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PROJECT COVER SHEET

Country/Region:	Nigeria
Project Title:	Investment Project for phasing out of CFC's at Gacol Nigeria Ltd.
Sector Covered:	Refrigeration (Rigid foams and Refrigerant) and Airconditioning. In Nigeria the total ODS consumption is is 272MT of CFC-11 and 436MT of CFC-12 in this sector.
Project Impact:	Phase out of annual Consumption of 1.8 MT of CFC-11, 1.0 MT of CFC-12 (Total ODP = 2.8 MT)
Project Duration:	18 months
Project Economic life time:	10 years
Total Proposed Project Cost:	US$ 604,857
Project Investment:	US$ 532,450
Implementing Agency's Overheads:	US$ 69,585
Incremental Operating Cost:	US$ 2,822 (Six months operational costs)
Proposed MF Financing:	US$ 604,857
Cost Effectiveness:	12.37 US$/kg
Counterpart Enterprise:	Gacol Nigeria Limited, Nigeria.
Implementing Agency:	United Nations Industrial Organisation (UNIDO)
Coordinating Agency:	Federal Environmental Protection Agency (FEPA).

PROJECT SUMMARY

This project has been designed to phase out 100% of the use of CFC-11 as blowing agent and CFC-12 as refrigerant agent from the production programme of refrigerators and freezers at the factory of **Gacol Nigeria Limited Nigeria Ltd.** Nigeria

The chosen replacements for the foam blowing agent and refrigerant are cyclopentane and HFC 134a respectively. 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, trail manufacturing and adaption, as well as reliability tests.

The conversion of the production facilities covers the refrigeration system and the insulation foam blowing system for refrigerators, but will not yet phase out the HCFC 22 refrigerant (ODP=0.05) for the production of air conditioners.

BACKGROUND

Sector Background

The subsector for domestic refrigerators and freezers in Nigeria is the main focus of the phase-out of ODS substances in the Refrigeration and Aircondition Sector. This is because HCFC-22, which is a transitional substance is the refrigerant commonly used now in airconditioners in Nigeria. The use of CFC-12 in this subsector has largely been discontinued. The domestic refrigerators and freezer subsector in the country consist of one large manufacturer, Thermocool Engineering Co. Ltd., two medium sized manufacturer, Debo Industries Ltd., and Kolinton Technical Industries Ltd. and several smaller manufacturers of which three of the companies namely Gacol Nigeria Limited, A.G Leventis Plc and Nigerian Engineering Works Ltd. belong. Major share of total ODP consumed in this sector in Nigeria is shared by the three leading companies, while the rest is shared by the smaller industries, including the three mentioned earlier.

CFCs are not produced in Nigeria. According to Nigerian import data, consumption of CFC-11 in the production of polyurethane foam in the refrigeration sector was about 208 MT in 1994. During the same year, CFC-12 consumption in the sector was 330 MT, out of which less than half was used to produce new appliances while, the major part was used for recharging existing appliances. The demand of ODS remained stagnant in 1995 with consumption patterns not far different from the 1994 levels. However, data collected for 1996 indicated an increase in the use of ODS in this subsector, geared by an upturn in economic activities in the country, which translated to higher number of domestically produced refrigerators and freezers. It has been estimated from preliminary data obtained from the leading companies that in 1996, 272 MT of CFC-11 was used in the production of polyurethane foam in the refrigeration sector in Nigeria, while about 436 MT of CFC-12 was used in producing new equipment as well as in recharging existing appliances.

In 1994, about 88,000 domestic refrigerators and freezers were produced in Nigeria while about 16,000 new refrigerators and freezers were imported. It has been estimated that about 15,000 used refrigerators were imported to Nigeria during the same period. Production and import figures for 1995 were not markedly different. However, due to the slight upturn of economic activities in 1996, about 119,859 domestic refrigerators and freezers were estimated to have been produced in Nigeria, representing a 35.6 % increase from 1994 levels. Importation of new and used appliances also rose but at a much lower rate during the same period.

Based on a 15 year life expectancy for these equipment, it has been estimated that a total of about 2.2 million refrigerators and freezers were in use in Nigeria by the end of 1996. Approximately 15% of this number will be annually recharged with about 176 MT of CFC-12 during refrigeration service. Due, partly to lack of equipment for the service sector, service staff often use CFC-12 for washing/flushing of cooling systems, instead of using vacuum pumps and charging boards. This causes in such cases, an up to 100% higher CFC-12 consumption in the service sector. Another part is loss by evaluation.

Counterpart's Background

Gacol Nigeria Limited was established in 1977. It is a private limited liability with 100% company operating in the manufacture and sale of Household, Commercial and Transport refrigerators, freezers air-conditioners and Auto condensers. The company was initially receiveing technical assistance for the production of refrigerators and freezers from Pacific Refrigeration, Italy.

Gacol Nigeria Limited has a total staff strength of 70 comprising of 60 in the production of appliances, while 10 were in service. The annual production for the last 3 years was in the range of 1,067 refrigerators and freezers units per year with a slightt decrease in 1996. The total installed capacity for the production of refrigerators at Gacol Nigeria Limited is 12,500 household refrigerator and freezer units per year produced in one shift.

Gacol Nigeria Limited covers about 5% of the Nigerian household refrigerator production.

Gacol Nigeria Limited produces the following refrigerators and freezers.

ONE DOOR REFRIGERATORS

Model 280 with 280L refrigerator including freezer component
Model 180 with 180L refrigerator including freezer component
Model 100 with 100L refrigerator including freezer component

CHEST FREEZERS

Model 180 with 180 litres
Model 280 with 280 litres
Model 480 with 480 litres

In addition Gacol Nigeria Limited Nigeria Limited produces

- Air conditioners (Window types)

- Gas cookers
- Auto condensers

2.3.2 EXISTING PRODUCTION LINE IN THE REFRIGERATOR AND FREEZER SECTION:

The Gacol Nigeria Limited factories consists of following production lines in the refrigerator and freezers section (the equipment on the lines for air conditioners and cold room storage are not mentioned in the following because the conversion of HCFC 22 filled air conditioners and cold room storagee cooling units are not considered in this conversion).
At the factory the following facilities are available:-

(i) Refrigerator and Freezer Factory

- Steel sheet processing line for refrigerator cabinet and door; chest freezer and lids;
- Manual spraying workshop with oven for drying after painting;
- Plastic forming line for refrigerator, cabinet and door; freezer chest and chest lid;
- Door gasket extrusion line;
- Pre-assembly line for cabinets, doors, chest freezer, chest lid and small items;
- Foaming line for refrigerator cabinet and door; chest freezer and chest lid;
- Assembly line;
- Evacuation, charging and testing line for refrigerators and freezer;
- Repair line;
- Testing line;
- Packing line.

The Company uses standard polyurethane foam without CFC reduction with a density in the range 27-31 Kg/m^3. Its foaming and refrigerator charging equipment are about 21 years old.
The foaming lines in the factory consist of the following:

- 1 Pc high pressure canon machine
- 3 Pcs Refrigeration cabinet foaming fixtures;
- 3 Pcs chest freezer chest foaming fixtures;

- 2 Pcs universal door foaming jig;
- 3 Pcs stationery door fixtures;
- 3 Pcs cabinet plugs;
- 3 Pcs chest plugs;
- 3 Pcs door moulds.

The evacuation, charging and testing sections of the refrigerator and chest freezer line consist of the following equipment:

- 2 Pcs vacuum pump from Robinair and pacific;
- 2 Pcs automatic evacuation and charging board from Edwards & Danfoss;
- 2 Pcs production electronic leak detectors from Toshiba.

The company has a performance test laboratory facilities, which is not sufficiently equiped to make the performance test require for the converted models. To optimize the R134a cooling system and to improve quality, equipment for such test laboratory will be needed.

Gacol's Refrigeration Service

The company also have a service shop equipped with a standard set of refrigeration service equipment. The shop is equipped with one charging board and a leak detector. Apart from servicing equipment produced by it, the company also services equipment of other manufacturers. In 1996, of all equipment serviced, about 25% were manufactured by other companies.

Gacol Nigeria Limited Nigeria Ltd. services about 1750 refrigerators and freezers in 1996.

PROJECT OBJECTIVE

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

PROJECT DESCRIPTION

Gacol Nigeria Ltd. is ready to phase out ODS in their refrigerators and freezers production immediately the new technology has been acquired; the necessary machinery and equipment installed and their technical staff trained.

Presently, there are many technological options available but Gacol Nigeria Ltd. has chosen

to replace CFC-12 by HFC-134a, because of the avaialbility of new compressors and the fact that the technology is matured and commercially applied.

As for the replacement of CFC-11 as blowing agent for PUF, the company has decided to avoid the application of any transitional substance and to introduce cyclopentane which is the ultimate solution.

Gacol Nigeria Ltd. through this project is seeking assistance, 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.

The refrigerator service workshop of Gacol needs 1 recovery unit and 10 recovery bags for CFC-12 as well as 1 set of equipment (service evacuation and charging board and service leak detector) which will be used for servicing HFC134a refrigeration system.

In Gacol, the following machinery and equipment need to be rebuilt, replaced or or have to be added:

A. Refrigeration System

- 2Pcs. production evacuation and 2Pcs. charging boards on each of the refrigerator and freezer line have to be replaced by 1Pc. new board suitable for HFC 134a.

- 2 existing production leak detectors need to be replaced by 1 special leak detector for R134a.

- 2 existing vacuum pumps cannot be re-used after the application of a special cleaning technology according to pump producers and need to be replaced by new pumps or renovated.

- 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. This implies that 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 a desiccant with 3AA pores or desiccant XH7 (Union

Carbide).

- The cooling system must not contain any chlorine and maximum 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

- 1 high pressure foaming presently available in the company needs to be modified to be used for cyclopentane;

- Retrofiting of the 3PCs. refrigerator cabinet foaming fixtures and 3 PCs of chest freezer chest foaming fixtures, all automatic with moulds in the bell position will be replaced by 3 new universal fixtures.

- The 2PCs. universal door foaming jig should be modified in a way that cyclopentane driven foam can be used by changing electrical components to ex-proof, adding exhaust etc;

- The 3Pcs. stationary door fixtures should be modified in a way that cyclopentane driven foam can be used by changing electrical components to ex-proof, adding exhaust, etc;

- 1Pc. cabinet wooden plug used for the 100L model of the refigerator cannot be used for cyclopentane and need to be replaced by aluminium plugs; the cost of the plugs will be borne by the counterpart.

- The 3 door moulds should be modified to be used for cyclopentane to reach a comparable cost effectiveness per phased out ODS the cost of this modification should be shared by the counterpart;

- The final specification of the cyclopentane to be used (purity and mix) will be defined after carrying out a market review in the country to assess its availability.

- 1 pre-mixing station since cyclopentane and polyol cannot be delivered pre-mixed in drums or tanks (unlike CFC-11).

