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PROJECT COVER SHEET

Country :	ALGERIA
Project Title :	Phasing out CFC-11 at LA MOUSSE DU SUD flexible polyurethane Foam plant.
Sectors Covered :	Flexible Polyurethane Foam Slabstock
ODS Use in Sector (1996) :	400 MT of CFC-11
Project Impact :	Phase-out of annual consumption of 85 MT CFC-11 in the production of flexible slabstock foams
Project Duration :	12 months
Project Economic Life :	10 years
Export to non-Article 5 countries :	Nil
Foreign ownership :	Nil
Incremental Operating Cost :	Not considered
Total Project Cost :	US$ 389,500
Implementing Agency's Support Cost (13%) :	US$ 50,635
Proposed MF Financing :	US$ 440,135
Cost Effectiveness :	4.58 US$/kg
Counterpart Enterprise :	Foam Industries Company
Implementing Enterprise	United Nations Industrial Development Organization (UNIDO)
Coordinating Ministry :	Ministère de l'Intérieur, des Collectivités Locales, et de l'Environnement.

PROJECT SUMMARY

This project will phase-out 100% of CFC-11 from the production of flexible slabstock foams used for the production of foam filled mattresses and furniture at LA MOUSSE DU SUD. The chosen replacement alternative are liquefied carbon dioxide (LCD) a method of blowing low density foam utilising liquid carbon dioxide as a blowing agent for flexible slabstock foams. The project will be implanted through modification of existing facilities and installation of supplementary equipment and instruments.

I. BACKGROUND

A. SECTOR BACKGROUND

Small and medium scale companies are included by the Government of ALGERIA in the country programme for conversion from CFC-11 to non ODS agent.

The sub-sector for flexible foams in ALGERIA consists of about 40 manufacturers who are responsible for the ODS consumption of CFC-11 in the sector of flexible polyurethane manufacturing. The primary product, flexible polyurethane foam, is consumed mainly in the home market. The product is mainly used in the production of soft furniture, upholstery, mattresses and the clothing industry.

ALGERIA does not produce any CFC-11 used in the flexible foam sector and hence ODS is imported from the European community and INDIA. In 1996, the total consumption was about 400 MT of ODS. Primary chemical companies importing polyurethane chemicals to ALGERIA for the flexible foam market are : Dow Chemicals - Switzerland, Bayer Ag - Germany, Basf - Germany, Rhone-Poulenc - France, Arco Chemicals - France, Air Products - Germany, EMSA - Spain, Ausimont - Italy, ICI - United Kingdom.

The total installed production capacity for flexible slabstock foam in the country is about 40,000 MT per year, but the present production is about 25,000 MT per year. This is largely due to the relative high cost of materials and hence price of the product and the economic situation in ALGERIA.

LA MOUSSE DU SUD is prepared to phase out ODS as soon as the new technologies have been acquired, the necessary machinery and equipment installed and the technical staff trained.

Among the technological options currently available on a commercial basis and line with the established policy of ALGERIA to phase out the use ODS, the company has chosen to replace CFC-11 by liquid carbon dioxide system in flexible PU - slabstock manufacturing.

Due to the relatively high CFC-11 consumption for the flexible foam manufacturing, LA MOUSSE DU SUD decided to avoid the use of any transitional substance and to introduce carbon dioxide as an ultimate solution.

B. COMPANY'S BACKGROUND

LA MOUSSE DU SUD is a private company owned 100% by Citizens of Algeria and is located in the industrial area of Touggourt.

LA MOUSSE DU SUD is a large producer in the flexible foam sector and employs 45 people. The production capacity of flexible foam is 6,000 Tons/year. The production of foam blowing with CFC is 2520 MT based on 1996 figures. LA MOUSSE DU SUD used, in 1996, 85 MT of CFC-11.

The company manufactures flexible foam blocks for the furniture and mattress industries. Block sizes are 1,40 metres wide, one metre high and 1,90 metres long. Density of foam is 22 kg/m^3.

LA MOUSSE DU SUD started its foam production in 1985 with a continuous production line, purchased from HENNECKE GmbH - GERMANY. The production line is kept in good condition and has a life of at least 10 years after conversion.

Summary of existing equipment and function

The bulk storage facilities are consisting of the following :

- Polyol and TDI : delivered to the factory in drum form and transferred to a storage room.
  The suppliers are DOW-Switzerland, ICI - United Kingdom, Rhone Poulenc - France and BAYER - Germany, MONTEDISON - BASF - ARCO.
- CFC-11 : delivered in drum form and stored in a room at ambient temperature.

Run Tanks

Consisting of the following :

- Polyol : 1 x 6,000 litres vertical vessel ;
- TDI : 1 x 3,000 litres vertical vessel ;
- CFC : 1 x 500 litres, vertical steel vessel.
- Amine : 1 x 250 litres, vertical steel vessel.
- Octoate : 1 x 250 litres vertical steel vessel.

