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Implementation of the Montreal Protocol

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PROJECT PROPOSAL: VIET NAM

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

Phasing out ODS at the SEAREFICO and SEAREE industrial refrigeration plants of SEAPRODEX Co. (UNIDO)

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Viet Nam
PROJECT TITLE:	Phasing out ODS at the SEAREFICO and SEAREE industrial refrigeration plants of SEAPRODEX Co.
BUDGET:	Capital Costs: US $465,570 Operating Costs: US $ 31,500
INCREMENTAL COSTS:	US $497,070
ODS PHASE-OUT:	40 MT CFC-11 and 1 mt R-502/yr
COST EFFECTIVENESS:	US $12.33 per kg ODP saved
PROJECT DURATION:	18 months
IMPLEMENTING AGENCY:	UNIDO
NATIONAL COORDINATING AGENCY:	Ministry of Fisheries, Viet Nam
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. The project proposal is the first to be submitted on behalf of the Government of Viet Nam. The Country Programme preparation is underway.

2. The project proposal will phase out 40 mt of CFC-11 and 1 mt R-502 per year in two of the three major industrial refrigeration companies; namely, SEAREFICO and SEAREE. Both companies are state owned.

3. The two companies will phase out the use of ODSs in the production of insulating panels and freezer truck containers.

4. The chosen replacement alternatives for R-502 and CFC-11 are respectively, HFC-134a in the refrigeration system, and HCFC-141b in the foam system.

5. The redesign of the existing freezer truck container models includes replacement of R-502 equipment with HFC-134a compatible equipment.

6. Conversion of the foaming system involves replacement of the low pressure foam machines with high pressure machines suitable for the use of HCFC-141b. The machines can be modified later for the use of zero-ODP blowing agent at a moderate cost.

7. Training is budgeted for in the project for enterprises personnel to deal with the new technologies.

8. Incremental operating costs are calculated for a six-month period. They will be incurred as a result of introducing more expensive chemicals and increased requirement of foam ingredients.

9. The project is cost effective.

SECRETARIAT'S RECOMMENDATION

10. The Secretariat recommends final approval of the project and the approval of the requested incremental costs in the amount of US $497,070.

19 November 1994

PROJECT COVER SHEET

Country:	Viet Nam
Project Title:	**Phasing out ODS at the SEAREFICO and SEAREE industrial refrigeration plants of SEAPRODEX Co., Viet Nam**
Sectors Covered:	Industrial Refrigeration /Rigid Foam/Refrigerant
ODS Use in Sector (1990):	200 mt of CFC-11and 10 mt of R-502
Project Impact :	Phase out of annual consumption of 40 mt CFC-11 and 1 mt R-502 (Total ODP = 40.3)
Project Duration:	18 months
Project Economic Life:	10 years
Total Project Cost:	US$ 497,070 (Total of capital cost and incremental operating cost for six month of operation)
Capital Cost:	US$ 465,570
Incremental Operating Cost:	US$ 31,500 (six month of operation)
Implementing Agency's Overheads (13%):	US$ 64,620
Proposed MF Financing:	US$ 561,690
Cost Effectiveness:	2.65 US$/kg
Counterpart Enterprises:	SEAREFICO and SEAREE
Implementing Agency:	UNIDO
Coordinating Ministry:	Ministry of Fisheries of Viet Nam, Hanoi

PROJECT SUMMARY

This project will phase out 100 percent of the use of CFC-11 and R-502 for the production of insulating panels and freezer truck containers at SEAREFICO AND SEAREE. The chosen replacement alternatives are HCFC 141b as foam blowing agent and HFC 134a as refrigerant. The project will include the redesign of all current freezer truck container models and the conversion of the foaming lines. The redesign of the existing freezer truck container models includes replacement of traditional cooling equipment of the containers using R-502 refrigerant blend with cooling equipment operating with HFC-134a. The conversion of the insulating panel production lines cover replacement of foam blowing system with high pressure machines enabling replacement of R-11 with HCFC-141b. The replacement alternatives and the time frame for phasing out the use of ODS will be in line with ODS phase out programme of the Government of Viet Nam.

I. BACKGROUND

A. Sector Background

The subsector for industrial refrigeration and air-conditioning systems in Viet Nam consists of 3 major companies - SEAREFICO, SEAREE and REE. These companies are active in the design, manufacture, installation and servicing of large scale refrigeration units for the food processing industry and air-conditioning systems of industrial, office, hotel, cultural, conference and other buildings.