- For safety at plant operation using the highly inflammable and explosive cyclopentane, it is necessary to have gas detector systems as well as a set of fire protection system;

- It is necessary to provide one storage tank for storing of cyclopentane in the factory and the size should be sufficient for one standard tank container; the tank should be equipped with necessary piping and safety systems;

- Since Nitrogen is highly required in the factory for pressurizing the cyclopentane/polyol tanks and flushing of the cabinet and door cavities during foaming process; a nitrogen generator and supply network should be provided; the network cost should be borne by the counterpart.

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

1. The c-pentane tank have to be placed underground and not less than 5m 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 the established safety rules for the machinery and the plant, it is necessary to provide and install exhaust and ventilation systems in the foaming department.

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 should be positioned outside the foaming area or switched off during he time of foaming.

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

C. Refrigeration Service

The refrigeration service is not considered for conversion since it is not part of this particular project but will be considered during the recovery and recycling project at the country level.

D. Justification for Selection of Alternative Technologies

All major manufacturers of compressors have accepted the use of HFC 134a as replacement for CFC-12 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. As a result 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

The following equipment existing in Gacol Refrigerator and Freezer production needs to be changed and new equipment should be provided as specified below:-

A.1	2 PCs.	Production evacuation and refrigerant HFC 134a charging boards with vacuum pump, refrigerant supply pump and vacuum check.
A.2		Vacuum Pumps;
A.3	1 pcs.	HFC 134a Production leak detectors;
A.4	1 set	Test equipment for model redesign;

B. Foam System

The following equipment needs to be changed/replaced or new equipment has to be provided as shown below:-

B.1		Some components of the high pressure foaming machine presently in use in the Gacol factory needs to changed to make it suitable for c-pentane;
B.2	1pcs.	PUR filling place for the fill of the foaming machines from drums;
B.3	1 pcs.	Pre-mixing station for c-pentane and polyol;
B.4	2 pcs	Gas detector systems with control board;
B.5	1 set	foam testing equipment;
B.6	2 set	Exhaust and ventilation system;
B.7		Encapsulation cabins to be provided by the counterpart;
B.8	1 pc.	New universal cabinet and chest fixtures in bath position suitable for cyclopentane;
B.9	1 pc.	Rebuilding of universal door fixture, replacing all the electrical components by ex-proof components, earthing etc.;

B.10 1 set Ex-proof pipe installation from filling place to tank;

B.11 1 set Ex-proof piping system from cyclopentane tank to pre-mixer;

B.12 1 set Ex-proof piping system from pre-mixer to the 1 polyol tank of PUR machines;

B.13 Antistatic floor cover;

B.14 1 set Fire protection system;

B.15 1 pc. Storage tank for cyclopentane with all necessary safety devices;

B.16 1 pc. Nitrogen generator for the nitrogen network needed for the cyclopentane foaming machines, pre-mixing, foaming jigs and tanks;

B.17 1 set Nitrogen net work to be provided by the counterpart;

B.18 1 pc. Universal and expandable chest freezer plugs to be used for cyclopentane;

To reach a comparable cost effectiveness per phased out ODS the costs for the necessary further chest freezer plugs will be borne by the counterpart;

B.19 3 pcs Modification of door moulds to be used for cyclopentane; to reach a comparable cost effectiveness per phased out ODS the cost for this modification should be taken over by the counterpart;

B.20 1 pc. Back-up power supply systems for ventilators;

The layout of the production equipment should be organised in such a way that the piping are short and SD valves for separation in sectors can be avoided.

C. Refrigeration Service

As stated earlier, the refrigeration service is not part of the conversion project rather it will be part of the recovery and recycling project for the whole country.

2. Conversion/Training

Within the framework of the project, personnel from the counterpart 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 current household refrigerators and freezers 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 partially included in the training component for technical staff, as well as in the international expert service component. The major part have to be covered by the counterpart.

As a common practice, necessary modifications of the production lines will be carried out during evenings and off-days and will, therefore, not cause too much losses in the regular production. In addition the installed capacity is not fully used, so that losses can be compensated in other periods of production.

PROJECT IMPLEMENTATION

The project implementation will be carried out according to the rules and procedures of UNIDO, under the management of the backstopping officer of UNIDO, in close cooperation with the Nigeria Federal Environmental Protection Agency (FEPA). Local coordination will be carried out by Gacol Nigeria Ltd., the counterpart.

Purchase of know-how is not considered in the project budget. However, to substaintively 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 prepared upon approval of the project.

The detailed Terms of Reference for the supplies and services to be provided under the project will be elaborated after project approval. This will be sent to FEPA and Gacol Nigeria Ltd. After competitive bidding, performed according to UNIDO's financial rules and procedures, a general Contractor will be appointed by UNIDO for the implementation of the major project components (foaming system, refrigeration system, etc.). The General Contractor will be responsible for the supply of equipment, commissioning and on-the-job training of Kolinton Technical Industries Ltd. staff.

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

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

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

Having accepted the conversion of its plants to the use of non-ODS under this project, Gacol Nigeria Limited 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 specification of these work will be elaborated by the General Contractor after project approval and necessary site inspection. Thus, the costs of construction work can be specified only after appointment of the General Contractor and finalization of the equipment list. The relevant construction work will have to be arranged by Gacol Nigeria Limited under the supervision of the General Contractor and in line with the established milestones for this project;

- Technical staff required by the General Contractor;

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

- Provision of materials, utilities, services, manpower, etc. related to commissioning, start-up, trial runs, prototyping and testing;

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

- All other expenses not included in this Project Document and not covered by the budget approved by the Multilateral Fund for the Implementation of the Montreal Protocol.

UNIDO as Implementating Agency has the necessary experience and capabilities for the successful implementation of this project at enterprise level. Upon approval of the project by the MFMP the whole 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.

TENTATIVE PLAN

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

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PROJECT COSTS

I. INCREMENTAL CAPITAL COST

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 COST

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

Modification	Incremental Cost (US$)
- HFC 134a compressor	3.50
- HFC 134a refrigerant	0.79
- Extra polyurethane foam because of higher density	0.84
Total	US$ 5.13

The above figures reflect the difference between relevant component price for CFC 11 and CFC 12 versus the component price for HFC 134a and cyclopentane.

All prices are without customs duty and tax.

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 is to be absorbed by the company.

Therefore, the total incremental operating cost increase for one year will be US$ 5,643 (based on production of 1,100 units per year in the first year: 1,100 x US$5.13 = US$ 5,643).

It was agreed that the counterpart will apply for the incremental operating cost for 6 months = US$ 2,821.5

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 COST

- Incremental investment cost, (Annex A: "Equipment, Specification and Cost Breakdown").
- The net incremental operating cost (as above).
- Executing agency's overhead cost (13%).
- 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$ 604,857**

Annex A: Equipment Specification and Cost Breakdown

Description		Qty.	Unit Cost US$	US$
A.	**Refrigeration System:**			
	- Charging board for HFC 134a	1	25,000	25,000
	- Vacuum pumps (1 new + 1 retrofit)			2,800
	- Production leak detector for HFC 134a	2	5,500	11,000
	- Test equipment for model redesign	1 set	25,000	25,000
	Sub-total for group (A)			**63,800**
B.	**Foaming System:**			
	- Replacing of some components of the High pressure foaming machines already in factory			70,000
	- Premixing stations	1	70,000	70,000
	- Gas detector system	1	40,000	40,000
	- Exhaust and Ventilation	2 sets	32,000	64,000
	- Universal chest plugs and modification of fixtures			80,000
	- Pipe installation from tank to premixing stations	1	12,000	12,000
	- Pipe installation from foaming machines			20,000
	- Antistatic floor			3,000
	- Fire protection system	1 set	20,000	20,000
	- Tank for cyclopentane	1	20,000	20,000
	- Nitrogen bank	1	25,000	25,000
	- Chiller	1	10,000	10,000
	Sub-total group (B)			**434,000**
TOTAL FOR GROUP A & B			US$	**497,800**

The cost of the following equipment and installation work is not included in the budget and is to be absorbed by Gacol Nigeria Ltd.

(a) Pre-heating ovens for foaming;

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

(c) Any inside and outside construction, nitrogen network and civil work for the installation of the cyclopentane tank and the premixing station;

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

(e) Any construction works like encapsulation cabins for the foam section;

(f) 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 Gacol Nigeria Ltd.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.

Annex B: Total Project Budget

Description		Duration (Man-Month)	Cost US$
(i)	Senior Technical Adviser	1.5	6,000
(ii)	International Refrigeration Specialist	2.5	20,000
(iii)	Sub-Contract		3,000
(iv)	Trial Materials		2,500
Sub-Total			31,500
Contigency 10%			3,150
Total			**34,650**

Project Investment cost = Total for Annex A + Total for Annex B = 497,800 + 34,650 = US$532,450..... 1

Incremental Operating Cost for Six Months = US$ 2,822 2

Implementing Agency's Overhead = 13% of (1 + 2) = (0.13) (532,450 + 2,822) = US$69,585

Annex C: Unit Abatement Cost

A	ODS Phase-Out	Unit	Total Project
A1	Average use of CFC-11 per year	MT	1.8
A2	Average use of CFC-12 per year	MT	1.0
A3	Total CFC used	MT	2.8
A4	ODP of CFC-11 and CFC-12	MT	1.0
A5	ODP weighted CFC-11 and CFC-12	MT	2.8
A6	Total ODP weighted phased-out	MT	2.8
B	**Annualized Capital Cost**	**Unit**	**Total Project**
B1	Total Capital Cost	US$	34,650
B2	Equipment Life	Year	10
B3	Discount rate	%	10
B4	Annualized Capital Cost (B1 * 0.1627)	US$	5,638
C	**Annualized Incremental Cost**	**Unit**	**Total Project**
C1	Annualized Incremental Cost (for six months)	US$	2,822
C2	Annualized Incremental Cost per kg ODP (C1/A6/1000)	US$/kg	1.0
D	**Unit Abatement Cost**	**Unit**	**Total Project**
D1	Annualized Capital Cost per kg ODS phased-out (B4/A6/1000)	US$/kg	2.0
D2	Unit Abatement Cost	US$/kg	3.0
E	Project Cost Effectiveness (B1/A6/1000)	US$/kg	12.37

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PROJECT COVER SHEET

Country/Region:	Nigeria
Project Title:	Investment Project for phasing out of CFC's at A.G. Leventis (Nigeria) Plc., Nigeria
Sector Covered:	Refrigeration (Rigid foams and Refrigerant) and Airconditioning. In Nigeria the total ODS Consumption is 272 of CFC-11 and 436 MT of CFC-12 MT in this sector.
Project Impact:	Phase-Out of annual Consumption of 8.3 MT of CFC-11, 2.8 MT of CFC-12 (Total ODP = 11.1 MT)
Project Duration:	18 Months
Project Economic life time:	10 Years
Total Proposed Project Cost:	US$ 821,795
Project Investment:	US$ 712,480
Implementing Agency's Overheads:	US$ 94,543
Incremental Operating Cost:	US$ 14,772
Proposed MF Financing:	US$ 821,795
Cost Effectiveness:	11.4 US$/kg
Counterpart Enterprise:	A.G.Leventis Plc., Nigeria.
Implementing Agency:	United Nations Industrial Organisation (UNIDO)
Coordinating Agency:	Federal Environmental Protection Agency (FEPA).