All the storage area is conditioned by hot air between 20 and 25 degrees Celsius.

Paper systems

One paper system is used (3 metres wide).

Conveyors

The conveyor is in 3 sections. The main angled conveyor is 10 metres driven by a variable speed motor (at 4,80 metres/minute speed). The extension conveyor is 15,000 metres long.

Mixed head

Consisting of a five component mixing system for polyol, TDI, CFC-11, stannous octoate, and amine. Amine and CFC-11 are premixed (stream A). The stream A is premixed with polyol (stream B). The stream B octoate and TDI are discharged at a pressure of 4 kg/cm^2.

Metering unit

Consisting of the following :

- Polyol : metering pump, 100 kg/min.
- TDI : metering pump, 100 kg/min.
- Stannous octoate : metering pump BOSCH, 8 kg/min.
- Amine : metering pump BOSCH, 8 kg/min.
- CFC-11 metering pump BOSCH, 15 kg/min.

Transfer conveyor

Installed between the extension conveyor and the end of the production building, 13 metres long.

Block cut-off

Horizontal knife cut-off unit, synchronised to the main conveyor.

Ventilation enclosure

The first part of the line is enclosed in sheet steel (Tunnel) from about one metre from the mixing head to the end of primary conveyor. The mixing head and secondary conveyor between the end of the main conveyor to the cut-off saw and beyond to the cure area are not ventilated.

Converting equipment

Consisting of the following :

- vertical band knife.
- horizontal wire cutter.
- vertical slitter.
- granulation for pillow filling.

II. PROJECT OBJECTIVE

The objective of this project is to eliminate the use of ODS such as CFC-11 in the production of flexible slabstock foams. The existing machinery will be converted to operate using a process know as Liquefied Carbon Dioxide (LCD). This process developed by several leading PU manufacturing and processing companies (HENNECKE, CANNON VIKING, BEAMECH) utilises liquid carbon dioxide as an auxiliary blowing agent replacing CFC-11.

III. PROJECT DESCRIPTION

Through the project, assistance will be provided in :

1) Procurement of new equipment ;

2) Renovation of present equipment wherever technically and economically feasible ;

3) Installation, mechanical and electrical commissioning, chemical commissioning and training ;

The following sections cover those areas of individual manufacturer's equipment which needs to be either procured, modified or replaced :

A. FOAM SYSTEM

It is envisaged that the following equipment will need to be procured.

- Liquid carbon dioxide storage equipment to ensure constant and accurate temperature and pressure monitoring.
- In order to install a liquid carbon dioxide system at this plant the following modifications will be required : a platform for the liquid carbon dioxide system and a second mixing head will be suspended above the operator platform.
- New high pressure polyol and TDI metering units are required ; these are supplied as the LCD system. A carbon dioxide bulk store system is also required, and finally, a framework is required to carry the laydown device.

- Carbon dioxide is a gas at normal temperature and atmospheric pressure ; therefore, to prevent its gassing off on mixing with other foam ingredients, and LCD froth dispensing unit is required. This consists of a carbon dioxide metering unit, a pre-blend polyol metering unit, a high pressure mixing head and laydown device.

- Metering units for the individual activator streams need to be modified (pressure increase, diverter valves and recirculation) and split in order to feed the existing and the liquid carbon dioxide mixing head.

- The new controls for the metering units and the LCD frothing unit will be located close to the laydown device.

- Adjustment of existing new and modified equipment to the existing conveyor systems and ventilation also needed.

- Compressed air used for nucleation is normally at 6 bar and the CO_2 system operates at up to 20 bar. A cheaper and safer solution is the use nitrogen instead of the air.

- Carbon dioxide has lower heat capacity than CFC-11 and less in used. This requires some of the water, usually in the formulation, to be replaced leading to lower foam hardness. To re-establish the hardness it is necessary to use crosslinkers or a co-polymer polyol, in a proportion of 5 to 20% of the current polyol. Also different surfactants are required.

- LA MOUSSE DU SUD is producing mainly low density - hard foams, so reformulation of the different grades is needed and the benefits of a less expensive blowing agent will be partially offset by the higher costs of this co-polymer polyols and surfactants.

B. JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGIES

Several other technologies to replace CFC-11 could be considered as alternatives to Methylene Chloride. Their advantages and disadvantages are detailed below.

Alternative Blowing Agent (ABA)

The polyurethane flexible foam industry still uses several auxiliary blowing agents such as, HCFC-141b, HCFC-142b/HCFC-22 combinations, pentane and acetone. Whilst foams similar or even identical to those previously made using CFC-11 can be produced, the use of this group of blowing agents can only be for the short term as either they do not have zero ODP or they contravene local or national emission standards.

