2 service leak detectors.

PENGUIN has a performance test laboratory in which they can simulate conditions up to +43°C. However, in order to optimize the R134a cooling system and to improve the quality, some equipment is still needed.

PENGUIN'S Refrigeration Service

PENGUIN has its own network of service shops with 5 main service centers in Damascus, Homs, Aleppo, Hama, Lattakia and their own service cars. Furthermore, their refrigerators are serviced by their distributor's service shops. All service centers are equipped with a standard set of refrigeration service equipment (altogether 10 sets). Presently, there is no CFC 12 recovery and reclaiming equipment or relevant expertise available in Syria.

PENGUIN services about 3,500 refrigerators and 1,200 freezers per year.

During the last 15 years (the period is equal to the average lifetime of refrigerators and freezers), PENGUIN has manufactured about 480,000 units of refrigerators and freezers of which 7% is expected to require service each year.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of ODS as CFC 11 and CFC 12 in the production of domestic refrigerators and freezers at PENGUIN through conversion to the use of HFC 134a as refrigerant for the refrigerators and freezers and cyclopentane as blowing agent for the polyurethane insulation foam.

PROJECT DESCRIPTION

PENGUIN is prepared to phase-out ODS in their refrigeration section as soon as the new technology has been acquired, the necessary machinery and equipment installed and the technical staff trained.

Among the technological options presently available, PENGUIN has chosen to replace CFC 12 by HFC 134a, since new compressors are available, the technology is matured and commercially applied.

As for the replacement of CFC 11 as blowing agent for polyurethane foam, the company has decided to avoid the application of any transitional substance and to introduce cyclopentane as an ultimate solution.

Assistance, through the project, is sought for:

(a) Procurement of new machinery and equipment;

(b) Re-building and partially replacing presently used equipment, such as vacuum pumps, PUR machines, fixtures, etc.

(c) Re-design, reconstruction, prototypes manufacturing and testing of refrigerators and freezers;

(d) Installation, commissioning, training of national personnel abroad and on-the-job training, trial operation and start-up, etc.

Each of the 5 refrigerator service centers of PENGUIN, needs 1 recovery unit and 10 recovery bags for CFC 12 as well as 2 sets of equipment (service evacuation, charging board and service leak detectors) which will be used for servicing HFC 134a refrigeration systems.

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

A. Refrigeration System

- 3 automatic production vacuum and charging boards for 3 refrigerator and freezer lines (2 in Aleppo and 1 in Lattakia) have to be replaced by boards suitable for HFC 134a.

- 2 service evacuation and charging boards (1 in each factory at their repairing line) have to be replaced by a system suitable for HCFC 134a.

- 2 existing production leak detectors need to be replaced by special leak detectors for R134a, one in each factory. Also 2 existing service leak detectors, used in the repair lines, have to be replaced.

- from 7 existing vacuum pumps, 5 can be re-used after application of a special cleaning technology (described in Annex D), but need to have manifolds added for better vacuum control.

- 2 vacuum pumps with a vacuum capacity lower than $8m^3/h$ have to be replaced by new ones to gain the same production capacity with R134a as existed with R12.

- to optimize the cooling system for the use of HFC 134a as refrigerant. In connection with the use of new HFC 134a compatible components and to compensate for lower efficiency of the system and higher thermal conductivity of the c-pentane blown foam, performance tests have to be carried out for each model. Therefore, some new testing equipment and materials need to be provided.

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

- Drier for HFC 134a has to use a desiccant with 3AA pores or desiccant XH7 (Union Carbide).

- The cooling system must not contain any chlorine and max. 1% non-condensable gases. Therefore, a new cleaning liquid has to be used.

- The capillary tube has to be optimized for an increased resistance at low evaporating temperatures because the volume flow with HFC 134a is about 80% of the volume flow with CFC 12.

B. Foam system

- 3 low pressure PUR foaming machines should be replaced with 2 high pressure machines (one for each factory), related equipment and systems necessary for c-pentane based foaming technology should also be provided. In this connection the layout of 2 production lines at Aleppo should be changed accordingly.

- To enable use of one high pressure PUR foaming machine for foaming of cabinets and doors, a 2nd foaming place should be provided consisting of a smaller mixing head, related to the hydraulic system, control unit, etc.

- 28 existing jigs in bell position (14 for cabinets and chests and 14 for doors) to be rebuilt in order to meet technological and safety requirements of cyclopentane-based foaming technology using high pressure foaming machine. However, using a high pressure foaming machine will reduce the foaming cycle from 10-14 minutes to 6-7 minutes and, therefore, the number of jigs can also be reduced to 4 jigs for cabinets and chests and 4 jigs for doors in bath position. Due to the cost and for safety reasons, it is suggested to replace 28 existing jigs with 8 new ones rather than rebuilding the old jigs and changing their position.

- The final specification of the cyclopentane to be used (purity and mix) will be defined after carrying out a market review in Syria to assess its availability. The current price level is about US $1,90/kg plus packaging and transportation. For the time being, there are no manufacturers of cyclopentane in Syria.

- Since cyclopentane and polyol cannot be delivered pre-mixed in drums or tanks (as CFC 11), it is necessary to provide a pre-mixing station in each of the 2 factories. For safety reasons, the pre-mixing should be done outside the production building so that only pre-mixed polyol and not pure c-pentane are transported into the foaming areas.