PROJECT SUMMARY

This project has been designed to phase out 100% of the use of CFC-11 as blowing agent and CFC-12 as refrigerant agent from the production programme of commercial refrigerators,freezers and bottle coolers at the factory of **A.G.Leventis Plc.Ibadan, Nigeria.**

The chosen replacements is HFC 134a as refreigerant. 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 and the insulation foam blowing system for refrigerators, but will not yet phase out the HCFC 22 refrigerant (ODP=0.05) of the production of air conditioners.

BACKGROUND

Sector Background

SECTOR BACKGROUND

The subsector for domestic refrigerators and freezers in Nigeria is the main focus of the phase-out of ODS substances in the Refrigeration and Aircondition Sector. This is because HCFC-22, which is a transitional substance is the refrigerant commonly used now in airconditioners in Nigeria. The use of CFC-12 in this subsector has largely been discontinued. The domestic refrigerators and freezer subsector in the country consist of one large manufacturer, Thermocool Engineering Co. Ltd., two medium sized manufacturer, Debo Industries Ltd., and Kolinton Technical Industries Ltd. and several smaller manufacturers of which three of the companies namely Gacol, A.G Leventis Plc and Nigerian Engineering Works Ltd. belong. Major share of total ODP consumed in this sector in Nigeria is shared by the three leading companies, while the rest is shared by the smaller industries, including the three mentioned earlier.

CFCs are not produced in Nigeria. According to Nigerian import data, consumption of CFC-11 in the production of polyurethane foam in the refrigeration sector was about 208 MT in 1994. During the same year, CFC-12 consumption in the sector was 330 MT, out of which less than half was used to produce new appliances while, the major part was used for recharging existing appliances. The demand of ODS remained stagnant in 1995 with consumption patterns not far different from the 1994 levels. However, data collected for 1996 indicated an increase in the use of ODS in this subsector, geared by an upturn in economic activities in the country, which translated to higher number of domestically produced refrigerators and freezers. It has been estimated from preliminary data obtained from the leading companies that in 1996, 272 MT of CFC-11 was used in the production of polyurethane foam in the refrigeration sector in Nigeria, while about 436 MT of CFC-12 was used in producing new equipment as well as in recharging existing appliances.

In 1994, about 88,000 domestic refrigerators and freezers were produced in Nigeria while about 16,000 new refrigerators and freezers were imported. It has been estimated that about 15,000 used refrigerators were imported to Nigeria during the same period. Production and import figures for 1995 were not markedly different. However, due to the slight upturn of economic activities in 1996, about 119,859 domestic refrigerators and freezers were estimated to have been produced in Nigeria, representing a 35.6 % increase from 1994 levels. Importation of new and used appliances also rose but at a much lower rate during the same period.

Based on a 15 year life expectancy for these equipment, it has been estimated that a total of about 2.2 million refrigerators and freezers were in use in Nigeria by the end of 1996. Approximately 15% of this number will be annually recharged with about 176 MT of CFC-12 during refrigeration service. Due, partly to lack of equipment for the service sector, service staff often use CFC-12 for washing/flushing of cooling systems, instead of using vacuum pumps and charging boards. This causes in such cases, an up to 100% higher CFC-12 consumption in the service sector. Another part is loss by evaluation.

Counterpart's Background

A.G. Leventis Plc's freezer and refrigeration manufacturing facilities came into existence in 1968. Its ownership structure is made up of 57% Nigerian equity and 43% British equity. The company, at establishment commenced the manufacture of refrigerators, freezers, electric bottle coolers and air conditioners. More recently, the manufacturing facilities located in Ibadan, has been concentrating on the manufacture of commercial refrigerators for clients such as Nigerian Bottling Company Ltd., makers of Coca-Cola and other soft drinks. The company produces currently under license from Frigorex, Greece. It used to have a technical assistance with LEC, UK, but this agreement has expired.

The company employs in the factory 61 staff in the production of these appliances, and about 20 staff members in the service shop. The annual production of commercial refrigerators averaged 3,317, 4,217 and 5,759 units for 1994,1995 and 1996 respectively. The company plans to expand the number of units produced to 8,000 by the end of 1997. These units are currently produced in two assembly lines in one shift with a duration of 5 hours/shift and 5 working days per week. Management is planning to expand production to 60,000 units per annum by the year 2,000. Since the company does not produce for the consumer market but for special clients on contract, it does not have information on its approximate domestic market share. It is the plan of management to commence the export of its appliances to the facilities of its special clients like Coca-Cola by the year 1998, however according to information made available to us, this is contingent on converting to CFC-free system.

A.G. Leventis Plc produces the following commercial refrigerators and freezers:

CHEST FREEZERS

Model CF 181 with 171L
Model CF 281 with 250L
Model CF 381 with 239L
Model CF 481 with 446L
Model CF 40 with 113L

COMMERCIAL REFRIGERATORS

VISI Cooler model FV 280 with 272L
VISI Cooler model FV 400 with 371L
Frigolux Bottle Cooler model BC 40 with 113L
Frigolux Cold display units model R80 with 215L

In addition, A.G. Leventis Plc also manufactures
- window/split units Air-conditioners.

2.4.2 EXISTING PRODUCTION LINES IN THE REFRIGERATOR AND FREEZER SECTION:

The A.G. Leventis Plc factories consist of two production lines dedicated to the manufacture of commercial refrigerators and chest freezers and a line for the air-conditioners. The refrigerator and freezer lines consist of the following facilities:

(i) Refrigeration Factory

- Steel sheet processing line for refrigerator cabinet and door;
- Pre-treatment line;
- Painting line/spray booth with oven drying for net paint
- Sheet thermoforming line for refrigerator cabinet and door;
- Door gasket extrusion line;
- Pre-assembly lines for cabinets, doors and small items;
- foaming lines for refrigerator cabinet and doors;
- Assembly lines;
- Evacuation, charging, and testing line for refrigeration;
- Repair line;
- Testing line;
- Packing line;

(ii) FREEZER FACTORY

- Steel sheet processing line for chest freezer and lids;
- Painting line;
- Pre-assembly lines for chest freezer and chest lid;
- Foaming lines for chest freezer chest and chest lid;
- Assembly line;
- Evacuation, charging and testing line for chest freezers
- Repair line;
- Testing line;
- Packing line.

A.G. Leventis Plc uses standard polyurethane foam without CFC reduction with a density range of between 33-35 Kg/m^3. The two foaming machines Viking 19A were purchased (used) in 1993 from LEC Refrigerator UK. The foaming lines in the factory-separated into refrigerator and freezer factory consists of the following:

- 2 Pcs low pressure Viking foaming machines model 19A for refrigerator cabinets, doors, chest freezers and chest lid foaming.
- 1 Pc. pre-mixing unit, manual from Santaco
- 2 Pcs refrigerator cabinet foaming fixtures, manual with moulds in bell and bath positions
- 3 Pcs chest freezer Chest foaming fixtures with moulds in bell and bath positions
- 1 Pc universal door foaming jig
- 4 Pcs stationary door fixtures, manual
- 12 Pcs chest plugs
- 32 Pcs cabinet plugs
- 12 Pcs door moulds

The evacuation, charging and testing sections of refrigerator lines and of the chest freezer lines consist of the following equipment:

- 12 Pcs vacuum pumps from ULVAC
- 1 Pc automatic evacuation and charging board from Vitto Oil Machinery Co. Ltd, Tokyo, Japan.
- 2 Pcs. production electronic leak detector from CPs products Inc.

40% of the evaporators used in its manufacturing operations are manufactured locally, while the balance is imported from LEC Refrigeration Plc, UK, and Frigorex ABEE, Greece. The company performs different kinds of required quality control test on the refrigerant and foam driving propellant in its performance test laboratories. The company does not however have the capability for the chemical analyses of refrigerant and refrigeration oil. The performance test laboratory as it exist currently is not sufficiently equipped to make the performance tests for the converted models. To optimize the R134a cooling system, and to improve the quality, test equipment for such laboratory will be needed.

A.G.Leventis's Refrigeration Service

A.G. Leventis Plc. have a service shop equipped with a standard set of refrigeration service equipment (altogether 12 Evaluation and charging Board and few leak detectors). Presently, there is no CFC 12 recovery and reclaiming equipment or relevant expertise available in Nigeria.

A.G. Leventis Plc. services about 2000 to 5000 refrigerators and freezers per year.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of ODS such as CFC-11 and CFC-12 in the production of domestic refrigerators and freezers at A.G. Leventis Plc. through conversion to the use of HFC-134a as refrigerant for refrigerators and cyclopentane as blowing agent for the polyurethane isolation foam.

PROJECT DESCRIPTION

A.G. Leventis Plc. is prepared to phase out ODS in their refrigerators section as soon as the new technology has been acquired, the necessary machinery and equipment installed and their technical staff trained.

Among the technological options available, A.G. Leventis Plc. has chosen to replace CFC-12 by HFC-134a, since new compressprs are avaialbility the technology is matured and commercially applied.

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

Assistance, throught 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, trail operation and start-up, etc.

The refrigerator service centers of A.G. Leventis Plc. needs 1 recovery unit and 10 recovery bags for CFC-12 as well as 1 set of equipment (service evacuation and charging board and service leak detector) which will be used for servicing HFC134a refrigeration system.

The machinery and equipment listed below need to be reconstructed, replaced or upgraded:

A. Refrigeration System

- 1 production evacuation and charging boards on the refrigerator and freezer line have to be replaced by 1 new boards suitable for HFC 134a.

- 2 existing production leak detectors need to be replaced by 1 special leak detector for R134a

- 12 existing vacuum pumps cannot be re-used after the application of a special cleaning technology according to pump producers and need to be replaced by new pumps or renovated.

- 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. This implies that 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 a desiccant with 3AA pores or desiccant XH7 (Union Carbide).