Acetone also has the added problems of being extremely volatile (low flash point), and therefore presents a high risk of fire and explosion. Any machinery used in the conversion to acetone, including ventilation, will need extensive modification to be certified as explosion proof, and rigid safety procedures need to be enforced and followed.

Methylene Chloride, is also under environmental pressure due to toxicological result and the fact that it is classed as a VOC (Volatile Organic Compound). It is restricted in its use in some countries in Europe and USA is therefore seen in the developed world as a short lived ABA. However, the relative high cost of alternative technologies in relation to the low production volumes and ODS usage means that it is a viable solution until the possible development of alternative technology, or the dominance of one of the alternatives discussed below.

Variable Pressure Foaming.

This process involves the purchase of a completely new machine which is based on the principle of simulating the principle of simulating the production of low density flexible foam at high altitude, as at high altitudes a blowing agent is not required to cool the foam. The process works by totally enclosing a full size production machine and in effect creating a reactor with a machine inside. The enclosure then provides a means of controlling temperature and pressure whilst the foam is being produced. The system was developed and patented by Recticel B.V. and Beamech UK and is subject to a license agreement (in certain countries) for the equipment and technology. According to manufacturers of the equipment, three plants are currently operating using this method with a fourth one under commission. The main advantages of the process include : a reduced amount of ventilated gases to control, thereby reducing the size of scrubbing equipment required (mainly used in Europe and the USA) ; low density foams can be produced without blowing agents ; densities as low as 8 kg/cu m can be produced, thereby opening other interesting markets to the manufacturers.

Disadvantages of the process include : high cost of equipment ; the process is very different from the way operators are used to working ; the operator cannot observe and touch the foam while it is still in machine ; equipment maintenance and reliability need to be good in order to prevent the risk of a breakdown ; an air lock is used to remove the cut block from the machine, this limits the size of the block to be produce, i.e if the block is to be 60 m long, then the airlock needs to be 60 m long, and hence power consumption is high.

Accelerated or Rapid Cure Systems

Most of exothermic heat generated in the manufacture of a urethane foam is the result of the chemical reaction between water and isocyanate. Normal practise (without a blowing agent) limits the slabstock block exotherm to 165 °C, which with an all water blown foam limits the lowest foam density to circa 21 kg/m^3. To produce lower density foams it was previously possible to increase the water level and keep with safe exothem limits by the addition of an auxiliary blowing agent such as CFC-11. With this now being an unacceptable route, the concept of « Accelerated or Rapid Cure » has developed.

The Accelerated Cure technology focuses on the total elimination of auxiliary blowing agents. It also provides the opportunity to remove undesirable emissions. The general concept of the process is the forced cooling of foam blocks thus allowing the production of low density water blown foams. If they were not cooled rapidly, foams produced in this manner would self ignite. The exothermic heat is thus dispersed by drawing air through the block for a relatively short time after production, nominally 10 minutes. The block temperature is thus reduced to a point where it is no longer critical.

The main advantages of the process are : auxiliary blowing agents are eliminated ; it is environmentally friendly - undesirable emissions are removed ; foam hardness distribution is improved ; cure time and hence foam storage time are reduced.

The disadvantages are mainly in the area of safety, although significant extra space will be needed to install the system for continuous processing. The safety aspect cannot be stressed too highly. Very accurate formulation control is essential to ensure consistent foam production and the need for electrical / mechanical back up systems is necessity in the event of an electrical power failure. Any failure in the system can potentially be disastrous as blocks can generate excessive exotherm through a formulation defect or become trapped in the transport system resulting in the possibility of fire. Another disadvantage of the system is that open cell foam with a good air flow rate must be produced to enable air to pass completely through the block during the cooling process. In certain markets, manufacturers of low density foam prefer to produce a semi closed cell foam to temporarily induce firmness into the foam, after being compressed and released over a period of time these closed cells burst and foam firmness reduces, therefore rapid cooling of these semi-closed cell foams is impossible. Where low density soft foams are required, the addition of softening agents is also required. It is therefore imperative that designed into any Accelerated Cooling process is a scheme which allows the rapid removal of hazardous blocks which is totally independent of the production process itself.

In certain instances, Accelerated Cure process are also subject to a license agreement with either General Foam, USA or Crain Industries, USA. However these patents are by no means sound and can be negated by selective design criterion.

Successful results of LCD technology development and its full scale industrial application have confirmed that this technology is the most advanced one to replace CFC-11 from environmental, technical and commercial points of view ; The use of LCD as a blowing agent has many advantages including the following :

- possibility for manufacturing of foams of low density (15 kg/m^3 and lower) ;
- local availability of liquid CO_2 (usually produced by air separation plants or by the CO_2 units at the soft drinks and beverages factories) ;
- CO_2 is environment friendly chemical material obtained from natural resources ;
- no special industrial safety and health protection arrangements required ;
- the technology proved its cost-effectiveness, technical and commercial advantages at more than 15 large scale industrial companies in different countries.