- For safety at the plant operation using the highly inflammable and explosive cyclopentane, it is necessary to have a gas detector system in the foaming department as well as to establish a fire protection system in each of the 2 factories.

- It is necessary to provide one storage tank for cyclopentane for each factory. The tank should be equipped with necessary piping and safety systems.

- Since the cyclopentane tank should be pressurized by nitrogen, which is also needed during the foaming process, each factory should also be provided with a nitrogen tank or respective nitrogen steel cylinders farm.

To operate c-pentane based PUR lines, the following safety conditions have to be fulfilled:

1. The c-pentane tanks have to be placed underground and not less than 5-10m away from the factory building.

2. Only well-trained operators and maintenance technicians are allowed to enter the foaming area.

3. The workers' clothes and shoes have to be made of antistatic materials, and the floor needs to be covered with an antistatic paint.

4. In order to achieve compliance with established safety rules for the machinery and the plant, it is necessary to provide and install exhaust and ventilation systems in the foaming departments.

5. Since cyclopentane is flammable and explosive, all machinery and equipment which will come in contact with cyclopentane or polyol/cyclopentane mixture have to be explosion proof. All electrical components like the electric heater of jigs (expensive water heaters are not necessary) are positioned outside the foaming area or switched off during the time of foaming.

6. All foaming jigs and plugs must be equipped with an earth connection to avoid the accumulation and discharge of static electricity.

7. PENGUIN's technicians have to be carefully selected and trained at the equipment suppliers' place in the new foaming technology as well as in design/calculation and performance test and calculation/ design of cooling systems. During the installation and start up of the new machinery and equipment, the supplier's engineers will have to train PENGUIN's technical staff in all aspects of the converted plant operation.

C. Refrigeration Service

To cover the requested service in the future, each of the 5 refrigerator service centers of PENGUIN should get 2 sets of R134a mobile charging boards, 2 sets of electronic leak detectors for R134a and 10 recovery bags for R12 (one set for stationary, the other for the service cars). Furthermore, each center should collect R12 from the recovery bags and send it back for reclamation.

This equipment will cover the needs of PENGUIN service centers only and not of other service shops.

D. Justification for Selection of Alternative Technologies

All major manufacturers of compressors have accepted the use of HFC 134a as replacement for CFC 12 for domestic refrigerators and freezers.

Relevant expertise and equipment for manufacturing and servicing of refrigerators and freezers based on HFC 134a is also available on the market.

Nearly all producers of refrigerators in Europe, and some in the Far East, have already switched or will switch in the near future to c-pentane as blowing agent due to good insulation values and cheaper cost of material. The manufacturing technology with highly flammable and explosive c-pentane is so matured and the control systems are reliable and safe so that it can be applied in developing countries if some strict processing regulations are followed and regularly controlled and the staff in this section are well selected and trained.

INPUTS

1. Capital Goods Replacement

A. Refrigeration System

At the 2 factories the following equipment needs to be changed and new equipment should be provided as specified below:

1.a 3 pcs. production evacuation and refrigerant HFC 134a charging boards with vacuum pump, refrigerant supply pump and vacuum check;

2.a 2 pcs. service evacuation and HFC 134a charging board with vacuum pump; refrigerant supply, pump for repair;

3.a 5 pcs. vacuum pumps have to be cleaned and refilled;

4.a 2 pcs. of the existing vacuum pumps have to be replaced with new evacuation stations to keep the same vacuum capacity;

5.a 2 pcs. production HFC 134a leak detectors;

6.a 2 pcs. service HCF 134a leak detectors for repair lines;

7.a 1 set of refrigerant test equipment and material for laboratory;

8.a 5 pcs. vacuum control for existing 5 pcs. vacuum pumps, which can be cleaned for use with R134a to increase the vacuum control on the more sensitive R134a charging process.

B. Foam System

At the 2 factories the following equipment needs to be changed or new equipment has to be provided as specified below:

1.b 3 pcs. low pressure foaming machines have to be replaced by 2 pcs. high pressure foaming machines for c-pentane, one machine for each factory; each machine has to be provided with 2 self-cleaning mixing heads of different size for foaming of cabinets and doors. Furthermore 2 different spare heads are needed in each factory to avoid interruptions in production and are **to be provided by the counterpart (PENGUIN)**.

2.b two new foaming places are to be installed (one at each factory) to enable using one foaming machine for filling of cabinet and door jigs;

3.b 2 pcs. pre-mixing stations for cyclopentane and polyol, one for each factory;

4.b 2 pcs. gas detector system with control boards, one for each factory, each with 20 pcs. gas sensors and 16 ventilation sensors for safety reasons;

5.b 2 sets of foam testing equipment;

6.b 2 sets exhausting and ventilation systems, one for each factory;

7.b 4 pcs. foaming jigs for all refrigerator cabinets and chest freezers will replace 14 existing jigs: 2 pcs. at Aleppo factory and 2 pcs. at Lattakia factory;

8.b 4 pcs. door foaming jigs will replace the existing 14 door jigs; 2 pcs. at the factory in Aleppo, 2 pcs. at the factory in Lattakia;