- The cooling system must not contain any chlorine and maximum 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

- 1 new high pressure foaming machine to replace the only 2 low pressure PUR foaming machine that are close to each other so as to utilize the refrigerator cabinet and chest freezer lines;

- 1 new mixhead for 2 different sizes is needed, since low pressure mixheads with high consumption of ODS for cleaning can not be modified to high pressure mixheads; the costs for the necessary 2 spare mixheads will be borne by the counterpart's side;

- Retrofiting the manual pre-mixing machine from Santaco with an automatic premixer;

- Retrofiting the 2 PCs. refrigerator cabinet foaming fixtures and 3 PCs. chest freezer chest foaming fixtures, all manual with moulds in the bell and each positions will come nearly in the range of 3 new universal fixtures;

- The universal door foaming jig should be modified in a way that cyclopentane driven foam can be used by changing electrical components to ex-proof, adding exhaust etc;

- The 4 stationary door fixtures should be modified in a way that cyclopentane driven foam can be used by changing electrical components to ex-proof, adding exhausts, etc;

- The 32 PCs. cabinet wooden plugs, cannot be used for cyclopentane and need to be replaced by aluminimum plugs; The company produce 4 different commercial refrigerator models and cool box on this line; to avoid preassembly and assembly mistake they need to foam only one model at the same time on the line, that means 16 plugs; to reach a comparable cost effectiveness per phased out ODS only 8 plugs will be granted and the cost of the other set will be borne by the counterpart;

- The 12 PCs. chest freezer wooden plugs cannot be used for cyclopentane and need to be replaced by aluminimum plugs; A.G. Leventis Plc. produce at moment only 5 different freezer models on this line; to avoid preassembly and assembly mistake they need to foam only one model at the same time on the line, to reach a comparable cost effectiveness per phased out ODS only 1 universal and expandable plugs will be granted and the cost of the second one will be borne by the counterpart;

- The door moulds need to be modified to be used for cyclopentane to reach acomparable cost effective per phased-out ODS the cost for the modification be shared by the counterpart;

- The final specification of the cyclopentane to be used (purity and mix) will be defined after carrying out a market review in the country to assess its availability.

- 1 pre-mixing stations since cyclopentane and polyol cannot be delivered pre-mixed in drums or tanks (as in CFC-11);

- For safety at plant operation using the highly inflammable and explosive cyclopentane,

it is necessary to have gas detector systems as well as to establish a fire protection system;

- It is necessary to provide one storage tank for cyclopentane for the factory in the size sufficient for one standard tank container; the tank should be equipped with necessary piping and safety systems;

- Since the cyclopentane/polyol tank shouldd be pressurized by nitrogen during the foaming process, the factory should also be provided with a nitrogen generator and a network cost should be borne by the counterpart;

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

1. The c-pentane tank have to be placed underground and not less than 5m 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 department.

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 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 accumulation and discharge of static electricity.

C. Refrigeration Service

The refrigeration service is not considered in this project as this will be part of a recovery and recycling project at country level.

D. Justification for Selection of Alternative Technologies

All major manufacturers of compressors have accepted the use of HFC 134a as replacement for CFC-12 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,a nd 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

The following quipment of the factory line in the section needs to be changed and new equipment should be provided as specified below:-

A.1.	1 PCs.	Production evacuation and refrigerant HFC 134a charging boards with vacuum pump, refrigerant supply pump and vacuum check.
A.2		Vacuum Pumps;
A.3	2 pcs.	Production HFC 134a leak detectors;
A.4	1 set	Test equipment for model redesign;

B. Foam System

The following equipment needs to be changed or new equipment has to be provided as indicated below:-

B.1	1 pc.	New high pressure foaming machine for c-pentane to be utilized in the existing refrigerator cabinet and chest freezer lines;
B.2	1pc.	PUR filling places to fill the foaming machines from drums;

B.3	1 pc.	New high pressure mixheads (2 different sizes) because, the low pressure mixheads cannot be converted to high pressure mixheads;
B.4	1 pc.	Pre-mixing station for c-pentane and polyol;
B.5	2 pcs	Gas detector systems with control board;
B.6	1 set	Foam testing equipment;
B.7	2 set	Exhaust and ventilation system;
B.8		Encapsulation cabins to be provided by the counterpart;
B.9	1 pc.	New universal cabinet and chest fixtures in bath position suitable for cyclopentane;
B.10	1 pc.	Rebuilding of universal door fixture, replacing all the electrical components by ex-proof components, earthing etc.;
B.11	2 pc.	Rebuilding of door fixtures, replacing all the electrical components by ex-proof components, earthing etc.;
B.12	1 set	Ex-proof pipe installation from filling place to tank;
B.13	1 set	Ex-proof piping system from cyclopentane tank to pre-mixer;
B.14	1 set	Ex-proof piping system from pre-mixer to the polyol tank of PUR machines;
B.15		Antistatic floor cover;
B.16	1 set	Fire protection system;
B.17	1 pc.	Storage tank for cyclopentane with all necessary safety devices;
B.18	1 pc.	Nitrogen generator for the nitrogen network needed for the cyclopentane foaming machines, pre-mixing, foaming jigs and tanks;
B.19	1 set	Nitrogen net work to be provided by the counterpart;
B.20	1 pc.	Fixed plugs for refrigerator cabinet to be used for cyclopentane;
		To reach a comparable cost effectiveness per phased out ODS the costs for the necessary further 4 refrigerator cabinet plugs will be borne by the counterpart;
B.21	3 pc.	Universal and expandable chest freezer plugs to be used for cyclopentane;
		To reach a comparable cost effectiveness per phased out ODS the costs

for the necessary further chest freezer plugs will be borne by the counterpart;

B.22 3 pcs Modification of door moulds to be used for cyclopentane; to reach a comparable cost effectiveness per phased out ODS the cost for this modification should be taken over by the counterpart;

B.23 1 pc. Back-up power supply systems for ventilators;

It is important to note that the layout of the production equipment should be organised in such a way that the piping are short and SD valves for separation in sectors can be avoided.

C. Refrigeration Service

As stated earlier, the refrigeration service is not part of the conversion project rather it will be part of the recovery and recycling project for the whole country.

2. Conversion/Training

Within the framework of the project, personnel from the counterpart 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 current household refrigerators and freezers 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 partially included in the training component for technical staff, as well as in the international expert service component. The mayor part have to be covered by the counterpart.

As a common practice, necessary modifications of the production lines will be carried out during evenings and off-days and will, therefore, not cause too much losses in the regular production. In addition the installed capacity is not fully used, so that losses can be compensated in other periods of production.

PROJECT IMPLEMENTATION

The project implementation will be carried out according to the rules and procedures of UNIDO, under the management of the backstopping officer of UNIDO, in close cooperation with the Nigeria Federal Environmental Protection Agency (FEPA). Local coordination will be carried out by A.G. Leventis Plc. Nigeria, the counterpart.

Purchase of know-how is not considered in the project budget. However, to substaintively 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 prepared upon approval of the project.

The detailed Terms of Reference for the supplies and services to be provided under the project will elaborated after project approval and sent to FEPA and A.G. Leventis Plc. Nigeria After competitive bidding, performed according to UNIDO's financial rules and procedures, a general Contractor will be appointed by UNIDO for the implementation of the major project components (foaming system, refrigeration system, etc.). The General Contractor will be responsible for the supply of equipment, commissioning and on-the-job training of A.G. Leventis Plc's staff.

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

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

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

Having accepted the conversion of its plants to the use of non-ODS under this project, A.G. Leventis Nigeria Plc. 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 specification of these work will be elaborated by the General Contractor after project approval and necessary site inspection. Thus, the costs of construction work can be specified only after appointment of the General Contractor and finalization of the equipment list. The relevant construction work will have to be arranged by A.G. Leventis Nigeria Plc. under the supervision of the General Contractor and in line with the established milestones for this project;

- Technical staff a required by the General Contractor;

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

- Provision of materials, utilities, services, manpower, etc. related to commissioning,

start-up, trail runs, prototyping and testing;

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

- All other expenses not included in this Project Document and not covered by the budget approved by the Multilateral Fund for the Implementation of the Montreal Protocol.

UNIDO as Implementating 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 whole 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.

TENTATIVE PLAN

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

EEE

PROJECT COSTS

I. INCREMENTAL CAPITAL COST

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 COST

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

Modification	Incremental Cost (US$)
- HFC 134a compressor	3.50
- HFC 134a refrigerant	0.79
- Extra polyurethane foam because of higher density	0.84
Total	US$ 5,13

The above figures reflect the difference between relevant component price for CFC 11 and CFC 12 versus the component price for HFC 134a and cyclopentane.

All prices are without customs duty and tax.

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$ 29,544 (based on production of 5,759 units per year in the first year: 5,759 x US$5.13 = US$ 29,544).

It was agreed that the counterpart will apply for the incremental operating cost for 6 months = US$ 14,772.

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 COST

- Incremental investment cost, (Annex A: "Equipment, Specification and Cost Breakdown").
- The net incremental operating cost (as above).
- Executing agency's overhead cost (13%).
- 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$ 821,795.**

Annex A: Equipment Specification and Cost Breakdown

Description		Qty.	Unit Cost US$	US$
A.	**Refrigeration System:**			
	- Charging board for HFC 134a	1	25,000	25,000
	- Vacuum pumps (1 new + 3 retrofit)			4,480
	- Production leak detector for HFC 134a	2	5,500	11,000
	- Test equipment for model redesign	1 set	25,000	25,000
	Sub-total for group (A)			**65,480**
B.	**Foaming System:**			
	- High pressure foaming machines for refrigerator and chest freezer lines	1	140,000	140,000
	- Self cleaning mixheads	1	15,000	15,000
	- Premixing stations	1	70,000	70,000
	- Gas detector system	1	40,000	40,000
	- Exhaust and Ventilation	2set	32,000	64,000
	- Universal chest plugs and modification of fixtures			80,000
	- Pipe installation from tank to premixing stations	1	12,000	12,000
	- Pipe installation from foaming machines			20,000
	- Antistatic floor			4,500
	- Fire protection system	1set	20,000	20,000
	- Tank for cyclopentane	1	20,000	20,000
	- Nitrogen bank	1	25,000	25,000
	- Chiller	1	10,000	10,000
	Sub-total group (B)			**520,500**
TOTAL FOR GROUP A & B			US$	**585,980**

The cost of the following equipment and installation work is not included in the budget and is to be absorbed by A.G. Leventis Nig. Plc..

(a) Pre-heating ovens for foaming;

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

(c) Any inside and outside construction, nitrogen network and civil work for the installation of the cyclopentane tank and the premixing station;

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

(e) Any construction works like encapsulation cabins for the foam section;

(f) 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 A.G. Leventis Nigeria Plc's 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.

Annex B: Total Project Budget

Description		Duration (Man-Month)	Cost US$
(i)	Senior Technical Adviser	3	12,000
(ii)	International Refrigeration Specialist	6	48,000
(iii)	Sub-Contract		50,000
(iv)	Trial Materials		5,000
Sub-Total			115,000
Contigency 10%			11,500
Total			**126,500**

Project Investment cost = Total for Annex A + Total for Annex B = US$585,980 + US$126,500 = US$712,480..... 1

Incremental Operating Cost for Six Months = US$ 14,772 2

Implementing Agency's Overhead = 13% of (1 + 2) = (0.13) (712,480 + 14,772) = US$94,543.