Based on the above analysis of the available alternative to CFC-11 blowing agents and taking into consideration the respective national rules and regulations, the counterpart is requesting the technical assistance to replace CFC-11 by LCD in manufacturing of flexible PU slabstocks.

IV. INPUTS

1. *Capital Goods Replacement*

The equipment to be replaced, and or rebuilt, as well as new equipment to be purchased is shown in Annex A

2. *Conversion / Training*

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

- quality control in relation to conversion ;
- operation of the new machinery and equipment ;
- maintenance of the new machinery and equipment ;
- formulating using LCD for low density foams ;
- safety regulations for using carbon dioxide and other chemicals used in the foam industry.

V. PROJECT IMPLEMENTATION

The project implementation will be carried out by UNIDO in close cooperation with the recipient company. Necessary local coordination will be done by the Department of the Environment.

All procurement by UNIDO on behalf of LA MOUSSE DU SUD will follow the competitive procurement guidelines consistent with the MFMP requirements. All local works will be subject to normal bidding procedures and competitive tender.

After competitive bidding, performed according to UNIDO's rules and procedures, subcontractors will be appointed by UNIDO for the implementation of the major project components (foaming system, ventilation requirements, both in the production area and the cure area). These subcontractors will be responsible for the supply of equipment, installation, commissioning and on-the-job training of technical staff. The detailed Terms of Reference for the services to be provided by the subcontractors will be elaborated after project approval.

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

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

Having accepted the conversion of its plants to the use of non-ODS under this project, the company will be committed to provide all activities and costs related to the construction work needed (including the provision of technical infrastructure) to accommodate the new technologies introduced under this project : (The relevant construction work will have to be arranged and paid for by the respective plant will be in line with the established milestones for this project. The costs for construction work are, therefore not reflected in the project budget. The specification for construction work needed will be elaborated after project approval and necessary site inspection). The recipient company will be committed to providing the following:

- Technical staff and personnel as required by the subcontractors;
- Provision of tools, transportation and lifting equipment as required;
- Local transport, communication, translation and secretarial facilities for the subcontractor's and UNIDO's staff involved in the project's implementation.

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

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

VI. PROJECT COSTS

I. INCREMENTAL OPERATING COSTS

Liquid CO_2 is lower in price than CFC-11 and the quantity needed in the formulation to produce foams of equal density is reduced. These savings are however offset by higher cost of additional chemicals, such as special polyols, surfactants and silicones to maintain the foam quality, the cost of operation and maintenance and the annual safety training required to educate personnel in the safe handing of liquid carbon dioxide.

The increase of the energy consumption to maintain CO_2, in liquid phase and operational costs to provide N_2 are to be taken into account.

A long *« technology learning and formulations adaptation curve »* is also considered. It will be dealing yield losses during at least the first two-three years of operation. However, no funds are requested for tests and trials by the project.

The incremental operating cost is not considered in this project.

II. CONTINGENCY FUND

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

III. TOTAL COSTS

Investment costs will cover capital investment costs (on CIF basis) for modification of existing manufacturing facilities, purchase of new machinery (see Annex A : « Equipment Specification and Cost Breakdown »), training, installation and consultancy services for modifications (see Annex : « Project Budget »).

- Implementing Agency's overhead costs are 13 percent.
- For the complete costs breakdown see Annex B : « Project Budget »
- Requested funding by the MFMP : US$ 440,135

Annex A : Equipment Specification and Cost Breakdown

Item	Unit Cost $
CO_2 bulk storage system, including CO_2, tank (2 m^3), pipework and insulation	15,000
LCD system to be fitted to the existing machine, comprising : * High pressure polyol blending unit * Liquid CO_2 Metering Unit including flow metre * CO_2 Mixing head, complete with variable speed drive, lubrication system and pipework * Froth distribution system * Instrumentation and protection equipment.	180,000
High pressure polyol and TDI transfer systems and boost pump bypass, manual blocking valves, piping and insulation	5,000
High pressure TDI metering unit	40,000
High pressure water metering unit	10,000
CO_2 transfer and pressure control unit	35,000
Support frame to allocate LCD system.	20,000
Licence agreement including technology transfer, computer programme of systems formulation	40,000
Commissioning and start-up	20,000
Total Capital Cost.	365,000

Annex B : Project Budget

Description	COST US$
General consultancy services and Training	20,000
Equipment	365,000
Contingency fund (10%)	34,500
TOTAL PROJECT COST	389,500
Implementing Agency Overheads (13%)	50,635
TOTAL PROJECT BUDGET	440,135

ODS PHASE-OUT : 85 MT

C/E : 4.58

Annex C : <u>Implementation Schedule</u>

MILESTONES/MONTH	1	2	3	4	5	6	7	8	9	10	11	12
1. Sign the project, receive funding												
2. Elaboration of a detailed project workplan												
3. Draft of plant layout												
Conversion												
4. Detail drawings and engineers study												
5. Selection of equipment bidding												
6. Purchase Equipment												
7. Packing/Shipping												
8. Installation												
9. Commissioning												
10. On-site traing												

It is estimated after 12 months, the complete conversion will been have carried out.