Viet Nam does not produce any ODS. All ODS used in the country are directly imported by the users. In 1990, according to the estimates of the Hydrometeorological Service of Viet Nam, the total consumption was 1,160 mt of ODS. This figure seems to be inflated and is under scrutiny by HMS in cooperation with UNEP experts. The main consumers of CFC-s are the domestic refrigerator and air-conditioner servicing, manufacturing of rigid foam insulation panels and manufacturing/servicing of industrial refrigeration and air-conditioning systems.

Rigid polyurethane foams are used in Viet Nam mainly for the manufacture of insulation panels, ice-boxes, industrial freezer appliances etc. All rigid foams are blown with CFC-11, in contrast with the flexible foams, which are produced with exclusively with water as blowing agent.

The total installed production capacity for insulation panels is about 100,000 m^2 per year, but the present production is only about 10,000 - 15,000 m^2 annually. The manufacturers expect a dynamic increase of production. This expectation is well justified based on the recently adopted "open-door" policy and economic reforms introduced by the Government, fast growing GDP and steadily increasing standard of living. One of the main foreign exchange earners of the country are fisheries and food processing. These sectors in line with priorities of the Government are boosting their production both for the growing local market and export.

In total about 200 freezing and cold storage facilities are in operation in the major cities, ports and in the numerous fishing areas along the long coast line of the Country. The refrigeration and freezer systems are all imported. They operate with various refrigerants - ammonia, HCFC-22 and R-502 blend. The freezing and cold storage facilities are designed, commissioned and serviced by the three above mentioned companies. Many of these facilities were and being built with insulating panels produced in Viet Nam. The transportation of fish and many other food products is performed by freezer trucks. The containers of these trucks are also produced locally by SEAREE and SEAREFICO, using domestic insulation panels and imported refrigeration equipment.

The growing economy is supplemented by fast urban development. Large number of office buildings, hotels restaurants, business centres, industrial estates etc. are under construction or reconstruction in the main cities. These new facilities and many industrial buildings are equipped with water-cooled air-conditioning systems. The design, installation and servicing of the large air-conditioning units, chillers are performed also by SEAREE, SEAREFICO and REE. The refrigerants used in this sector vary, however many appliances are filled with CFC-12 or R-502 along with the less harmful HCFC-22. Large portion of the chillers are obsolete, which in conjunction with the inadequate housekeeping and maintenance practices caused in many cases by poor availability of spare parts cause up to 50% or even higher annual release of their refrigerant charge and require urgent and effective remedial measures.

The number of domestic refrigerators, freezers and air-conditioners is growing rapidly. Presently almost exclusively traditional refrigerators and freezers filled with R-12 are imported. Annually about 10 percent of the new and a growing number of the old, obsolete appliances are serviced and a part of them recharged during refrigeration service with CFC-12. The repair of domestic appliances is carried out by very small, ill-equipped repair shops scattered around the country. Because of lack of environmental awareness, know-how and equipment in the service sector, service staff use CFC-12 for washing/flushing of the cooling systems, instead of using vacuum pumps and charging boards. This causes up to 500 percent excess CFC-12 consumption in the service sector.

According to the information collected up till now, currently no Vietnamese company manufactures domestic refrigerators/freezers, however, establishment of assembly lines could be expected in the near future.

B.1 Searefico's Background

SEAPRODEX Refrigeration Industry Company (SEAREFICO), Ho Chi Minh City, is a subsidiary of the state owned sea food processing and trading company SEAPRODEX. It employs 270 people, including 30 design technicians and engineers.

The main areas of activity of SEAREFICO are as follows:

- Design, manufacture and installation of refrigeration and air-conditioning systems;
- Repair and maintenance of industrial cooling equipment throughout Viet Nam;

- Production of
  - polyurethane sandwich panels (10,000-15,000 m^2 per year);
  - contact freezers up to 1,000 kg/shift capacity (30-50 units annually);
  - refrigeration truck containers up to 12 tonnes payload (20-30 units annually);
  - ice boxes (20,000 pieces annually);
  - ice making plants (up to 500 tonnes per day total capacity)
  - cold storage and tunnel freezers up to 10,000 mt capacity
  - polyurethane spray foam tank and roof insulations;
  - heat exchangers, cooling towers and other mechanical engineering products.