Annex C: Unit Abatement Cost

A	ODS Phase-Out	Unit	Total Project
A1	Average use of CFC-11 per year	MT	8.3
A2	Average use of CFC-12 per year	MT	2.8
A3	Total CFC used	MT	11.1
A4	ODP of CFC-11 and CFC-12	MT	1.0
A5	ODP weighted CFC-11 and CFC-12	MT	11.1
A6	Total ODP weighted phased-out	MT	11.1
B	**Annualized Capital Cost**	**Unit**	**Total Project**
B1	Total Capital Cost	US$	126,500
B2	Equipment Life	Year	10
B3	Discount rate	%	10
B4	Annualized Capital Cost (B1 * 0.1627)	US$	20,582
C	**Annualized Incremental Cost**	**Unit**	**Total Project**
C1	Annualized Incremental Cost	US$	14,772
C2	Annualized Incremental Cost per kg ODP (C1/A6/1000)	US$/kg	1.33
D	**Unit Abatementt Cost**	**Unit**	**Total Project**
D1	Annualized Capital Cost per kg ODS phased-out (B4/A6/1000)	US$/kg	1.82
D2	Unit Abatement Cost	US$/kg	3.18
E	Project Cost Effectiveness (B1/A6/1000)	US$/kg	11.4

EEE

PROJECT COVER SHEET

Country/Region:	Nigeria
Project Title:	Investment Project for phasing out of CFC's at Nigeria Engineering Works (NEW) Ltd. Port Harcourt Rivers State, Nigeria.
Sector Covered:	Refrigeration (Rigid foams and Refrigerant) and Airconditioning. In Nigeria the total ODS consumption is 272MT of CFC-11 and 436MT of CFC-12MT this sector.
Project Impact:	Phase out of annual Consumption of 9.90MT of CFC-11 3.54MT of CFC-12 (Total ODP = 13.44MT).
Project Duration:	18 months
Project Economic life time:	10 years
Total Proposed Project Cost:	US$ 892,479
Project Investment:	US$ 763,000
Implementing Agency's Overheads:	US$ 101,524
Incremental Operating Cost:	US$ 17,955 (Six Months Operational Cost)
Proposed MF Financing:	US$ 892,479
Cost Effectiveness:	11.46 US$/kg.
Counterpart Enterprise:	Nigerian Engineering Works (NEW) Ltd. Nigeria.
Implementing Agency:	United Nations Industrial Organisation (UNIDO)
Coordinating Agency:	Federal Environmental Protection Agency (FEPA).

PROJECT SUMMARY

This project has been designed to phase out 100% of the CFC-11 as blowing agent and CFC-12 as refrigerant agent from the production programme of refrigerators and freezers at the factory of Nigerian Engineering Works (NEW) Port-Harcourt Nigeria.

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 will also include, redesigning 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, trail manufacturing and adaptation, as well as reliability tests.

The conversion of the production facilities covers the refrigeration system and the insulation foam blowing system for refrigerators. This project does not cover the phase-out of HCFC 22 (ODP=0.05) used as refrigerant in the production of air-conditioners.

BACKGROUND

Sector Background

The subsector for domestic refrigerators and freezers in Nigeria is the main focus of the phase-out of ODS substances in the Refrigeration and Aircondition Sector. This is because HCFC-22, which is a transitional substance is the refrigerant commonly used now in airconditioners in Nigeria. The use of CFC-12 in this subsector has largely been discontinued. The domestic refrigerators and freezer subsector in the country consist of one large manufacturer, Thermocool Engineering Co. Ltd., two medium sized manufacturer, Debo Industries Ltd., and Kolinton Technical Industries Ltd. and several smaller manufacturers of which three of the companies namely Gacol, A.G Leventis Plc and Nigerian Engineering Works Ltd. belong. Major share of total ODP consumed in this sector in Nigeria is shared by the three leading companies, while the rest is shared by the smaller industries, including the three mentioned earlier.

CFCs are not produced in Nigeria. According to Nigerian import data, consumption of CFC-11 in the production of polyurethane foam in the refrigeration sector was about 208 MT in 1994. During the same year, CFC-12 consumption in the sector was 330 MT, out of which less than half was used to produce new appliances while, the major part was used for recharging existing appliances. The demand of ODS remained stagnant in 1995 with consumption patterns not far different from the 1994 levels. However, data collected for 1996 indicated an increase in the use of ODS in this subsector, geared by an upturn in economic activities in the country, which translated to higher number of domestically produced refrigerators and freezers. It has been estimated from preliminary data obtained from the leading companies that in 1996, 272 MT of CFC-11 was used in the production of polyurethane foam in the refrigeration sector in Nigeria, while about 436 MT of CFC-12 was used in producing new equipment as well as in recharging existing appliances.

In 1994, abo 88,000 domestic refrigerators and freezers were produced in Nigeria while about 16,000 new refrigerators and freezers were imported. It has been estimated that about 15,000 used refrigerators were imported to Nigeria during the same period. Production and import figures for 1995 were not markedly different. However, due to the slight upturn of economic activities in 1996, about 119,85[illegible] lomestic refrigerators and freezers were estimated to have been produced in Nigeria, representing a 35.6 % increase from 1994 levels. Importation of new and used appliances also rose but at a much lower rate during the same period.

Based on a 15 year life expectancy for these equipment, it has been estimated that a total of about 2.2 million refrigerators and freezers were in use in Nigeria by the end of 1996. Approximately 15% of this numbe. will be annually recharged with about 176 MT of CFC-12 during refrigeration service. Due, partly to lack of equipment for the service sector, service staff often use CFC-12 for washing/flushing of cooling systems, instead of using vacuum pumps and charging boards. This causes in such cases, an up to 100% higher CFC-12 consumption in the service sector. Another part is loss by evaluation.

Counterpart's Background

Nigerian Engineering Works(NEW) Ltd. was established in 1966. The ownership of the Company comprises of the River State Government and Nigerian Industrial Development Bank (NIDB) controlling 60% of the company's shares, while the Birla Brothers, India controls the remaining 40% shares. The company operation is in the manufacture of domestic refrigerators, freezers and air-conditioners. The Company receives technical assistance for their production of refrigerators and freezers from Whirpool (Italy). The Company employs in the factory 20 staff in the production of appliances while 8 staff members work in the service shops. The annual production of refrigerator and freezers in the last three years averaged 3,200, 5,000 and 7,000 units for 1994, 1995, 1996 respectively. The total installed production capacity of the company is 12,000 units of household refrigerator and freezer per year produced in one shift. The company account for over 5% of the Nigerian household refrigerator production and shares about 3% of the market including imports of new and used refrigerators in 1995.
Nigerian Engineering Works Ltd. produces the following refrigerators and freezers.

ONE DOOR REFRIGERATORS

Model 200 with 170L refrigerator including freezer Component
Model 220 with 220L refrigerator including freezer Component
Model 220 [illegible]ith 270L refrigerator including freezer Component

TWO DOOR REFRIGERATOR

Model 410 with 410L refrigerator including freezer Component

CHEST FREEZERS

Model 270 with 270 Litres
Model 330 with 330 Litres
Model 410 with 410 Litres

In addition Nigerian Engineering Works Ltd. produces

- Air-Conditioners
- Car Air-conditioners
- Gas cookers
- Ceiling fan
- Flourescent fittings

2.2.2 EXISTING PRODUCTION LINE IN THE REFRIGERATOR AND FREEZER SECTION

The Nigerian Engineering Works (NEW) Limited factory consist of the following production lines in the refrigerator and freezer section. (equipment of the lines for airconditioners are not mentioned in this report because the conversion of HCFC-22 filled air conditioners is not a subject of this project)

(a) Refrigerator Factory

- Steel sheet processing lines for refrigerator cabinets and doors;
- Painting line;
- Pre-assembly lines for cabinets, doors and small items;
- foaming line for refrigerator cabinets and doors;
- Assembly line;
- Evacuation charging and testing lines for refrigerators,
- Repair line;
- Testing line;
- Packing line.

(b) Freezer factory

- Steel sheet processing lines for chest freezers and lids;
- Painting line;
- Pre-assembly line for chest freezers, lids and small items;
- foaming line for chest freezers chests and chest lids;
- Assembly line;
- Evacuation,Charging and testing lines for chest freezers;
- Repair line;
- Testing line;
- Packing line.

The company uses standard polyurethane foam without CFC reduction with a density in the range 24--35 Kg/m^3. Its foaming and refrigerator charging equipment are about 11 years old.

The foaming line in the factory consist of the following:

- 1 Pc low pressure OMS Impiante machine;
- Pre-mixing unit;
- 2 Pcs Refrigerator cabinet foaming fixture mounted in bell position;
- 1 Pc Chest freezer foaming fixture mounted in bell position;
- 3 Pcs universal foaming jigs;
- 2 Pcs Stationery door fixtures;
- 1 Pc Universal Chest plug;
- 2 Pcs cabinet plugs;
- 3 Pcs Universal door moulds.

In addition, the evacuation, charging and testing section of the refrigerator and chest freezer lines consist of the following equipment:

- 5 Pcs vacuum pumps from Edwards;

- 4 Pcs manual evacuation and chargingboards from Air serco and Ticino;

- 4 Pcs production electronic leak detectors from Robin Air.

The company has a performance test laboratory facilities, which is not sufficiently equipped to make the performance tests required for the converted models. To optimize the R134a cooling system and to improve quality, test equipment for such test laboratory will be needed.

NEW's Refrigeration Service

The company also have 3 service shops equipped with a standard set of refrigeration service equipment. There are 4 charging boards and 3 leak detectors. Apart from servicing equipment produced by it, the company also services equipment of other manufacturers. In 1996, of all equipment serviced, about 50% were manufactured by other companies.

Nigerian Engineering Works Ltd. services over 50 refrigerators and freezers in 1996.

PROJECT OBJECTIVE

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

PROJECT DESCRIPTION

NEW 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 presently available, NEW 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 PUF, 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 personel abroad and on-the-job training, trial operation and start-up, etc.

Each of the three refrigerator service centers of NEW needs 1 recovery unit and 10 recovery bags for CFC-12 as well as 1 set of equipment (service evacuation and charging board and service leak detector) which will be used for servicing HFC134a refrigeration system.

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

A. Refrigeration System

- 4Pcs. production evacuation and charging boards on the refrigerator and freezer line have to be replaced by 2 new charging board suitable for HFC 134a.

- 4Pcs. existing leak detectors need to be replaced by 2 special leak detectors for R134a.

- 5Pcs. existing vacuum pumps cannot be re-used after the application of a special cleaning technology according to pump producers and need to be replaced be new pumps or renovated.

- 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 a desicent with 3A pores or desiccant XH7 (Union Carbide).

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

- 1 Pc. new high pressure foaming machine to replace the 1Pc. low pressure PUR foaming machine;

- 1 pc. new mixhead for the foaming area is needed; the existing low pressure mix head with high consumption of ODS for cleaning cannot be modified to high pressure mixhead;

- Retrofiting of the 2 PCs, refrigerator cabinet foaming fixtures and 1Pc. chest freezer foaming fixture, all manual with moulds in the bell position will come nearly in the range of 2 new universal fixtures;

- The 3Pcs. universal door foaming jigs should be modified in a way that cyclopentane driven foam can be used by changing electrical components to ex-proof, adding exhaust etc;

- The 2Pcs. stationary door fixtures should be modified in a way that cyclopentane driven foam can be used by changing electrical components to ex-proof, adding exhaust;

- The 3PCs. door moulds should be modified to be used for cyclopentane;

- The final specification of the cyclopentane to be used (purity and mix) will be defined after carrying out a market review in the country to assess its availability.