PROJECT COVER SHEET

Country :	ALGERIA
Project Title :	Phasing out CFC-11 at Ets MATELAS DJURDJURA flexible polyurethane Foam plant.
Sectors Covered :	Flexible Polyurethane Foam Slabstock
ODS Use in Sector (1996) :	400 MT of CFC-11
Project Impact :	Phase-out of annual consumption of 28 MT CFC-11 in the production of flexible slabstock foams
Project Duration :	12 months
Project Economic Life :	10 years
Export to non-Article 5 countries :	Nil
Foreign ownership :	Nil
Incremental Capital Cost :	US$ 102,000
Incremental Operating Cost :	US$ -43,281
Total Project Cost :	US$ 58,719
Implementing Agency's Support Cost (13%) :	US$ 7,633
Proposed MF Financing :	US$ 66,352
Cost Effectiveness :	2.09 US$/kg
Counterpart Enterprise :	Foam Industries Company
Implementing Enterprise	United Nations Industrial Development Organization (UNIDO)
Coordinating Ministry :	Ministère de l'Intérieur, des Collectivités Locales, de l'Environnement.

PROJECT SUMMARY

This project will phase-out 100% of CFC-11 from the production of flexible slabstock foams used for the production of foam filled mattresses and furniture at Ets MATELAS DJURDJURA. The chosen replacement alternative is Methylene Chloride, a chemical blowing agent used for producing low density flexible polyurethane foam.

I. BACKGROUND

A. SECTOR BACKGROUND

Small and medium scale companies are included by the Government of ALGERIA in the country programme for conversion from CFC-11 to non ODS agent.

The sub-sector for flexible foams in ALGERIA consists of about 40 manufacturers who are responsible for the ODS consumption of CFC-11 in the sector of flexible polyurethane manufacturing. The primary product, flexible polyurethane foam, is consumed mainly in the home market. The product is mainly used in the production of soft furniture, upholstery, mattresses and the clothing industry.

ALGERIA does not produce any CFC-11 used in the flexible foam sector and hence ODS is imported from the European community and INDIA. In 1996, the total consumption was about 400 MT of ODS. Primary chemical companies importing polyurethane chemicals to ALGERIA for the flexible foam market are : Dow Chemicals - Switzerland, Bayer Ag - Germany, Basf - Germany, Rhone-Poulenc - France, Arco Chemicals - France, Air Products - Germany, EMSA - Spain, Ausimont - Italy, ICI - United Kingdom.

The total installed production capacity for flexible slabstock foam in the country is about 40,000 MT per year, but the present production is about 25,000 MT per year. This is largely due to the relative high cost of materials and hence price of the product and the economic situation in ALGERIA.

Ets MATELAS DJURDJURA is prepared to phase out ODS as soon as the new technologies have been acquired, the necessary machinery and equipment installed and the technical staff trained.

Among the technological options currently available on a commercial basis and line with the established policy of ALGERIA to phase out of ODS, the company has chosen to replace CFC-11 by Methylene Chloride.

As a blowing agent for flexible polyurethane foam it is recommended to use Methylene Chloride as a transitional substance rather than other alternative technologies due to cost considerations and it is widely used by European and USA flexible foam manufacturers.

B. COMPANY'S BACKGROUND

Ets MATELAS DJURDJURA is a private company owned 100% by Algerian citizen. Its plant is located in Algiers and employs 20 people. The production of foam blowing with CFC-11 is 500 MT based on 1996 figures. For this foam production, Ets MATELAS DJURDJURA used 28 MT of CFC-11.

The company manufactures flexible foam blocks for the furniture and mattress industries. Block size are 1,85 m x 1,35 m x 1,00 m. Density of foam is between 14 and 18 kg/m^3 (foam with CFC-11) and 25 - 35 kg/m^3 (foam without CFC-11)

Ets MATELAS DJURDJURA started its foam production in 1980 with a non-continuous production unit purchased from SPUHL - Switzerland. This production unit is kept in good condition and has a life of at least 10 years after conversion.

Summary of Existing Equipment and Function

The Bulk facilities are consisting of the following :

Polyol, TDI and CFC-11 are delivered in drum form and are stored in a room at ambient temperature. These chemical suppliers are AUSIMONT - Italy, ARCO - France, BAYER - Germany, BASF -Germany and DOW - United Kingdom.