9.b 14 pcs. refrigerator cabinet and chest foaming plugs (11 fixed and 3 expandable) for the jigs have to be made. **50% of the cost will be borne by the company PENGUIN;**

10.b 14 pcs. door foaming profiles have to be modified to gain defined venting channels;

11.b 2 sets of ex-proof piping systems from cyclopentane tank to premixers and then to polyol tank;

12.b 2 sets of antistatic floor cover, one for each factory;

13.b 2 sets of fire protection systems, one for each factory;

14.b 2 pcs. storage tank for cyclopentane with all necessary safety devices pressurized by nitrogen, one for each factory;

15.b 4 pcs. pumps and piping for the c-pentane tank, 2 sets of 2 pumps and pipes for each of the factories;

16.b 2 pcs. UPS for the gas detector systems, one in each factory;

17.b 2 pcs. back-up power supply systems for ventilators, one for each factory **to be provided by the counterpart (PENGUIN)**;

18.b 2 pcs. water chillers as an integral part of the foaming line, one for each factory.

The layout of the production equipment should be organized in such a way that special heating of the pipes for high viscose polyol compound can be avoided.

C. Refrigeration Service

1.c 5 pcs. HFC 134a charging boards for refrigeration service, one for each of 5 PENGUIN's centers;

2.c 50 pcs. recovery bags for CFC 12, 10 in each center;

3.c 5 pcs. stationary recovery units for CFC 12, one in each center;

4.c 5 pcs. electronic leak detectors for HFC 134a, one for each service centre.

2. Conversion/Training

Within the framework of the project, personnel from Syrian Batric Co. will be trained in (among others) the following areas:

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

3. Model Redesign

It is foreseen that all 15 current models will be redesigned due to replacement of CFC 12 by HFC 134a and followed by the manufacture of some prototypes and refrigeration performance tests. The costs for these activities are included in the training component for technical staff, as well as in the international expert service component.

As a common practice, necessary modifications of the production lines will be carried out during evenings and off-days and will, therefore, not cause losses in the regular production.

PROJECT IMPLEMENTATION

The project will be implemented in close cooperation with the General Commission for Environmental Affairs. Local coordination will be carried out by PENGUIN, the counterpart.

According to the experience of implementation of such projects in developing countries, the overall responsibility for the conversion should be with one general contractor to make sure that all activities of supplies of equipment and services are well coordinated.

The scope of supply, related services and responsibilities of the counterpart, potential contractors or suppliers as well as of UNIDO, will be specified in the Terms of Reference to be prepared at a later stage as an integrated part of the project document.

For operation of an industrial plant using highly inflammable and explosive materials, a local authorization for the operation is needed and such plants have to be regularly controlled by the responsible local authority.

Any construction work needed to accommodate the equipment for the new foaming technology using cyclopentane will have to be carried out by PENGUIN and are not reflected in the project budget. The specification for construction work will be elaborated by the selected contractor after project approval and site inspection.

TENTATIVE PLAN

	Months: 1 2 3 4 5 6 7 8 9 10 11 12 14 16 18
General:	
1. Sign the project document, receive funding	X
2. Elaboration of detailed work plan and terms of reference	X
3. Initial training of management	X
FOAM:	
4. Final selection of equipment	XXXXXXX
5. Purchase and subcontracting of equipment and services	XXXXXXX
6. Training	X XX
7. Delivery of equipment, installation, commissioning	XXXXXXXXXXXXXXXX
8. Start of production	XXXXXXX
REFRIGERATION:	
9. Redesign of models, training	XXXXXXXX
10. Selection of equipment	XX
11. Purchase, installation and commissioning	XXXXXXX
12. Prototypes and testing	XXXXXXXXXXXXXXXX
13. Start production with HFC 134a	XXXXXX
REFRIGERATION SERVICE:	
14. Selection of equipment	XXXXXX
15. Purchase, installation commissioning and training	X XX

PROJECT COSTS

I. INCREMENTAL CAPITAL COSTS

The incremental investment cost will cover cost for modification of manufacturing facilities, new machinery, materials, testing equipment, training, installation and consultancy services for modifications. This cost is shown in Annex A: "Equipment Specification and Cost Breakdown".

The cost of transportation and insurance of equipment (but not installation) is included in the cost of equipment.

II. INCREMENTAL OPERATING COSTS

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

Modification	Incremental cost (US$)
- HFC 134a compressor	5,95
- Capillary tube modification	0,20
- Condenser modification	1,10
- Evaporator modification	1,90
- 3 AA drier	0,20
- HFC 134a refrigerant	0,79
- Extra polyurethane foam because of higher density (+10%) and increase of insulation (5%) minus reduced blowing agent cost	0,33
Total	US $ 10,47

The above figures reflect the difference between the relevant component price for CFC 11 and CFC 12 versus the component price for HFC 134a and cyclopentane. The price level is higher than in the other projects because 50% of current PENGUIN refrigerator production is of large refrigerators and large freezers which need large compressors with electrical capacity of more than 220W and cooling capacity of more than 195 Kcal/h. Furthermore 25% of their production programme is NO FROST models for which the absolute and respective relative cost are increased by switching from R12 to R134a.

All prices are without customs duty and tax.