SEAREFICO operates two foaming machines:

a. Low pressure foaming machine

Capacity: 24 kg/min
Manufacturer: Korasia Co., Ltd. South Korea
Year of purchase: 1988

The above low-pressure machine is used primarily for the production of polyurethane sandwich panels. The installed capacity of the sandwich panel line is 48,000 m^2, however currently the plant is producing only 10,000 m^2 annually. A part of the foaming machine's capacity is utilized for the manufacture of other insulated products of the company.

The sandwich panel foaming line is equipped with manual daylight presses. Foaming material is introduced from the front end of the panel, via manual injection through a foaming tube. This process characterized with excessive waste of foam. The facing of the panels is prepainted, coated steel, stainless steel, aluminium or plastic.

Both the facings and the chemicals are imported.

The chemicals used are:

Polyol:	RF 5233/OA	APU, Singapore
	DALTOFOAM	ICI
Propellant:	R-11 (supplied premixed to the polyol)	
MDI:	RF5233/OB	APU, Singapore
	Suprasec 5005	ICI
Cleaning solvent:	Methylchloride	
Release agent:	Paraffin	

The maximum size of the panels is 6,000x900 mm, thickness: 50, 75, 100, 125 or 150 mm. Foam density: 38-42 kg/m^3.

b. High pressure portable foaming machine

Manufacturer: Gusmer, USA
Model: Gusmer H2000
Year of purchase: 1992

The portable high pressure foaming machine is used for the execution of spray foaming jobs (roof and tank insulation etc.) and for the manufacture of various products of the company. The chemicals used are the same as above.

Among the products of the Company an important role play the refrigeration truck containers used for the transportation of frozen food, meat, fish, dairy products, fruits and vegetables. The containers are built from the aluminium faced polyurethane sandwich panels produced in the plant. The cooling machinery is imported e.g. from Thermo King, USA or Zanotti, Italy. These machines are filled with R-502 refrigerant. The refrigerant charge is from 10 to 15 kg/unit, depending on the cooling capacity.

SEAREFICO recently obtained several foam and refrigeration testing and development equipment and quality control instruments e.g. for the measurement of thermal conductivity and compression strength.

In 1993 SEAREFICO consumed 20 tonnes of R-11 as blowing agent, 28.5 tonnes of HCFC-22 and 4.5 tonnes of R-502 as refrigerant for the production, installation and servicing of cooling equipment.

B.2 SEAREE's Background

Refrigeration and Engineering Enterprise (SEAREE), Danang is a subsidiary of the state owned SEAPRODEX described above, similarly to SEAREFICO. It carries out design, manufacturing, installation, repair and maintenance of industrial refrigeration facilities all around Viet Nam. The Company's products include cold storage and freezer plants, contact freezers (15-20 sets per year), insulated refrigeration truck containers (12 units per year), insulating panels etc. Since 1994 SEAREE is an associate member of the International Institute of Refrigeration.

SEAREE has 300 employees. About half of the staff is working in Ho Chi Minh City to carry out servicing and installation of cooling systems, in many cases on turn-key basis.

Until now SEAREE has been using prefabricated PS insulating boards for many of its product. This situation has been a major obstacle for the expansion of the Company' market share. To remedy the situation in 1993 SEAREE purchased a low pressure machine from OMS, Italy for the production of polyurethane sandwich panels. The equipment has been delivered and put into operation. The foaming jigs are being manufactured and production will start late 1994.

The planned production range of the new line include polyurethane sandwich panels with 0.5 mm thick coated/prepainted corrugated steel plate facing. Length: up to 6,000 mm, width: 1,200 mm, thicknesses: 75, 100, 150 mm. The production level in the first year is estimated to 20,000 m^2.

SEAREE has carefully studied the rapidly expanding local market and the import of polyurethane insulation panels into Viet Nam. The production target was set to replace about 60% of imports. The designed plant capacity is about three times higher than the 20,000 m^2/year production target. The main fields of application of SEAREE's insulated panels are cooling and refrigeration systems, building construction etc. Further amounts of rigid foam produced by the foaming machine will be used for the production of foam slabstock and in the manufacture of the various other products of SEAREE.

The foaming machine has the following data:

Type: Low-pressure
Model: FM-110
Manufacturer: OMS Impianti, Italy
Year of purchase: 1993
Jigs: manual aluminium plates and table

The characteristics of the foam and the of the chemicals are the same as described at SEAREFICO. The supplier of raw materials is DOW Chemicals.