The block foam unit SPUHL - SPB 531 is consisting of the following :

- Polyol : transferred from drum by a ROTAN pump SRT - 40 (flow : 65 litres/min) to a premix tank (of 900 kg capacity ; temperature controlled by internal heating serpentin).
- CFC-11 : added manually in the premix tank.
- Activators : added manually in the premix tank. The stream "A", made of a mixture of polyol, CFC-11 and activators, is transferred by ROTAN pump SRT40 at a flow of 65 litres/min to the weight tank cylinder.
- TDI : consisting of stream "B" is transferred by diaphragm pump SB 1-A (30 litres/min) to the weight tank cylinder.

Streams "A" and "B" are injected to the premix container maximum weight at streams "A" + "B" is 70 kg. The mixture time is controlled and discharged in a rectangular mould.

Converting Equipment

Consisting of the following :

- vertical band knife.
- horizontal wire cutter.
- granulator for pillow filling.

Ventilation

Foam production area and cure area are not ventilated. This is inadequate for use Methylene Chloride.

Modifications for the exiting equipment

The following is an assessment of those changes to the existing plant which need to be carried out for conversion to the Methylene Chloride system.

The existing block foam unit remain unchanged with the exception to the method of metering the blowing agent and the ventilation system. Areas in need of modification are :

Ventilation of the production hall will be required to ensure the fumes generated are extracted sufficiently, this will be done by providing two ventilation fans.

The cure area will require both low and high level ventilation in the form of extraction points fitted with grill diffusers spaced every 3 - 4 metres along the entire cure area.

Manually feeding system for the CFC-11 will be replaced with a metering pump system for methylene chloride.

II. PROJECT OBJECTIVE

The objective of this project is to eliminate the use of ODS such as CFC-II in the production of flexible slabstock foams. The existing machinery will be converted to operate using an auxiliary blowing agent known as Methylene Chloride.

III. PROJECT DESCRIPTION

Through the project, assistance will be provided in :

1) Procurement of new equipment ;

2) Renovation of present equipment wherever technically and economically feasible;

3) Installation, mechanical and electrical commissioning, chemical commissioning and training.

The following sections cover those areas of individual manufacturer's equipment which needs to be either procured, modified or replaced.

A. FOAM SYSTEM.

Its is envisaged that the following equipment will need to be procured.

- Methylene Chloride system including.
  200 litres, stainless steel, pump, valve, tubing, transfer pump.

- New electrical control system for the blowing agent metering unit.

- Ventilation system consisting of two ventilation fans in foaming area and ventilation fans, ducting and grill diffusers for installing in the cure area. This will be estimated on the bases of the current production volume per annum with a 50% contingency.

- Procurement of fire and safety equipment.

The project budget includes also an international foam process expert to assist the company in making the necessary formulation adjustments.

B. JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGIES

Several other technologies to replace CFC-11 could be considered as alternatives to Methylene Chloride. Their advantages and disadvantages are detailed below.

Alternative Blowing Agent (ABA)

The polyurethane flexible foam industry still uses several auxiliary blowing agents such as, HCFC-141b, HCFC-142b/HCFC-22 combinations, pentane and acetone. Whilst foams similar or even identical to those previously made using CFC-11 can be produced, the use of this group of blowing agents can only be for the short term as either they do not have zero ODP or they contravene local or national emission standards.

Acetone also has the added problems of being extremely volatile (low flash point), and therefore presents a high risk of fire and explosion. Any machinery used in the conversion to acetone, including ventilation, will need extensive modification to be certified as explosion proof, and rigid safety procedures need to be enforced and followed.

Methylene Chloride, the chosen technology is also under environmental pressure due to toxicological result and the fact that it is classed as a VOC (Volatile Organic Compound). It is restricted in its use in some countries in Europe and the USA and its therfore seen in the developed world as a short lived ABA. However, the relative high cost of alternative technologies in relation to the low production volumes and ODS usage means that it is a viable solution until the possible development of alternative technology, or the dominance of one of the alternatives discussed below.

Variable Pressure Foaming

This process involves the purchase of a completely new machine which is based on the principle of simulating the principle of simulating the production of low density flexible foam at high altitude, as at high altitudes a blowing agent is not required to cool the foam. The process works by totally enclosing a full size production machine and in effect creating a reactor with a machine inside. The enclosure then provides a means of controlling temperature and pressure whilst the foam is being produced. The system was developed and patented by Recticel B.V. and Beamech UK and is subject to a license agreement (in certain countries) for the equipment and technology. According to manufacturers of the equipment, three plants are currently operating using this method with a fourth one under commission. The main advantages of the process include : a reduced amount of ventilated gases to control, thereby reducing the size of scrubbing equipment required (mainly used in Europe and the USA) ; low density foams can be produced without blowing agents ; densities as low as 8 kg/cu m can be produced, thereby opening other interesting markets to the manufacturers.