The increase in price is due to the following:

- Purchase of new one size bigger HFC 134a compressor to cope with the lower capacity at low evaporating temperature, (but no heavy duty compressor, designed to cope with significant voltage fluctuations);

- Capillary tube prolongation and changes (average plus US $0,20);

- Evaporator and condenser on the average 1-2 coils or 1-2 serpentines or few fins larger, average US $1,90 and US $1,10 more respectively;

- HFC 134a charge is about 10% less than with CFC 12; based on an average charge of 0,32 kg CFC 12 at US $3,00/kg as a current price and a current price for HFC 134a at US $5,75/kg, excluding customs/tax: 0,320 kg x 0,90 x US $(5,75 - 3,00)/kg = US $0,79);

Comparative cost analysis of foam system:

R11 system				C-pentane system			
Chemicals	Weight %	Price $/kg	Cost US$	Chemicals	Weight %	Price $/kg	Cost US$
Polyol + MDI	86	1,60	1,376	Polyol + MDI	94	1,70	1,598
R11	14	3,30	0,462	C-pentane	6	5,30	0,1038
		Average:	1,838			Average:	1,702

PU cost US$/kg	1,838	PU costs US$/kg:	1,702
Kg per unit:	9,500	Kg per unit:	10,450
Total costs US$/ unit:	17,46	Total costs US$/ unit:	17,79

Incremental cost difference: US $0,33.

The operation cost of the enterprise after the conversion is not expected to increase very much as a result of higher wages of several highly qualified operators, maintenance and services of modern machines, safety related systems and instrumentation etc. This cost to be absorbed by the company.

Therefore, the total incremental operating cost increase for one year will be US$ 691,000 (Based on production of 60,000+10% units per year = 66,000 units in the first year: 66,000xUS $10,47 = US $691,000).

It was agreed that the counterpart will apply for the incremental operating cost for 6 months = US $345,000.

III. CONTINGENCY FUND

A contingency fund (10% of the total budget) was calculated to cover unforeseen expenses which might incur during the project implementation.

IV. TOTAL COSTS

- Incremental investment cost, (Annex A: "Equipment Specification and Cost Breakdown").	US $1,597,000
- The net incremental operating cost (as above).	US $ 345,000
- Executing agency's overhead cost (13%).	US $ 254,500
- Preparatory Assistance funding	US $ 16,000
- Complete project cost breakdown (Annex B "Project Budget")	
- Calculation of the unit abatement cost (Annex C: "Unit Abatement Cost").	
- Requested funding by the MFMP:	US $2,212,500

Annex A: Equipment Specification and Cost Breakdown

	Description	Qty.	Unit cost US$	Total cost US$
A.	**Refrigeration System:**			
	- Charging board for HFC134a	3	21,000	63,000
	- Repair charging board for HFC 134a	2	1,000	2,000
	- Vacuum pump (5 renovations)	5	100	500
	- Evacuation stations	2	4,000	8,000
	- Production leak detector for HFC 134a	2	4,500	9,000
	- Electr. leak detector for R134 for repair line	2	250	500
	- Test equipment for prototypes	1 set	31,250	31,250
	- Vacuum control (for existing pumps)	5	100	500
	- Prototype Material	14 sets	1,000	14,000
	Sub-total for group (A)			**128,750**
B.	**Foaming System:**			
	- High pressure foaming machine	2	160,000	320,000
	- 2nd foaming place for door foaming	2	20,000	40,000
	- Self cleaning mixheads	4	25,000	100,000
	- Premixing station	2	60,000	120,000
	- Gas detector system	2	70,000	140,000
	- Infrared gas feelers	20	1,500	30,000
	- Foam test equipment	2 sets	1,000	2,000
	- Exhausting and ventilation	2 sets	45,000	90,000
	- Foam jigs for cabinet/chest	4	50,000	100,000*
	- Foam jigs for doors	4	20,000	40,000*
	- Foam plug for refrigerator	11	5,000	27,000*
	- Foam plugs for chest, expandable	3	5,000	8,000*
	- Pipe installation from tank to premixing stations	2	10,000	20,000
	- Pipe installation from premixing to PUR machine	2	10,000	20,000
	- Antistatic floor	700 m^2		6,000
	- Fire protection system	2 sets	9,000	18,000
	- Tank for cyclopentane	2	42,000	84,000
	- Chiller	2	11,000	22,000
	- Material for start up (10 sets of 14 models each of US$ 300)	10x14	300	21,000*
	Sub-total group (B)			**1,208,000**

*) 50 % cost sharing with PENGUIN

C. **Refrigeration Service:**

- Charging board for service	5	1,000	5,000
- Recovery unit for CFC 12	5	1,500	7,500
- Recovery bag for CFC12	50	30	1,500
- Electronic leak detector for R 134a	5	250	1,250
Sub-total group (C)			**15,250**
TOTAL		**US$**	**1,223,250**

* The cost of the following equipment and installation work is not included in the budget and is to be absorbed by PENGUIN:

(a) Pre-heating ovens for foaming (existing);

(b) Electrical power back-up systems for the foaming areas as required by the safety regulation.

(c) Roller or conveyors for transport of cabinets in and out of pre-heating oven and foaming jigs;

(d) Tank and installations for pipelines for delivery of HFC 134a to the charging boards;

(e) Any inside and outside construction and civil work for the installation of the cyclopentane tanks and the premixing stations;

(f) Any special work related to the site preparation to receive ISO tank or truck with cyclopentane to be discharged in the storage tank;

(g) Any change of lay-out of the factory which requires changing the position of the machinery and equipment as well as re-allocation of the old equipment.