II. PROJECT OBJECTIVE

The objective of this project is to eliminate the use of ODS such as CFC-11 and R-502 in the production of rigid polyurethane foam sandwich panels and in the manufacturing and servicing of refrigeration truck containers at SEAREFICO and SEAREE through conversion to the use of HFC 134a as refrigerant for the cooling system and HCFC-141b as blowing agent for the polyurethane insulation foam.

III. PROJECT DESCRIPTION

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

SEAREFICO and SEAREE have accepted to replace CFC 11 with HCFC 141b because the technology is mature and commercially applied outside Viet Nam.

Through the project assistance will be provided in:

a) Procurement of new machinery and equipment;

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

c) Redesign, reconstruction, prototype manufacturing and testing of sandwich panels, cold storage/freezing facilities and refrigeration truck containers;

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

e) Servicing.

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

A. *Refrigeration System*

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

- Because the traditional leak detectors react on Cl molecules, special HFC-134a leak detectors have to be provided.

- To improve the performance of the cooling system and compensate for a little lower polyurethane insulation value due to the conversion to HFC-134a as the new refrigerant and HCFC-141b for the foam, it is necessary to optimize the cooling system as well as the energy consumption to keep an acceptable TEWI value. Therefore, it is necessary to redesign, reconstruct and carry out performance tests for all redesigned models of refrigerator / freezer units and containers.

- It will be necessary to train manufacturing and service technicians at the equipment suppliers' place in new foaming technology as well as provide on the job training in foaming and using HFC-134a refrigerant, design/calculation and performance testing of cooling systems. During the installation and run-in of the new machinery and equipment the suppliers engineers will train local technical staff in using the new equipment.

B. ***Foam System***

- CFC-11 is miscible with polyols and has an effect of considerably reducing (by factor 10) the viscosity of the mix. HCFC-141b does not have this effect, thus, it modifies the physical behaviour and properties of the foaming mix. In order to achieve an acceptable foam quality and insulation value at lowest price, high pressure foaming machines need to be introduced instead of the present low pressure machines to enable proper mixing of the higher viscosity raw materials.
  Adaptation of the currently used low pressure foaming machines for HCFC-141b would require substantial modifications to be carried out at the machine supplier's premises. Apart from the substantial adaptation costs, a further burden would be the several months interruption of production for decommissioning, rebuilding, transportation and recommissioning of the machinery. Thus, the only economically viable solution is to replace the low pressure foaming machines with suitable high pressure ones.

  According to our information collected in Viet Nam, there is no domestic market for the second hand low pressure foaming machines, since all the foam manufacturers are replacing their low pressure foaming machines with high pressure machines. Thus, similarly to the previously approved by the MFMP foam sector projects the high pressure machines are budgeted at their full cost.

- Due to the higher viscosity the foam cannot be introduced into the 6 metres long panels from only one point at their end or side. This would result in uneven distribution of the foam and significant deterioration of the quality of products. The prefered technical solution is to use lance technique instead of the presently used multidaylight (4 layers) presses. In this case the foaming lance is inserted and the mixing head is travelling alongside the press evenly distributing the foam on the surface of the lower facing. After injection the press is closed and foam rising and curing takes place. The lance technique corresponds to the present production rate, without making any compromise on product quality would enable the use of cyclopentane in the future.

- To keep control over the quality of the foam it is recommended to introduce a minimum specification of test equipment. SEAREFICO has certain testing facilities, but since currently no test equipment is being used by SEAREE it is recommended to equip it as well, however, this can not be provided under this project.

C. ***Refrigeration Service***

- The refrigeration truck containers produced by SEAREE and SEAREFICO should be serviced in the future exclusively by the manufacturers. Thus, filling up or recharging the refrigerator units with HFC-134a could be implemented with the production equipment available at the manufacturer, and there is no need to provide additional service equipment and training through this project.

- On the other side collecting and recycling units will be provided for the collection of R-502 to prevent its release to the atmosphere and facilitate reclaiming of used refrigerant.

D. *Justification for Selection of Alternative Technologies*

As new refrigerant in the transport refrigeration many of the major manufacturers have chosen HFC 134a as replacement for R-502. Thus, for the Vietnamese manufacturer this would be a viable, commercially available option.