- 2 pre-mixing stations since cyclopentane and polyol cannot be delivered pre-mixed in drums or tanks (unlike with CFC-11);

- For safety at plant operation using the highly inflammable and explosive cyclopentane, it is necessary to have gas detector systems as well as to establish a fire protection ystem;

- It is necessary to provide one storage tank for cyclopentane for the factory in the size sufficient for one standard tank container; the tank should be equipped with necessary piping and safety systems;

- Since Nitrogen is highly required in the factory for pressurizing the cyclopentane/polyol tanks and flushing of the cabinet and door cavities during foaming process; a nitrogen generator and supply network should be provided; the network cost should be borne by the counterpart.

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

1. The c-pentane tank have to be placed underground and not less than 5m 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 department.

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 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 accumulation and discharge of static electricity.

C. Refrigeration Service

The conversion of the refrigeration service is not considered in this project as this will be part of a recovery and recycling project at country level.

D. Justification for Selection of Alternative Technologies

All major manufacturers of compressors have accepted the use of HFC 134a as replacement for CFC-12 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

The following equipment of the factory line in this section needs to be changed and new equipment should be provided as specified below:-

A.1	2 PCs.	Production evacuation and refrigerant HFC 134a charging boards with vacuum pump, refrigerant supply pump and vacuum check.
A.2		Vacuum Pumps
A.3	2 pcs.	Production HFC 134a leak detectors
A.4	1 set	Test equipment for model redesign

B. Foam System

The following equipment needs to be changed or new equipment has to be provided as specified below:-

B.1	1 pc.	New high pressure foaming machine for c-pentane to replace the existing low pressure foaming machine.
B.2	1 pc.	PUR filling places to fill the foaming machines from drums.
B.3	1 pc.	New high pressure mix head because the low pressure mix-head cannot be converted to high pressure mix-head.
B.4	1 pc.	Pre-mixing station for c-pentane and polyol.
B.5	1 pc.	Gas detector system with control board.
B.6	1 set	Foam testing equipment.
B.7	1 set	Exhaust and ventilation system.
B.8		Encapsulation cabins to be provided by the counterpart.
B.9	2 pcs.	New universal cabinet and chest fixtures in bell position suitable for cyclopentane;

B.10	3 pcs.	Rebuilding of universal door fixture, replacing all the electrical components by ex-proof components, earthing etc.;
B.11	3 pcs.	Rebuilding of door fixtures, replacing all the electrical components by ex-proof components, earthing etc.;
B.12	1 set	Ex-proof pipe installation from filling place to tank;
B.13	2 set	Ex-proof piping system from cyclopentane tank to pre-mixers;
B.14	2 set	Ex-proof piping system from pre-mixer to the 2 polyol tanks of PUR machines;
B.15		Antistatic floor cover;
B.16	1 set	Fire protection system;
B.17	1 pc.	Storage tank for cyclopentane with all necessary safety devices;
B.18	1 pc.	Nitrogen generator for the nitrogen network needed for the cyclopentane foaming machines, pre-mixing, foaming jigs and tanks;
B.19	1 set	Nitrogen net work to be provided by the counterpart;
B.20	1 pc.	Back-up power supply systems for ventilators;

The layout of the production equipment should be organised in such a way that the piping are short and SD valves for separation in sectors can be avoided.

C. Refrigeration Service

The conversion of the refrigeration service is not considered in this project as this will be part of the recovery and recycling project for the whole country.

2. Conversion/Training

Within the framework of the project, personnel from the counterpart 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 current household refrigerators and freezers 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 partially included in the training component for technical staff, as well as in the international expert service component. The mayor part have to be covered by the counterpart.

As a common practice, necessary modifications of the production lines will be carried out during evenings and off-days and will, therefore, not cause too much losses in the regular production. In addition the installed capacity is not fully used, so that losses can be compensated in other periods of production.

PROJECT IMPLEMENTATION

The project implementation will be carried out according to the rules and procedures of UNIDO, under the management of the backstopping officer of UNIDO, in close cooperation with the Nigeria Federal Environmental Protection Agency (FEPA). Local coordination will be carried out by Nigerian Engineering Works Ltd., the counterpart.

Purchase of know-how is not considered in the project budget. However, to substaintively 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 prepared upon approval of the project.

The detailed Terms of Reference for the supplies and services to be provided under the project will elaborated after project approval and sent to FEPA and Nigerian Engineering Works Ltd. After competitive bidding, performed according to UNIDO's financial rules and procedures, a general Contractor will be appointed by UNIDO for the implementation of the major project components (foaming system, refrigeration system, etc.). The General Contractor will be responsible for the supply of equipment, commissioning and on-the-job training of Nigerian Engineering Works Ltd staff.

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

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

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

Having accepted the conversion of its plants to the use of non-ODS under this project, Nigerian Engineering Works Ltd. 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 specification of these work will be elaborated by the General Contractor after project approval and necessary site inspection. Thus, the costs of construction work can be specified only after appointment of the General Contractor and finalization of the equipment list. The relevant construction work will have to be arranged by Nigerian Engineering Works Ltd. under the supervision of the General Contractor and in line with the established milestones for this project;

- Technical staff a required by the General Contractor;

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

- Provision of materials, utilities, services, manpower, etc. related to commissioning, start-up, trail runs, prototyping and testing;

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

- All other expenses not included in this Project Document and not covered by the budget approved by the Multilateral Fund for the Implementation of the Montreal Protocol.

UNIDO as Implementating 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 whole 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.

TENTATIVE PLAN

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

PROJECT COSTS

I. INCREMENTAL CAPITAL COST

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) in included in the cost of equipment.

II. INCREMENTAL OPERATING COST

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

Modification	Incremental Cost (US$)
- HFC 134a compressor	3.50
- HFC 134a refrigerant	0.79
- Extra polyurethane foam because of higher density	0.84
Total	US$ 5,13

The above figures reflect the difference between relevant component price for CFC 11 and CFC 12 versus the component price for HFC 134a and cyclopentane.

All prices are without customs duty and tax.

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

In this respect, the total incremental operating cost increase for one year will be US$ 35,910 (based on production of 7,000 units per year in the first year: 5.13 x 7,000 = US$ 35,910).

It was agreed that the counterpart will apply for the incremental operating cost for 6 months = US$ 17,955.

III. CONTINGENCY FUND

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

IV TOTAL COST

- Incremental investment cost, (Annex A: "Equipment, Specification and Cost Breakdown").
- The net incremental operating cost (as above).
- Executing agency's overhead cost (13%).
- 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 $ 892,479.**

Annex A: Equipment Specification and Cost Breakdown

Description		Qty.	Unit Cost US$	US$
A.	**Refrigeration System:**			
	- Charging board for HFC 134a	2	25,000	50,000
	- Vacuum pumps (1 new + 3 retrofit)			4,480
	- Production leak detector for HFC 134a	2	5,000	11,000
	- Test equipment for model redesign	1 set	25,000	25,000
	Sub-total for group (A)			**90,480**
B.	**Foaming System:**			
	- High pressure foaming machines for refrigerator factory and chest freezer factory	1	140,000	140,000
	- Self cleaning mixhead	1	15,000	15,000
	- Premixing stations	1	70,000	70,000
	- Gas detector system	2	40,000	40,000
	- Exhaust and Ventilation	2set	32,000	64,000
	- Universal chest plugs and modification of fixtures		80,000	80,000
	- Pipe installation from tank to premixing stations	1	12,000	12,000
	- Pipe installation from foaming machines			20,000
	- Antistatic floor			3,000
	- Fire protection system	1 set	20,000	20,000
	- Tank for cyclopentane	1	20,000	20,000
	- Nitrogen bank	1	25,000	25,000
	- Chiller	1	10,000	10,000
	Sub-total group (B)			**519,000**
TOTAL for A & B			US$	**609,000**

The cost of the following equipment and installation work is not included in the budget and is to be absorbed by Nigerian Engineering Works:

(a) Pre-heating ovens for foaming;

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

(c) Any inside and outside construction, nitrogen network and civil work for the installation of the cyclopentane tank and the premixing station;

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

(e) Any construction works like encapsulation cabins for the foam section;

(f) 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 Nigerian Engineering Works Ltd. supply, services and their responsibilities related to the plant conversion will also specified in the terms of reference(s) for provision of equipment and services by UNIDO and in the work plan of the project execution.

Annex B: Total Project Budget

Description		**Duration (Man-Month)**	**Cost US$**
(i)	Senior Technical Adviser	4	16,000
(ii)	International Refrigeration Specialist	8	64,000
(iii)	Sub-Contract		50,000
(iv)	Trial Materials		10,000
Sub-Total			140,000
Contigency 10%			14,000
	Total		**154,000**

Project Investment cost = Total for Annex A + Total for Annex B = 609,000 + 154,000 = US$763,000..... 1

Incremental Operating Cost for Six Months = US$ 17,955..... 2

Implementing Agency's Overhead = 13% of (1 + 2) =(0.13) (763,000 + 17,955) = US$101,524

Annex C: Unit Abatement Cost

A	ODS Phase-Out	Unit	Total Project
A1	Average use of CFC-11 per year	MT	9.9
A2	Average use of CFC-12 per year	MT	3.54
A3	Total CFC used	MT	13.44
A4	ODP of CFC-11 and CFC-12	MT	1.0
A5	ODP weighted CFC-11 and CFC-12	MT	13.44
A6	Total ODP weighted phased-out	MT	13.44
B	**Annualized Capital Cost**	**Unit**	**Total Project**
B1	Total Capital Cost	US$	154,000
B2	Equipment Life	Year	10
B3	Discount rate	%	10
B4	Annualized Capital Cost (B1 * 0.1627)	US$	25,056
C	**Annualized Incremental Cost**	**Unit**	**Total Project**
C1	Annualized Incremental Cost (for six months)	US$	17,955
C2	Annualized Incremental Cost per kg ODP (C1/A6/1000)	US$/kg	1.34
D	**Unit Abatement Cost**	**Unit**	**Total Project**
D1	Annualized Capital Cost per kg ODS phased-out (B4/A6/1000)	US$/kg	1.86
D2	Unit Abatement Cost	US$/kg	3.20
E	Project Cost Effectiveness (B1/A6/1000)	US$/kg	11.46

PROJECT COVER SHEET

Country/Region:	Nigeria
Project Title:	Investment Project for phasing out of CFC's at Kolinton Technical Industries Ltd., Lagos State, Nigeria.
Sector Covered:	Refrigeration (Rigid foams and Refrigerant) and Airconditioning. In Nigeria the total ODS consumption is 272MT of CFC-11 and 436MT of CFC-12MT this sector.
Project Impact:	Phase out of annual Consumption of 28.8 MT of CFC-11, 9.6 MT of CFC-12 (Total ODP = 38.4 MT).
Project Duration:	18 months
Project Economic life time:	10 years
Total Proposed Project Cost:	US$ 1,149,549
Project Investment:	US$ 966,000
Implementing Agency's Overheads:	US$ 132,249
Incremental Operating Cost:	US$ 51,300
Proposed MF Financing:	US$ 1,149,549
Cost Effectiveness:	9.45 US$/kg
Counterpart Enterprise:	Kolinton Technical Industries Ltd.,Nigeria.
Implementing Agency:	United Nations Industrial Organisation (UNIDO)
Coordinating Agency:	Federal Environmental Protection Agency (FEPA).