The scope of PENGUIN supply, services and their responsibilities related to the plant conversion will also be specified in the terms of reference(s) for provision of equipment and services by UNIDO and in the work plan of the project execution.

TECHNICAL SPECIFICATIONS OF EQUIPMENT

A. Refrigeration System:

- Evacuation and charging board for HFC 134a for production
  Fully automatic board with vacuum check
  2 stages vacuum pumps $8m^3/h$
  4 charging channels - built-in supply pump
  Refrigerant: HFC 134a
  Charges: Min 50g - Max 2200g +/- 1% or 1g

- Vacuum pump renovation
  Min. capacity $8m^3/h$
  Time for evacuation to vacuum level for the appliances
  Max. 15 minutes
  Maximum limit of non-condensable gases 1% (vol) after evacuation

- Leak detector for production for HFC 134a
  Type HLD 4000A
  Sensitivity range: 0.5 to 150g/year
  Microprocessor controlled
  Calibration gas: HFC 134a
  Calibration: Automatic by the incorporated leak standard

- Vacuum station $16m^3/h$, 2 stages vacuum pump, including Pirami vacuum gauge with pass/fail indication for vacuum OK, 2 evacuation hoses with Hansen 2H.

- Test equipment for Performance Test for HFC 134a
  The test equipment is completed by:

  a. Pressure transducers for HFC 134a for suction and discharge pressure range +/- 0.005 bar
  b. Materials for prototypes
  c. Refrigerator test recorder, temperature controlling interface unit and feelers, humidity controlling interface unit and feeler, etc.
  d. Performance test material according to ISO 7371
  e. Service charging board for HFC 134a
  f. Service leak detector for HFC 134a

B. Foam System:

- High pressure foaming machine for cyclopentane includes the following main equipment:

1 pc. Special metering pump NG 28 P for Polyol-Pentane, in corrosion-proofed design, suited for a prepressure of 10 bars, nominal output 40 (32) l/min., with high capacity rotary shaft seal and leakage monitoring device

1 pc. Additional venting valve of the pump housing with return to the work tank (closed design)

1 pc. Metering pump NG 28, max. nominal output 40 (32) l/min. for isocyanate

2 pcs. AC motors 15 kW/1,500 rpm (11 kW/1,200 rpm) for polyol and isocyanate

1 pc. Hydraulic unit with 2 accumulators, valves and accessories

1 pc. Leakage-free special filter on suction side in rust-proof design for polyol-pentane mixture

1 pc. Edge filter on suction side in corrosion-resistant design for isocyanate

2 pcs. Contact pressure gauge with min. contact, suction side

2 pcs. Contact pressure gauge with min./max. contacts, pressure side

2 pcs. Safety valve in special steel design

2 pcs. Throttle valves for setting the circulation pressure, placed in media return lines polyol throttle valve equipped with connection to leakage monitoring device

2 pcs. Removable, large-sized leakage basin inside the machine frame 4 m Flexible lines to the mixhead

1 pc. Throttle-controlled mixhead with:
2 hydraulically controlled recirculation injectors for polyol and isocyanate, polyol injector equipped with leakage monitoring device,
1 hydraulically controlled injector for inertizing the to be foam filled cavity
1 hydraulically switched, adjustable mixture throttle
1 cleaning piston
1 removable outlet pipe (with 2-component)

1pc. Device for checking the switching function of the isocyanate-mixhead nozzle (a polyol-pentane mixing as single component is not possible)

1 pc. Flow sensor for Nitrogen-gas for inertizing

1 pc. Tank station consisting of:

1 pc. Work tank, special design suitable for Pentane, size operating pressure up to 10 bar for polyol/pentane mixture, double-walled for temperature control with unpressurized water, inner shell made of stainless steel

with
1 stirrer driven via coupling and motor (no stirrer shaft seal)
1 filling level sensor for continuous measurement via the refilling control system
1 filling level sensor for preventing overfilling, in compliance with the regulations of the local water resources law
1 set of fittings and accessories for connecting nitrogen supply
2 pneumatically driven self-closing safety ball valves with solenoid valves
1 non-return valve 10 bar, firmly set
1 safety valve, adjustable, for limiting the rise of tank pressure during refilling

Tank to be designed in compliance with the international safety standards, delivered with a test certificate like TÜV.

1 pc. Work tank for isocyanate

Size 500 l, working pressure 4 bar, double-walled for temperature control with unpressurized water, made of normal steel, with stirrer 51 min -1, 0.25 kW; with parallel inspection pipe for optical filling level display and with possibility for connecting level switches which are adjustable in height; complete with all necessary fittings and accessories as well as connector for dry compressed air.

Tank to be designed in compliance with the international safety standards delivered with a test certificate like TÜV.

1 pc. Temperature control device in special design for polyol/pentane

For raw material temperature control via the double jacket of the work tank; with electr. heating of 5kW and 1 cooling system for direct cooling by means of cold water of about 14°C produced by a chiller, as cold water is not available in this country.