As new blowing agent for the polyurethane foam the situation is quite different. The major alternatives are:

Blowing agent	*ODP*
100% CO_2	0
HCFC-141b	0.11
HCFC-22	0.065
HCFC-142b + HCFC-22	0.06
HFC-134a	0
Cyclopentane	0
HFC-356	0

The major advantages and disadvantages of the various alternatives are as follows[1]:

100% CO_2

- Advantages
  - Environmentally attractive
- Disadvantages
  - Poorer physical properties
  - Poorer foam adhesion
  - 20-25% increase in initial k-factor (thermal conductivity)
  - Fast foam aging, due to gas diffusion, if foam not protected
  - Higher exotherm may limit cure in thick sections
  - Significant cost increase (+30%)
  - Polyol viscosity limitations

HCFC-141b

- Advantages
  - Low flammability impact
  - 15% more efficient blowing agent than CFC-11
  - k-factor comparable to CFC-11
  - Good foam aging characteristics
  - Cost effective
  - No plant modification required (if high pressure foaming is already used)

[1] Source: M. J Cartmell, Workshop on CFC Substitutes, 2-4 February 1993, Polymer Institute, University of Detroit Mercy

- Disadvantages
  - Transitional substance
  - Higher solvency effect

<u>HCFC-22</u>

- Advantages
  - Lower ODP than HCFC-141b
  - Non-flammable
  - Low cost
- Disadvantages
  - Lower boiling point requires significant changes to processing and handling equipment
  - Frothing effect at higher levels
  - Higher initial k-factor
  - Without impermeable facers k-factor will increase rapidly due to gas diffusion

<u>HCFC-22/HCFC-142b blends (40:60)</u>

- Advantages
  - Low ODP
  - Non-flammable
  - Frothing effect less than HCFC-22
  - Slower rate of gas diffusion than HCFC-22
- Disadvantages
  - Low boiling point
  - Higher cost than HCFC-22 alone

<u>Pentane</u>

- Advantages
  - Zero ODP
  - Halogen free
  - Low cost
  - Liquid at room temperature
  - Good foam aging characteristics
  - Foam properties acceptable
- Disadvantages
  - Highly flammable
  - Plant modifications required
  - Low solubility in polyols
  - 5-10% increase in initial k-factor

HFC-134a

- Advantages
  - Zero ODP
  - No-toxicity
  - Non-flammable
  - k-factor aging similar to CFC-11
- Disadvantages
  - Expensive
  - Higher initial k-factor
  - Lower solubility in polyols
  - Frothing effect worse than HCFC-22
  - Requires significant changes to processing and handling equipment

HFC-356

- Advantages
  - Environmentally attractive
  - Boiling point 24°C
  - Non-flammable
  - Relatively soluble in standard PU raw materials
  - k-factor similar to CFC-11
  - good foam aging characteristics
- Disadvantages
  - Toxicity unknown
  - Cost unknown
  - Availability uncertain

Although 100% CO_2 is a very attractive solution from environmental point of view it can not be selected as an acceptable technology for the production of sandwich panels due to the poor insulating properties of the foam.

Pentane is an excellent solution and widely used mainly in Europe. The technology however requires extensive precautionary measures due to the flammable and explosive character of pentane. This would drastically increase the investment cost especially in case of non-continuous panel production, such as applied in Viet Nam. With view of the low production volumes the cost difference between the pentane and other less hazardous technologies would render the project economically not viable. On the other hand application of pentane driven foam for spraying or other insulation jobs would pose additional safety hazards, thus, the pentane technology in this case is not a viable option.

Application of HFC-356 and other new foaming agents (e.g. fluorinated ethers) are not mature technologies as yet.

The use of HFC-134a is incompatible with existing spray, slabstock and board stock processes. The other draw back of this propellant is its higher cost.

HCFC-141b, HCFC-22 and HCFC-142b + HCFC-22 blend are transitional substances. The latter two similarly to HFC-134a are incompatible with existing spray, slabstock and board stock processes.

Among all the above solutions HCFC-141b is the technically and economically most acceptable one, even though it is transitional. This technology is still being introduced and widely used in the USA, Japan and many other developed and developing countries and is a process route recommended by the OORG Refrigerator/freezer Foam Working Group (May 1994) and UNEP (Protecting the Ozone Layer, Vol. 4, Foams) both for sandwich panels and spray foams.