PROJECT SUMMARY

This project has been designed to phase out 100% of the use of CFC-11 as blowing agent and CFC-12 as refrigerant agent from the production programme of refrigerators and freezers at the factory of Kolinton Technical Industries Ltd., Nigeria.

The chosen replacements for the foam blowing agent and refrigerant are cyclopentane and HFC 134a respectively. 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 and the insulation foam blowing system for refrigerators, but will not yet phase out the HCFC 22 refrigerant (ODP=0.05) for the production of air conditioners.

BACKGROUND

Sector Background

The subsector for domestic refrigerators and freezers in Nigeria is the main focus of the phase-out of ODS substances in the Refrigeration and Aircondition Sector. This is because HCFC-22, which is a transitional substance is the refrigerant commonly used now in airconditioners in Nigeria. The use of CFC-12 in this subsector has largely been discontinued. The domestic refrigerators and freezer subsector in the country consist of one large manufacturer, Thermocool Engineering Co. Ltd., two medium sized manufacturer, Debo Industries Ltd., and Kolinton Technical Industries Ltd. and several smaller manufacturers of which three of the companies namely Gacol, A.G Leventis Plc and Nigerian Engineering Works Ltd. belong. Major share of total ODP consumed in this sector in Nigeria is shared by the three leading companies, while the rest is shared by the smaller industries, including the three mentioned earlier.

CFCs are not produced in Nigeria. According to Nigerian import data, consumption of CFC-11 in the production of polyurethane foam in the refrigeration sector was about 208 MT in 1994. During the same year, CFC-12 consumption in the sector was 330 MT, out of which less than half was used to produce new appliances while, the major part was used for recharging existing appliances. The demand of ODS remained stagnant in 1995 with consumption patterns not far different from the 1994 levels. However, data collected for 1996 indicated an increase in the use of ODS in this subsector, geared by an upturn in economic activities in the country, which translated to higher number of domestically produced refrigerators and freezers. It has been estimated from preliminary data obtained from the leading companies that in 1996, 272 MT of CFC-11 was used in the production of polyurethane foam in the refrigeration sector in Nigeria, while about 436 MT of CFC-12 was used in producing new equipment as well as in recharging existing appliances.

In 1994, about 88,000 domestic refrigerators and freezers were produced in Nigeria while about 16,000 new refrigerators and freezers were imported. It has been estimated that about 15,000 used refrigerators were imported to Nigeria during the same period. Production and import figures for 1995 were not markedly different. However, due to the slight upturn of economic activities in 1996, about 119,859 domestic refrigerators and freezers were estimated to have been produced in Nigeria, representing a 35.6 % increase from 1994 levels. Importation of new and used appliances also rose but at a much lower rate during the same period.

Based on a 15 year life expectancy for these equipment, it has been estimated that a total of about 2.2 million refrigerators and freezers were in use in Nigeria by the end of 1996. Approximately 15% of this number will be annually recharged with about 176 MT of CFC-12 during refrigeration service. Due, partly to lack of equipment for the service sector, service staff often use CFC-12 for washing/flushing of cooling systems, instead of using vacuum pumps and charging boards. This causes in such cases, an up to 100% higher CFC-12 consumption in the service sector. Another part is loss by evaluation.

Counterpart's Background

Kolinton Technical Industries Ltd was established in 1968. It is a 100% Nigerian owned private company operating in the manufacture and sales of domestic refrigerators and freezers. The Company receives technical assistance for their production of refrigerators and freezers from Siltal (Italy I.A.R)

The company employs in the factory 200 staff in the production of appliances while 50 staff members work in the service shops. The annual production of refrigerators and freezers in the last three years averaged 11,500, 15,000 and 20,000 units for 1994, 1995, and 1996 respectively. The total installed production capacity of the company is 105,000 units of household refrigerator and freezer units per year produced in three shifts. The company covers over 15% of the Nigerian household refrigerator production and shares more than 9.0% of the market including imports of new and used refrigerators in 1995

Kolinton Technical Industries Ltd produces the following refrigerators and freezers:

ONE DOOR REFRIGERATORS
Model 220 with 220L refrigerator including freezer compartment.

TWO DOOR REFRIGERATORS
Model 240 with 240L refrigerator including freezer compartment

CHEST FREEZERS
Model 180 with 180 litres
Model 280 with 280 litres
Model 380 with 380 litres
Model 480 with 480 litres

In addition Kolinton Technical Industries Ltd. produces:

- Air-conditioners (window and split)

- Gas cookers
- Electrical fans

2.1.2 EXISTING PRODUCTION LINES IN THE REFRIGERATOR AND FREEZER SECTION:

Kolinton Technical Industries Ltd's factory consist of the following production lines in the refrigerator and freezer section (the equipment of the lines for air-conditioners are not mentioned in this report because the conversion of HCFC-22 filled air conditioners is not a subject of this project)

(a) Refrigerator Factory

- Steel sheet processing lines for refrigerator cabinets and doors;
- Painting line;
- Plastic injection moulding machine;
- Plastic sheet thermoforming line for refrigerator cabinets and doors;
- Door gasket extrusion line;
- Pre-assembly line for cabinets; doors and small items;
- Foaming line for refrigerator cabinets and doors;
- Assembly lines;
- Evacuation, charging and testing line for refrigerators;
- Repair line;
- Testing line;
- Packing line.

(b) Freezer Factory

- Steel sheet processing line for chest freezer and lids;
- Painting line;
- Pre-assembly line for chest freezer, chest and chest lids;
- Foaming line for chest freezer, chest and chest lids;
- Assembly line;

- Evacuation, charging and testing line for chest freezer;
- Repair line;
- Testing line;
- Packing line.

The company uses standard polyurethane foam without CFC reduction with a density in the range 32-35 kg/m^3. Its foaming and refrigerator charging equipment are about 17 years old. The foaming lines in the factories consist of separate lines for the refrigerator and freezer lines and consist of:

- 2 Pcs low pressure Cannon foaming machines for refrigerator cabinets, doors, chest freezers and chest lid foaming;
- 4 Pcs refrigerator cabinet foaming fixtures;
- 7 Pcs chest freezer chest foaming fixtures, automatic with moulds in bath position;
- 1 Pc universal door foaming jig;
- 2 stationary door fixtures;
- 7 Pcs chest plugs in bath position;
- 10 Pcs cabinet plugs in bath position;
- 7 Pcs door moulds.

The evacuation, charging and testing sections of the refrigerator and chest freezer lines consist of the following equipment:

- 12 Pcs vacuum pumps from Edwards;
- 2 Pcs automatic evacuation and charging board from Edwards;
- 1 Pc production electronic leak detection equipment.

The company has a performance test laboratory facilities, which is not sufficiently equipped to make the performance tests required for the converted models. To optimize the R134a cooling system and to improve quality, test equipment for such test laboratory will be needed.

Kolinton's Refrigeration Service

The company also have 2 service shops equipped with a standard set of refrigeration service equipment. There are 4 charging board and few leak detectors. Apart from servicing equipment produced by it, the company also services equipment of other manufacturers. In 1996, of all equipment serviced, about 40% were manufactured by other companies in Nigeria.

Kolinton Technical Industries Ltd. services about 6000 refrigerators and freezers in 1996.

PROJECT OBJECTIVE

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

PROJECT DESCRIPTION

Kolinton Technical Industries Ltd. is ready to phase out ODS in their refrigerators and freezers production immediately the new technology has been acquired; the necessary machinery and equipment installed and their technical staff trained.

Presently, there are many technological options available but Kolinton Technical Industries Ltd. has chosen to replace CFC-12 by HFC-134a, because of the avaialbility of new compressors and the fact that the technology is matured and commercially applied.

As for the replacement of CFC-11 as blowing agent for PUF, the company has decided to avoid the application of any transitional substance and to introduce cyclopentane which is the ultimate solution.

Kolinton Technical through this project is seeking assistance, 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 2 refrigerator service centers of Kolinton Technical Industries needs 1 recovery unit and 10 recovery bags for CFC-12 as well as 1 set of equipment (service evacuation and charging board and service leak detector) which will be used for servicing HFC 134a refrigeration system.

The following machinery and equipment listed below need to be reconstructed, replaced or upgraded:

A. Refrigeration System

- 2 production evacuation and 4 charging boards on the 2 refrigerator and freezer lines have to be replaced by 2 new boards suitable for HFC 134a.

- 2 existing production leak detectors need to be replaced by 1 special leak detector for R134a

- 12 existing vacuum pumps cannot be re-used after the application of a special cleaning technology according to pump producers and need to be replaced by new pumps or renovated.

- 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. This implies that 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 a desiccant with 3AA pores or desiccant XH7 (Union Carbide).

- The cooling system must not contain any chlorine and maximum 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

- 1 new high pressure foaming machine to replace the 2 low pressure PUR foaming machine (one for refrigerant and door lines and 1 on the chest freezer chest and lid lines closer to each other) thereby maintaining the existing foaming area;

- 1 new mixhead for 2 different foaming places in 2 different sizes is needed; low pressure mixheads with high consumption of ODS for cleaning cannot be modified to high pressure mixheads;

- Retrofiting of the 4 PCs, refrigerator cabinet foaming fixtures and 7 PCs of chest

freezer foaming fixtures, all automatic with moulds in the bath position will come nearly in the range of 5 new universal fixtures.

- The 2 PCs universal door foaming jig should be modified in a way that cyclopentane driven foam can be used by changing electrical components to ex-proof, adding exhaust etc;

- The 2 PCs. stationary door fixtures should be modified in a way that cyclopentane driven foam can be used by changing electrical components to ex-proof, adding exhaust;

- The 10 PCs. cabinet wooden plugs, cannot be used for cyclopentane and need to be replaced by aluminimum plugs; Kolinton Technical Industries Nig. Ltd. produce 2 different refrigerator models on this line; to avoid preassembly and assembly mistake they need to foam only one model at the same time on the line, that means 6 plugs; to reach a comparable cost effectiveness per phased out ODS only 3 plugs will be granted and the cost of the second set (further 3 plugs) will be borne by the counterpart;

- The 7 PCs. chest freezer wooden plugs cannot be used for cyclopentane and need to be replaced by aluminimum plugs; Kolinton Technical Industries Nig. Ltd. produce at moment only 4 different freezer models and the cool box on this line; to avoid preassembly and assembly mistake they need to foam only one model at the same time on the line, to reach a comparable cost effectiveness per phased out ODS, 2 universal and expandable plugs will be granted and the cost of the ramaining two plugs will be borne by the counterpart;

- The 7 PCs door moulds need to be modified in order to be used for cyclopentane. For effective cost per phased-out ODS, it is advisable that the cost for the modification be shared by the counterpart;

- The final specification of the cyclopentane to be used (purity and mix) will be defined after carrying out a market review in the country to assess its availability.