1 pc. Temperature control device for the isocyanate work tank

For raw material temperature control via the double jacket of the work tank; with electr. heating of 5kW and 1 cooling system for direct cooling by means of cold water of about 14°C; water consumption during cooling 40l/min. max.

1 pc. Heat exchanger unit with circulation pump by the isocynate line (pentane suited)

In case of higher requirements having to be met by the raw material temperature control system like, for example, in the case of multiple metering, long mixhead lines, quick shot sequence, etc. it is recommended to use the complete heat exchanger unit ensuring the automatic raw material temperature control by means of constant circulation.

Equipment for 1 unit:
1 heat exchanger WTK2R with abt. 10.5 MJ/h
(= ca. 2500 kcal/h) at a cooling water temperature of 15°C and the fluid having to be cooled down from 24 to 20°C,

1 circulation pump with a capacity of abt. 20 l/min, with double shaft sealing and leakage monitoring device on the Polyol side

1 complete piping system

The heat exchanger is connected to the temperature control device of the isocyanate work tank.

1 pc. System for automatic transfer from the premixing station polyol/blowing agent mixture

The filling level is measured and displayed by a sensor (component of tank). When the set min. filling level has been reached, the premixing machine is started and the filling valve of the work tank is opened.

When the set max. filling level has been reached, the replenishing procedure is finished.

The filling process is monitored by a timer. When the time is exceeded, filling is interrupted immediately and a signal is given.

When the overfilling sensor is reached/responds, the replenishing procedure is also interrupted and a signal is given.

This filling control has interfaces for a superior safety control and corresponds to the valid regulations in developed countries.

1 pc. Heat exchanger unit with circulation pump for polyol/c-pentane mixture

Equipment for 1 unit:

1 heat exchanger WTK2R with abt. 10.5 MJ/h
(= abt. 2500 kcal/h) at a cooling water temperature of 15°C and the fluid having to be cooled down from 24°C to 20°C,
1 circulation pump with a capacity of about 20l/min, 1 complete piping system

The heat exchanger is connected to the temperature control device of the mixture work tank.

1 pc. System for automatic transfer from the tank farm for isocyanate

For automatic refilling of the work tank, with 3 level switches adjustable in height, 1 pneumatically operated shut-off valve with limit switch monitoring.

The pre-pressure in the circular line with overflow valve to be available is supposed to lie above the prepressure in the work tank.

1 pc. Refrigerating machine for re-cooling the water for the temperature control devices

Designed as air-cooled compressor unit with a cooling capacity of about 17 MJ/h (= about 4000 kcal/h) - at an ambient temperature of about 30°C (43°C max.)

Advantage: No water consumption due to closed circuit with temperature control devices.

1 pc. Pre-mixing station

Independent unit for automatic metering and mixing of polyol with pentane

The pre-mixing station is a metering device for the production of polyol/ pentane mixture with a constant mixing ratio which can be preselected.

The premixing station operates according to the principle of difference metering. By means of the first part of a tandem pump, a partial quantity is taken from the constant polyol stream metered by the main pump. The other half of the tandem pump delivers a defined greater volume back into the polyol stream resulting in an automatic feeding of the missing partial quantity out of the pentane line which is under pre-pressure.

The required mixing ratio can be set by means of the frequency-controlled drive motor of the tandem pump. The pentane throughput is precisely recorded and documented by means of a mass flow meter; the polyol throughput by means of a gear-type flow meter. The mixing of the component streams meeting each other takes places by static mixing elements.

The tightness of the system towards the outside is obtained by the design (tandem pump) and the use of suitable construction elements. in order to avoid corrosion by hydrous polyols, all component-contacting parts are corrosion-resistant. Only sealing materials with proven resistance to polyol, pentane and nitrogen can be used.

The advantages of the metering principle are:
- High metering accuracy by favourable polyol/blowing agent ratio and favourable viscosities of the fluids (no pure blowing agent)
- High metering accuracy obtained by small pressure differences at the metering pumps
- no blowing agent leakage
- good mixing by static mixer

The Premixing station consists of the following construction elements:

1 pc. edge filter
1 pc. contact pressure gauge 0-10 bar
1 pc. gear wheel metering pump set for basic polyol
1 pc. gear tandem pump set for metering of blowing agent
2 pcs. static mixer kits
1 pc. pressure switch 0.100 bar
1 pc. pressure gauge 0-60 bar
1 pc. safety valve on the polyol side
1 pc. flow meter for blowing agent
1 pc. special shut-off valve for blowing agent
1 pc. contact pressure gauge 0-10 bar (blowing agent)
1 pc. pipe filter
1 pc. pneumatic safety shutoff valve (blowing agent)

All connecting pipe lines made of special steel; with special screw connections.

As secondary safety equipment, the Premixing station has to include an overall casing with an exhaust socket (DN 100) -at the lower third of the back wall - for connecting a run-controlled fan to be provided separately (below); design for example in accordance with VDMA regulation 24169, part 1;

1 pc. 1 electr. control system

By means of this electric control, given rated values are automatically monitored and kept constant in a closed control circuit within given limit values.

Control, data entry and display of relevant parameters are effected via PC compatible control computer with a 16-line LCD display as well as a foil keyboard.