IV. INPUTS

1. *Capital Goods Replacement*

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

A. Refrigeration System

a1.	2 pcs.	HFC 134a charging units with vacuum pump, leak check as well as refrigerant supply pump (one for each company);
a2.	2 pcs.	HFC 134a leak detectors (one for each company);
a3.	2 pcs.	Recycling/collecting units for R-502 (one for each company)

B. Foam System

b1.	2 pcs.	High pressure foaming machines (one for each company);
b2.	2pcs.	Mixing tanks (one for each company);
b3.	2pcs.	Foaming lance (one for each company);
b4.	2pcs.	Foaming car (one for each company).

2. *Conversion/Training*

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

- redesign and reconstruction of refrigerators and freezers to non-CFC models;
- quality control in relation to conversion;
- operation of the new machinery and equipment;
- maintenance of the new machinery and equipment;
- refrigeration laboratory tests;
- new technologies for foam and refrigerant;
- specifications for materials;
- safety regulations for flammable/explosive chemicals;
- refrigeration service.

3. *Model Redesign*

It is foreseen, that for all refrigeration truck container models slight redesign and reconstruction are required, followed by the manufacture of some prototypes and refrigeration performance tests. The model redesign will be carried out by the local staff under the supervision of specialized international consultants for this project.

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

V. PROJECT IMPLEMENTATION

The project implementation will be carried out by UNIDO in close cooperation with SEAREFICO and SEAREE. Necessary local coordination will be done by the Ministry of Fisheries.

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

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

The final equipment specification and the work plan can only be elaborated after approval of the basic approach for project implementation by the MFMP.

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

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

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

- Technical staff as required by the General Contractor;

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

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

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

For the project implementation, milestones are set in Annex E.

VI. PROJECT COSTS

I. INCREMENTAL OPERATING COSTS

The price increase will be caused by:

- for polyurethane foaming at least 15 % more of the complete mix needs to be charged due to the higher foam density using HCFC 141-b;
- less amount of blowing agent is required, however with increased unit price;
- the foam price is calculated according to the new composition, based on the local price level.

R-11 system				**HCFC-141b system**			
Chemical	*wt-%*	*Price $/kg*	*Cost $*	*Chemical*	*wt-%*	*Price $/kg*	*Cost $*
Polyol +MDI	85	1.6	1	Polyol + MDI	93	1.7	2
R 11	15	1.8	0	HCFC-141b	7	3.5	0
PU-cost,$/kg			1	PU-cost, $/kg			2
Consumption, kg/m^2			4.5	Consumption, kg/m^2			5
Total cost, $\$/m^2$			5	Total cost, $\$/m^2$			10
			Cost difference, $\$/m^2$	5			

Based on above, the total incremental operating costs for SEAREE and SEAREFICO for **one year of operation** are:

a. Production of sandwich panels:

Company	**Production**	**Unit incremental cost**	**Total annual incremental cost**
SEAREFICO	10.000 m^2/year	US\$1.8/m^2	US\$18,000
SEAREE	20.000 m^2/year	US\$1.8/m^2	US\$36,000

b. Production of rigid foam for other applications

The above calculation shows US\$1.8 incremental cost for 1 m^2 of 100 mm thick sandwich panel. This equals to US\$18/m^3 foam used for spraying and other injection foam insulation of various appliances as contact freezer, ice boxes etc. The incremental cost of conversion to HCFC-141b driven foams in these applications amounts to:

Company	**Production**	**Unit incremental cost**	**Total annual incremental cost**
SEAREFICO	500 m^3/year	US\$18/m^3	US\$9,000

Thus, the total incremental operating cost for six months amounts to:

a. **SEAREFICO** (18,000+9,000)/2=US\$13,500

b. **SEAREE** 36,000/2=US\$18,000

TOTAL: **US\$31,500**

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

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

II. CONTINGENCY FUND

A contingency fund (10 percent of the total investment cost) was calculated. The MFMP is proposed to cover unforeseen expenses which might be incurred during the project implementation, e.g. purchase of small testing instruments, which might be required during the conversion process, miscellaneous expenses, price escalation, etc.

III. TOTAL COSTS

- Investment costs will cover capital investment costs (at CIF basis) for modification of existing manufacturing facilities, purchase of new machinery (see Annex A: "Equipment Specification and Cost Breakdown"), training, installation and consultancy services for plant and product modifications (see Annex B: "Labour Cost of Subcontractor's Services" and Annex C: "Project Budget").