- 1 pre-mixing station since cyclopentane and polyol cannot be delivered pre-mixed in drums or tanks (unlike with CFC-11)

- For safety at plant operation using the highly inflammable and explosive cyclopentane, it is necessary to have gas detector systems as well as to establish a fire protection system;

- It is necessary to provide one storage tank of cyclopentane for the factory in the size sufficient for one standard tank container; the tank should be equipped with necessary piping and safety systems;

- Since Nitrogen is highly required in the factory for pressurizing the cyclopentane/polyol tanks and flushing of the cabinet including the door cavities during foaming process; a nitrogen generator and supply network should be provided;

the network cost should be borne by the counterpart.

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

1. The c-pentane tank have to be placed underground and not less than 5m 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 department.

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 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 accumulation and discharge of static electricity.

C. Refrigeration Service

The refrigeration service is not considered for conversion since it is not part of this particular project but will be considered during the recovery and recycling project at country level.

D. Justification for Selection of Alternative Technologies

All major manufacturers of compressors have accepted the use of HFC 134a as replacement for CFC-12 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

The equipment listed below for the 2 factory lines in the refrigeration section needs to be changed and replaced with equipment as specified below:-

A.1	2 PCs.	Production evacuation and refrigerant HFC 134a charging boards with vacuum pump, refrigerant supply pump and vacuum check.
A.2		Vacuum Pumps;
A.3	1 pcs.	Production HFC 134a leak detectors;
A.4	1 set	Test equipment for model redesign;

B. Foam System

The following equipment needs to be changed/replaced or new equipment has to be provided as indicated below:-

B.1	1 pc.	New high pressure foaming machine for c-pentane, this foaming machiine will serve both the refrigerator cabinet and the chest freezer line to replace the existing 2 low pressure foaming machines.
B.2	1pc.	PUR filling places for the filling of the foaming machines from drums;
B.3	1 pcs.	New high pressure mixhead because the low pressure mixheads cannot be converted to high pressure mixheads;
B.4	1 pc.	Pre-mixing station for c-pentane and polyol;
B.5	1 pc.	Gas detector systems with control board;
B.6	1 set	foam testing equipment;
B.7	2 sets	Exhaust and ventilation system;
B.8		Encapsulation cabins to be provided by the counterpart;
B.9	1 pc.	New universal cabinet and chest fixtures in bath position suitable for cyclopentane;

B.10	1 pc.	Rebuilding of universal door fixture, replacing all the electrical components by ex-proof components, earthing etc.;
B.11	2 pcs.	Rebuilding of door fixtures, replacing all the electrical components by ex-proof components, earthing etc.;
B.12	1 set	Ex-proof pipe installation from filling place to tank;
B.13	1 set	Ex-proof piping system from cyclopentane tank to pre-mixer;
B.14	1 set	Ex-proof piping system from pre-mixer to the polyol tank of PUR machine;
B.15		Antistatic floor cover;
B.16	1 set	Fire protection system;
B.17	1 pc.	Storage tank for cyclopentane with all necessary safety devices;
B.18	1 pc.	Nitrogen generator for the nitrogen network needed for the cyclopentane foaming machine, pre-mixing, foaming jigs and tanks;
B.19	1 set	Nitrogen network to be provided by the counterpart;
B.20	3 pcs.	Fixed plugs for refrigerator cabinet to be used for cyclopentane; To reach a comparable cost effectiveness per phased out of ODS, the costs for the necessary further 3 refrigerator cabinet plugs will be borne by the counterpart;
B.21	2 pcs.	Universal and expandable chest freezer plugs to be used for cyclopentane; To reach a comparable cost effectiveness per phased out ODS the costs for the necessary further chest freezer plugs will be borne by the counterpart;
B.22	7 pcs.	Modification of door moulds to be used for cyclopentane; to reach a comparable cost effectiveness per phased out ODS the cost for this modification should be taken over by the counterpart;
B.23	1 pc.	Back-up power supply systems for ventilators;

It is important to note that the layout of the production equipment should be organised in such a way that the piping are short and SD valves for separation in sectors avoided.

C. Refrigeration Service

As stated earlier, the refrigeration service is not part of the conversion project rather it will be part of the recovery and recycling project for the whole country.

2. Conversion/Training

Within the framework of the project, personnel from the counterpart 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 current household refrigerators and freezers 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 partially included in the training component for technical staff, as well as in the international expert service component. The major part have to be covered by the counterpart.

As a common practice, necessary modifications of the production lines will be carried out during evenings and off-days and will, therefore, not cause too much losses in the regular production. In addition the installed capacity is not fully used, so that losses can be compensated in other periods of production.

PROJECT IMPLEMENTATION

The project implementation will be carried out according to the rules and procedures of UNIDO, under the management of the backstopping officer of UNIDO, in close cooperation with the Nigeria Federal Environmental Protection Agency (FEPA). Local coordination will be carried out by Kolinton Technical Industries Nigeria, the counterpart.

Purchase of know-how is not considered in the project budget. However, to substaintively 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 prepared upon approval of the project.

The detailed Terms of Reference for the supplies and services to be provided under the project will be elaborated after project approval. This will be sent to FEPA and Kolinton Technical Industries Nigeria After competitive bidding, performed according to UNIDO's financial rules and procedures, a general Contractor will be appointed by UNIDO for the implementation of the major project components (foaming system, refrigeration system, etc.). The General Contractor will be responsible for the supply of equipment, commissioning and on-the-job training of Kolinton Technical Industries Ltd. staff.

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

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

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

Having accepted the conversion of its plants to the use of non-ODS under this project, Kolinton Technical Industries Nigeria Ltd. 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 specification of these work will be elaborated by the General Contractor after project approval and necessary site inspection. Thus, the costs of construction work can be specified only after appointment of the General Contractor and finalization of the equipment list. The relevant construction work will have to be arranged by Kolinton Technical Industries Nigeria Ltd. under the supervision of the General Contractor and in line with the established milestones for this project;

- Technical staff required by the General Contractor;

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

- Provision of materials, utilities, services, manpower, etc. related to commissioning, start-up, trial runs, prototyping and testing;

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

- All other expenses not included in this Project Document and not covered by the budget approved by the Multilateral Fund for the Implementation of the Montreal Protocol.

UNIDO as Implementating Agency has the necessary experience and capabilities for the successful implementation of this project at enterprise level. Upon approval of the project by the MFMP the whole 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.

TENTATIVE PLAN

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

EEE

PROJECT COSTS

I. INCREMENTAL CAPITAL COST

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 COST

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

Modification	Incremental Cost (US$)
- HFC 134a compressor	3.50
- HFC 134a refrigerant	0.79
- Extra polyurethane foam because of higher density	0.84
Total	US$ 5.13

The above figures reflect the difference between relevant component price for CFC 11 and CFC 12 versus the component price for HFC 134a and cyclopentane.

All prices are without customs duty and tax.

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 is to be absorbed by the company.

In this respect, the total incremental operating cost increase for one year will be US$ 538,650 (based on production of 20,000 units per year in the first year: 20,000 x US$5.13 = US$ 102,600).

It was agreed that the counterpart will apply for the incremental operating cost for 6 months = US$ 51,300.

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 COST

- Incremental investment cost, (Annex A: "Equipment, Specification and Cost Breakdown").
- The net incremental operating cost (as above).
- Executing agency's overhead cost (13%).
- 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$1,149,549**

Annex A: Equipment Specification and Cost Breakdown

Description		Qty.	Unit Cost US$	US$
A.	**Refrigeration System:**			
	- Charging board for HFC 134a	2	25,000	50,000
	- Vacuum pumps (1 new + 3 retrofit)			4,480
	- Production leak detector for HFC 134a	1 set	5,500	5,500
	- Test equipment for model redesign		25,000	25,000
	Sub-total for group (A)			**84,980**
0B.	**Foaming System:**			
	- High pressure foaming machines for refrigerator factory and chest freezer factory	1	140,000	140,000
	- Self cleaning mixhead	1	15,000	15,000
	- Premixing stations	1	70,000	70,000
	- Gas detector system	1	40,000	40,000
	- Exhaust and Ventilation	2sets	32,000	64,000
	- Universal chest plugs and modification of fixtures			80,000
	- Pipe installation from tank to premixing stations	1	12,000	12,000
	- Pipe installation from foaming machines			20,000
	- Antistatic floor			3,000
	- Fire protection system	1 set	20,000	20,000
	- Tank for cyclopentane	1	20,000	20,000
	- Nitrogen bank	1	25,000	25,000
	- Chiller	1	10,000	10,000
	Sub-total group (B)			**519,000**
TOTAL FOR A AND B			US$	**603,980**

The cost of the following equipment and installation work is not included in the budget and is to be absorbed by Kolinton Technical Industries Ltd.

(a) Pre-heating ovens for foaming;

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

(c) Any inside and outside construction, nitrogen network and civil work for the installation of the cyclopentane tank and the premixing station;

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

(e) Any construction works like encapsulation cabins for the foam section;

(f) 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 Kolinton 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.

Annex B: Total Project Budget

Description		**Duration (Man-Month)**	**Cost US$**
(i)	Senior Technical Adviser	6	24,000
(ii)	International Refrigeration Specialist	12	96,000
(iii)	Sub-contract		200,000
(iv)	Trial Materials		10,000
Sub-Total			330,000
Contigency 10%			33,000
Total			**363,000**

Project Investment cost = Total for Annex A + Total for Annex B = 603,980 + 363,000 = US$966,000..... 1

Incremental Operating Cost for Six Months = US$ 51,300 2

Implementing Agency's Overhead = 13% of (1 + 2) = (0.13) (966,000 + 51,300) = US$132,249

Annex C: Unit Abatement Cost

A	ODS Phase-Out	Unit	Total Project
A1	Average use of CFC-11 per year	MT	28.8
A2	Average use of CFC-12 per year	MT	9.6
A3	Total CFC used	MT	38.4
A4	ODP of CFC-11 and CFC-12	MT	1.0
A5	ODP weighted CFC-11 and CFC-12	MT	38.4
A6	Total ODP weighted phased-out	MT	38.4
B	**Annualized Capital Cost**	**Unit**	**Total Project**
B1	Total Capital Cost	US$	363,000
B2	Equipment Life	Year	10
B3	Discount rate	%	10
B4	Annualized Capital Cost (B1 * 0.1627)	US$	59,060
C	**Annualized Incremental Cost**	**Unit**	**Total Project**
C1	Annualized Incremental Cost	US$	51.300
C2	Annualized Incremental Cost per kg ODP (C1/A6/1000)	US$/kg	7.9
D	**Unit Abatementt Cost**	**Unit**	**Total Project**
D1	Annualized Capital Cost per kg ODS phased-out (B4/A6/1000)	US$/kg	1.53
D2	Unit Abatement Cost	US$/kg	9.43
E	Project Cost Effectiveness (B1/A6/1000)	US$/kg	9.45