Disadvantages of the process include : high cost of equipment ; the process is very different from the way operators are used to working ; the operator cannot observe and touch the foam while it is still in machine ; equipment maintenance and reliability need to be good in order to prevent the risk of a breakdown ; an air lock is used to remove the cut block from the machine, this limits the size of the block to be produce, i.e if the block is to be 60 m long, then the airlock needs to be 60 m long, and hence power consumption is high.

Accelerated or Rapid Cure Systems

Most of exothermic heat generated in the manufacture of a urethane foam is the result of the chemical reaction between water and isocyanate. Normal practise (without a blowing agent) limits the slabstock block exotherm to 165 °C, which with an all water blown foam limits the lowest foam density to circa 21 kg/m^3. To produce lower density foams it was previously possible to increase the water level and keep with safe exothem limits by the addition of an auxiliary blowing agent such as CFC-11. With this now being an unacceptable route, the concept of « Accelerated or Rapid Cure » has developed.

The Accelerated Cure technology focuses on the total elimination of auxiliary blowing agents. It also provides the opportunity to remove undesirable emissions. The general concept of the process is the forced cooling of foam blocks thus allowing the production of low density water blown foams. If they were not cooled rapidly, foams produced in this manner would self ignite. The exothermic heat is thus dispersed by drawing air through the block for a relatively short time after production, nominally 10 minutes. The block temperature is thus reduced to a point where it is no longer critical.

The main advantages of the process are : auxiliary blowing agents are eliminated ; it is environmentally friendly - undesirable emissions are removed ; foam hardness distribution is improved ; cure time and hence foam storage time are reduced.

The disadvantages are mainly in the area of safety, although significant extra space will be needed to install the system for continuous processing. The safety aspect cannot be stressed too highly. Very accurate formulation control is essential to ensure consistent foam production and the need for electrical / mechanical back up systems is necessity in the event of an electrical power failure. Any failure in the system can potentially be disastrous as blocks can generate excessive exotherm through a formulation defect or become trapped in the transport system resulting in the possibility of fire. Another disadvantage of the system is that open cell foam with a good air flow rate must be produced to enable air to pass completely through the block during the cooling process. In certain markets, manufacturers of low density foam prefer to produce a semi closed cell foam to temporarily induce firmness into the foam, after being compressed and released over a period of time these closed cells burst and foam firmness reduces, therefore rapid cooling of these semi-closed cell foams is impossible. Where low density soft foams are required, the addition of softening agents is also required. It is therefore imperative that designed into any Accelerated Cooling process is a scheme which allows the rapid removal of hazardous blocks which is totally independent of the production process itself.

In certain instances, Accelerated Cure process are also subject to a license agreement with either General Foam, USA or Crain Industries, USA. However these patents are by no means sound and can be negated by selective design criterion.

CarDio TM

This process involves the use of Carbon Dioxide as an alternative blowing agent to CFC-11. The process itself involves continuously blending liquid carbon dioxide into a standard chemical formulation (excluding CFC-11) and keeping this blend of chemicals at sufficient pressure to ensure the carbon dioxide does not leave the solution as a gas. Because carbon dioxide rapidly changes state from a liquid to a gas, unless the process of reducing the pressure of the blend is controlled accurately the foam produced will have pin holes buck shot and chimneys spread throughout the cellular structure of the foam. To control this pressure drop and hence to produce foams of uniform structure, the inventors of the process, CarDio TMB.V and Cannon have developed a special laydown device and premixing system. The equipment is patented and subject to a license agreement. The license agreement is base either on a one time lump sum payment or a running royalty, dependant on the country involved and the production volumes. Further details on the license agreement are available on request from CarDio TMB.V. The current market situation has shown that as many as twelve producers in the world have signed license agreements and produced equipment from one the licensed equipment manufacturers. Similar processes are procured equipment from one the licensed equipment manufacturers. Similar process are now available from Beamech, Laader Berg and Henecke. However, all CO2 processes are expensive to install and thus cannot be considered for limited CFC-11 usage, as in this case.

IV. INPUTS

1. *Capital Goods Replacement*

The equipment to be replaced, and or rebuilt, as well as new equipment to be purchased is shown in Annex A

2. *Conversion / Training*

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

- quality control in relation to conversion ;
- operation of the new machinery and equipment ;
- maintenance of the new machinery and equipment ;
- formulating using Methylene Chloride for low density foams ;
- safety regulations for using methylene chloride and other chemicals used in the foam industry.

V. PROJECT IMPLEMENTATION

The project implementation will be carried out by UNIDO in close cooperation with the recipient company. Necessary local coordination will be done by the Department of the Environment.