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

- Implementing Agency's overhead costs are 13 percent.

- For the complete costs breakdown see Annex C: "Project Budget".

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

- Requested funding by the MFMP: **US$ 576,603**

Annex A: Equipment Specification and Cost Breakdown

Item	Quantity	Unit cost,	Total cost,
		US$	US$
Refrigeration system			
Evacuation and charging	2	10,000	20,000
HFC 134a leak detectors	2	4,500	9,000
R-502 collection station	2	2,500	5,000
Foaming system			
High pressure foaming machine	2	97,000	194,000
Mixing tank	2	10,000	20,000
Foaming lance	2	40,000	80,000
Installation, Piping	2	10,000	20,000
Trials	2	1,000	2,000
Total			**350,000**

Annex B: Labour Cost of Subcontractor's Services

Title	Unit	Qty.	Unit cost,	Total cost,
			US$	US$
A. Refrigeration system				
(1 supervisor for 2 weeks)				
Air ticket, Europe - Viet Nam	pc.	1	5,000	5,000
Expert fee	days	14	550	7,700
Daily subsistence allowance	days	14	160	2,240
Subtotal				14,940
B. Foam system				
(1 supervisor for 2 weeks,				
Air ticket, Europe - Viet Nam	pc.	1	5,000	5,000
Expert fee	days	14	550	7,700
Daily subsistence allowance	days	14	160	2,240
Subtotal				14,940
TOTAL				**29,880**

Annex C: Project Budget

Budget line	Duration, work months	Cost, US$
11-50 International Consultants	2	30,000
21-01 Subcontract		379,880
51-00 Miscellaneous:		
10% contingency fund on capital cost		40,990
Incremental operating cost		31,500
Preparatory assistance		14,700
Total miscellaneous cost		87,190
99-99 Subtotal		497,070
Implementing Agency Overhead, 13%		64,620
PROJECT TOTAL		**561,690**

Annex D: Calculation of Unit Abatement Cost

A	***ODS Phase out***	Unit	Total Project
A1	Average use of CFC 11 per year	mt	40
A2	ODP of CFC 11		1
A3	ODP-weighted CFC 11 phase out (A1*A2)	mt	40
A4	Average use of R-502 per year	mt	1
A5	ODP of R-502		0.34
A6	ODP-weighted CFC 12 phase out (A4*A5)	mt	0.34
A7	Total ODP weighted phase out (A3+A6)	mt	40.34
B	***Annualized capital cost***	Unit	Total Project
B1	Total investment cost		
	(model redefinition + production conversion)	US$	464,068
B2	Equipment life	year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	75,504
C	***Annual incremental operating cost***	US$	31,500
D	***Unit abatement cost***	Unit	Total Project
D1	Annualized capital cost per kg ODS phased out (B4/A7/1000)	US$/kg	1.87
D2	Annual incremental operating cost per kg ODS phased out (C/A7/1000)	US$/kg	0.78
D3	Unit abatement cost (D1+D2)	US$/kg	**2.65**

Annex E. Implementation Schedule

MILESTONES / MONTH	1	2	3	4	5	6	7	8	9	1	1	1	1	1	1	1	1	18
FOAMING																		
1. Sign the project, receive funding	■																	
2. Appointment of General Contractor, site inspection		■																
3. Elaboration of a detailed project work-plan		■																
4. Draft of plant layouts		■																
5. Training						■				■	■							
6. Selection of equipment, bidding		■	■	■														
7. Rebuild foaming machines									■	■								
8. Modification of existing equipment									■	■								
9. Purchase, installation commissioning				■	■	■	■	■	■	■	■							
10. Prototyping & testing											■	■						
11. Start production with HCFC-141b											■	■	■	■	■	■	■	■
REFRIGERATION																		
12. Redesign of models, training		■	■	■														
13. Selection of equipment, bidding		■																
14. Purchase, installation commissioning and training				■	■	■	■	■	■									
15. Prototyping and testing										■	■	■	■					
16. Start production with HFC-134a												■	■	■	■	■	■	■

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

PROJECT REVIEW
by Kimmo J. Sahramaa
PUR-Technology Consultant

Country: Viet Nam

Project Title: Phasing out ODS at the SEAREFICO and SEAREE industrial refrigeration plants of SEAPRODEX Co.