Control:

- Switching motors and valves on and off as well as corresponding monitoring functions
- Pressure monitoring (contact pressure gauges),
- Switching the machine off in case limit values are exceeding
- Error message: optical and acoustical fault indication, message in plain language on the LCD display

Operation modes:

(a) Automatic operation
(b) Manual operation
(c) Test operation

Data entry:

Via function keys with LEDs or entry keys; entry of desired blowing agent portion as well as entry possibility for correction factor for converting the flow quantities.

Data display:
- Rated value of blowing agent portion
- Actual value of blowing portion
- Throughout quantity

Technical data (with 59 cycles)

In general:

- Adjustable blowing agent portion	4 - 25 vol %
- Necessary Polyol entry pressure	min. 4 bar, max. 10 bar
- Necessary Pentane entry pressure	min. 3 bar, max. 10 bar
- Exit pressure of mixture	max. 15 bar
- Compressed air supply	min. 5 bar
- Polyol viscosity	max. 10,000 m Pas

The connecting line from Premixing station to work tank (polyol-pentane-mixture) has to be designed for an operating pressure of 60 bar.

Output of basic polyol min.	9,2 l/min.
Drive	N = 1,1, kW
Output of blowing agent:	
- continuously adjustable -	0,36 to 2,3 l /min.
Drive of tandem pump	N= 1,1, kW

- Gas detector system with control board for gas sensors and air flow controls of fan motors
  Number of gas sensors: 20 pcs
  Number air flow controls: 16
  Flammable limits: In air 1.4-8%

- Foam Test Equipment
  Scale 0-1000gr +/- 0.01g
  Measuring glass 0-1000 cm^3 +/- 1 deviation
  Shearing box for foam
  Foam knife
  Stirrer
  Laboratory cup for foam
  Freezers to measure dimension stability are existing

- Exhausting and ventilation
  Capacity: 2 steps a min 4,000 m^3/h and min 8000 m^3/h
  Air change: 53 times per hour
  Total capacity: Min 16,000 m^3/h
  Point exhausting: Min 30 pcs
  Ex-proof or placed outside O-Zone

- Foaming cabinet jigs
  Electrical heating elements and all electric components have to be automatically disconnected in time of foaming.
  Earth connection of jigs.
  Automatic opening, in and out of cabinets
  Bath position
  Gas venting profiles with connectors to exhaust system

- Foaming door jigs
  Electrical heating elements and all electric components have to be automatically disconnected in time of foaming.
  Earth connection of jigs.
  Automatic opening, in and out of cabinets
  Gas venting profiles with connectors to exhaust system

- Pipe installation from tank for cyclopentane to mixing stations with double wall tubes and leak control
(Built-in SD valves for separation into sectors in case proposed layout will not be followed)

- Antistatic floor
Painting of floor in foaming area with antistatic paint

- Pipe installation from premixers to foaming machines double wall tubes or hoses without any assembly, with leak control for polyol.
(Built-in SD valves separation into sectors in the polyol line in case proposed layout will not be followed).

- Fire protection systems
Foam spray system for polyurethane chemicals and cyclopentane according to local regulation

- Tank for cyclopentane
40 m^3 capacity, made of double wall stainless steel
Pressure: 7 bar
Insulation of tank
Valves and fittings for connection
Connection for nitrogen pre-pressure
Pumps and Pipe work for cyclopentane tank
2 pcs. double pumps ex-proof of which one is only used during repair works of the other
Level control for tank with shut-down valve

  2 pcs. gas detectors connected to the gas detector system of the PUR machine
Pump for tank for loading at tank
Level control at leak container for cyclopentane

- Chiller
Cooling range: 0-15°C
Pump capacity: about 6,000 ltr/h
Circulation medium: water
Cooling capacity: 15 kW

C. **Refrigeration Service:**

- Service charging board for HFC134a
manually operated
2-stages vacuum pump
Refrigerant: HFC 134a
Charge: 50g to 500g +/- 5g
Hoses connection with quick connectors

- Recovery unit for CFC 12
Capacity: 1100g CFC 12

- Recovery bag for CFC 12 part of (Reclaiming system)

- Electronic leak detectors for HFC 134a for service

B. Refrigeration System:		
- Machinery:		**138,750**
3 pcs Charging boards for HFC134a	63,000	
2 pcs Charging boards for repair line	2,000	
5 pcs Vacuum pumps renovation	500	
2 pcs Evacuation stations	8,000	
2 pcs Production leak detectors	9,000	
2 pcs Repair of leak detector	500	
5 pcs Vacuum controls,	500	
1 set Test and monitoring equipment	31,250	
14 sets Materials for prototypes	14,000	
Equipment installation, commissioning & local training (3 weeks, 1 specialist)	10,000	
C. Refrigeration Service		
- Machinery:		**15,250**
5 pcs Charging board for service	5,000	
5 pcs Recovery units for CFC12	7,500	
50 pcs Recovery bags for CFC12	1,500	
5 pcs Electronic leak detectors	1,250	
Subtotal		**1,452,000**
Miscellaneous:		
Contingency Fund (10% of the incremental cost of all equipment, services and operating incremental costs calculated)		145,000
Subtotal I		1,597,000
Incremental operating cost (half year of operation)		345,000
funds needed for preparatory assistance		16,000
Subtotal II (sub-total 1 + incr. op. cost + prep. ass.)		1,958,000
Agency's Overheads (13% of all)		254,500
TOTAL	US $	2,212,500

Refrigeration Service (Unit Abatement Cost)

By investment in recovery units, it will be possible to reclaim about 50% of the used CFC12 from the refrigerators and freezers for service, if the suppliers of the cooling agent will take back the used materials for recycling.

PENGUIN's service organization is expected to service about 47,000 refrigerators and freezers per year with an average CFC12 refrigerant charge 0,45 kg CFC 12; but not all need recharging.

The above mentioned is based on delivery of recovery units to all PENGUIN's main service centres, but not to the service shops of their distributors.

Annex B: Project Budget

Budget line	Description		Budget US$
	General consultancy Engineering design services related to: modification of production layout, conversion of manufacturing processes and equipment, re-designing of refrigeration systems, civil and construction works, utility systems modification		**50,000**
	Checking/Ex-proofing of PUR machine, tanks, Premixing and foaming places * Antistatic floor, safety training of Al Hafez Co.'s staff (two weeks, two specialists)		**20,000**
	If available local subcontract for provision of: * 2 tanks for cyclopentane * 2 sets of pumps, pipe work for tank, * 2 sets of pipe installation from tank, from tank to premixing and from premixing to PUR machine and PUR machine to foam place * 2 sets of antistatic floors including installation and commissioning of the system (two weeks, two specialists)		**130,000**
	Local subcontract for provision of: * 2 sets if fire protection system including equipment installation, training and commissioning of the system (one week, two specialists)		**18,000**
	Subcontract for provision of: * 2 sets of exhausting and ventilation including equipment installation and commissioning of the system (one week, two specialists)		**90,000**
	A. Foaming System: - Machinery: service and starting up		**990,000**
	2 pcs High pressure foaming machine (cabinets and doors)	320,000	
	2 pcs 2nd foaming place for doors	40,000	
	4 pcs Mixheads 2 in 2 different sizes	100,000	
	2 pcs Premixing stations	120,000	
	2 sets Gas detector systems with sensors	140,000	
	2 pcs Foam test equipment	2,000	
	2 pcs Chiller	22,000	
	4 pcs Foam jigs for cabinet and chest	100,000	
	4 pcs Foam jigs for doors	40,000	
	11 pcs Plugs for cabinet	27,000	
	3 pcs Expandable plug for chest	8,000	
	Equipment installation, commissioning & local training (9 weeks, two supervisors and 2 engineers 2 weeks)	50,000	
	10 sets Material for starting up x 14 models (each US $300)	21,000	

Annex C: Calculation of Unit Abatement Cost:

A	ODS Phase out		Total Project
A1	Average use of CFC 11 per year	MT	52,3
A2	ODP of CFC 11		1
A3	ODP-weighted CFC 11 phase (A1*A2)	MT	52,3
A4	Average use of CFC 12 per year plus service	MT MT	25 5
A5	ODP of CFC 12		1
A6	ODP weighted CFC 12 phase out (A4xA5)	MT	30
A7	Total ODP-weighted phase out	MT	82,3
B	Annualized capital cost		
B1	Total investment cost (model redefinition + production conversion)	US$	1,597,000
	Equipment life	Year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1x0.1627)	US$	259,831
C	Annual incremental recurrent cost (1/2)	US$	345,000
D	Unit Abatement cost		
D1	Annualized capital cost per kg ODS phased out (B4/(A7x1000)	$/kg	3,15
D2	Six months incremental recurrent cost per kg ODP phased out (C/(A7x1000))	$/kg	4,19
D3	Unit abatement cost (D1+D2)	$/kg	7,34

Annex D: Cleaning Technology for Vacuum Pumps

If vacuum pumps which have been used for evacuating of CFC 12 systems have to be used for HFC 134a refrigeration systems, it is possible to clean the pumps and use them, if:

a. The vacuum pump is in good condition; and
b. The vacuum pump has a minimum capacity of $8m^3$/hour.

Cleaning process

1. Replace the hose from the vacuum pump to the connector (Hansen coupling) for the service tube of the compressor (or filter) with a new one;

2. The connector (Hansen coupling) can still be used also for HFC 134a refrigerator system;

3. Load the vacuum with about 50 cm^3 Ester oil via the hose and start the vacuum pump. Let it run for 30 minutes;

4. Empty the vacuum pump of the used Ester oil and charge it again with 50 cm^3 Ester oil;

5. Start the vacuum pump and let it run for another 30 minutes;

6. Empty the vacuum pump for the second time and recharge it with 50 cm^3 of Ester oil;

7. Start the vacuum pump for the third time and let it run for 30 minutes;

8. Empty the vacuum pump and now it is ready for use for HFC 134a refrigeration systems;

9. Connect the vacuum pump to a HFC 134a refrigeration system and evacuate the system down to the specified vacuum level;

10. Connect the refrigeration system to the HFC 134a charging board and re-evacuate. Charge again with the specified amount of HFC 134a;

11. Start the compressor and let the system run for about one hour.

    If some mineral oil or chloride is still left the vacuum pump on the suction side it will be transferred to the HFC 134a refrigeration system and the capillary tube will be blocked after few minutes.

Note: After the vacuum pump has been washed with Ester oil, it should only be used for HFC 134a refrigeration systems.