Sector Covered: Industrial refrigeration/rigid foam/refrigerant

Implementing Agency: UNIDO

Technology: UNIDO's plan related to SEAREFICO's and SEAREE's rigid foam application: The plan suggests converting from present CFC 11 blowing agent to 141 b, acquiring new high-pressure measuring units and oyster presses for both of the plants. We would suggest UNIDO would reconsider the plan and use the following technology arrangement and approach in transferring this technology:

--Rather than 141 b, convert to C-pentane as a final solution. Allow two (2) years of usage of 141 b before the C-pentane is finally to be used on commercial production scale. Provide good safety and safe operation manuals and training related to C-pentane foaming application before the commercial C-pentane foaming starts. Arrange review of the conditions of installed hardware, facilities, and evaluate the success of training before the implementation agency certifies the plant for commercial operation.

--Allow the company to acquire pentane delivery systems for both plants; drum-based system would most probably be most feasible. There are containerized systems available including drum handling and gravity feed of pentane to a small stainless steel tank, feeding pump to deliver pentane via stainless steel pipe to the application area. The containerized system is equipped with pentane sensor systems.

--Pentane system requires a Penta Module to premix pentane to polyol. The Penta Module needs to be in an enclosure. Polyol needs to have appr. 500 l bulk tank arrangement to feed Penta Module. These need to be acquired.

--Premixed polyol is fed to high-pressure measuring units which need to be acquired. High-pressure unit is recommended to have 150 l machine tanks and poly-tank should have an agitator. Poly-side of the high-pressure unit is separated with an enclosure from the rest of the unit. The measuring unit is sized in 60 kg/min. category because we suggest your plan be based on lance delivery system. Measuring unit is thus substantially smaller than would be required, for example, for a one-shot operation.

--The foam would be distributed with pull-out lance which has, for example, a 38 mm high mixing head. The foam delivery needs to be recirculating because pentane-polyol mixture would not stay functional in a closed-end type of arrangement. The lance is power-pulled to assure a controlled foam distribution.

--We suggest the company would continue using their existing press hardware. The lance system described above would inject the lance from the other end of the press into each press slot and distributes the foam to one slot/panel at a time. A closed press configuration is considered more feasible for pentane application than an open oyster press.

--Press needs to be in an enclosure which should have, we assume, at the other end a door to allow demolding of the press and refilling. The door needs to be sensor-controlled to be closed before foaming may take place. The enclosure needs to have property sized, two-speed ventilation, the basic ventilation to be forced on when foaming takes place and aggressive ventilation of the pentane sensors are activated at detected 40% of LEL.

--Safe pentane application requires disciplined operation and closely followed, safe operation practices. In addition, all the hardware and enclosure structures need to have good grounding, floors have antistatic coating, operators use antistatic clothing and shoes. To eliminate dangerous pentane concentrations in the panel cavity or to be ventilated from the panel cavity, nitrogen gas is recommended to be injected into the panel before the foam is injected. A fine protection system is also required.

--As described above, all system components which come into contact with pentane or pentane-polyol mixture need to be enclosed. Each potential critical location should have a sensor placed and connected to the control system.

Costs: Two identical systems are needed:

--Containerized drum-handling, pentane feed system would cost $115,000

--For pentane feeding, stainless steel pipes, $15,000, could be accepted, depending on the distance of the container to the application area.

--A high-pressure measuring unit, enclosed and suitable for pentane operation would cost $110,000.

--A Penta Module would cost $75,000. An enclosure would add $10,000.

--A lance system is available for $40,000.
--For press enclosure and ventilation, we suggest a budget cost of $20,000.
--A complete leak detection system with control board should be budgeted at $40,000.
--Antistatic grounding/applications, fire protection system, and nitrogen feed systems we suggest would be budgeted for total of $45,000.

Refrigeration: We agree with your assessment of technology and costs.

Implementation time frame: We suggest the project will be phased in the following phases:
--Construction and delivery of new pentane-feed and foaming application machinery including enclosures and leak detection systems within the schedule you have reserved in your plan.
--Implementation of 141 b foaming system by using the new installed and commissioned high-pressure foam application machinery. Extensive safety training needs to be provided during a two-year period.
--Review of company's readiness to start commercial-scale pentane foaming applications.
Note: Any testing and trials of pentane systems prior full review of company's readiness to meet safe operation standards have to be managed by implementing agency's pentane-experienced specialist.

Recommendation: We recommend the project to be approved with modifications.