All procurement by UNIDO on behalf of Ets MATELAS DJURDJURA will follow the competitive procurement guidelines consistent with the MFMP requirements. All local works will be subject to normal bidding procedures and competitive tender.

After competitive bidding, performed according to UNIDO's rules and procedures, subcontractors will be appointed by UNIDO for the implementation of the major project components (foaming system, ventilation requirements, both in the production area and the cure area). These subcontractors will be responsible for the supply of equipment, installation, commissioning and on-the-job training of technical staff. The detailed Terms of Reference for the services to be provided by the subcontractors will be elaborated after project approval.

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

Having accepted the conversion of its plants to the use of non-ODS under this project, the company will be committed to provide all activities and costs related to the construction work needed (including the provision of technical infrastructure) to accommodate the new technologies introduced under this project : (The relevant construction work will have to be arranged and paid for by the respective plant will be in line with the established milestones for this project. The costs for construction work are, there for event reflected in the project budget. The specification for construction work needed will be elaborated after project approval and necessary site inspection). The recipient company will be committed to providing the following:

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

VI. PROJECT COSTS

I. INCREMENTAL OPERATING COSTS

Methylene chloride is lower in price than CFC-11 and the quantity needed in the formulation to produce foams of equal density is reduced (typically 8-9 parts by weight to every 10 parts by weight of CFC-11) These saving are however offset by a slight reduction in foam quality and the cost of operation, maintenance and the annual safety training required to educate personnel in the safe handing of methylene chloride. (The improper use of methylene chloride can lead to respiratory problems and skin problems depending on the nature of the accident). These costs are calculated as per the rules issued by the Ex. Com. of the Multilateral Fund, and are shown in Annex B.

II. CONTINGENCY FUND

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

III. TOTAL COSTS

Investment costs will cover capital investment costs (on CIF basis) for modification of existing manufacturing facilities, purchase of new machinery (see Annex A : « Equipment Specification and Cost Breakdown »), training, installation and consultancy services for modifications (see Annex C : « Project Budget »).

- The incremental operating costs associated with this project are as above and detailed in Annex B.
- Implementing Agency's overhead costs are 13 percent.
- For the complete costs breakdown see Annex C : « Project Budget ».
- Requested funding by the MFMP : US$ 66,352.

Annex A : Equipment Specification and Cost Breakdown

Item	Cost US$ Ex. Com.
MC metering system	15,000
Process ventilation system	50,000
Transfer technology and training	15,000
Safety devices	5,000
Commissioning and start-up.	10,000
Total Ex. Com.	95,000

Annex B : Incremental operating costs

Incremental Operating Costs

Item	Price US$/ton	Ton/year (before)	Consumption (after)
CFC-11	2,000	28	0
MC	900	0	25.2
Amines	7,500	3	3.12
Tin	8,200	4	4.24
Energy (kWh)	0.1		45,000
Production	2,000	1,500	1,500

Investment in equipment : U$ 100,000

CFC / MC Ratio : 1.00/0.90

Yield loss : 3/2/1/0% per year on 15 % production

Maintenance : 5% of equipment investment

Calculations

Cost Item US$ x 1,000	1997	1998	1999	2000	TOTAL US$
Baseline					
CFC-11	56	56	56	56	
Amines	22.5	22.5	22.5	22.5	
Tin	32.8	32.8	32.8	32.8	
Total	111.3	111.3	111.3	111.3	
Post Project					
MC	22.68	22.68	22.68	22.68	
Amines	23.40	23.40	23.40	23.40	
TIN	34.77	34.77	34.77	34.77	
Incr. yield loss	13.5	9.0	4.5	0	
Incr. energy	4.5	4.5	4.5	4.5	
Incr. maintenance	5	5	5	5	
Total	103.85	99.35	94.85	90.35	
Incr. Oper. Cost	-7.45	-11.95	-16.45	-20.95	
Discount factor	0.91	0.83	0.75	0.68	
NPV	-6.780	-9.918	-12.337	-14.246	
Total Incremental Operation Costs					(-43,281)

Annex C : Project Budget

Budget line	Description	EXCOM US$
11-01	Technology Transfer and training	15,000
21-00	Subcontract	80,000
51-01	Contingency fund (10%)	7,000
99-01	Incremental capital costs	102,000
99-02	Incremental operating costs	-43,281
	TOTAL PROJECT COST	58,719
	Implementing Agency Overheads	7,633
	TOTAL PROJECT BUDGET	66,352

ODS PHASE-OUT : 28 MT

C/E : 2.09

Annex D : Implementation Schedule

MILESTONES/MONTH	1	2	3	4	5	6	7	8	9	10	11	12
1. Sign the project, receive funding												
2. Elaboration of a detailed project workplan												
3. Draft of plant layout												
Conversion												
4. Detail drawings and engineers study												
5. Selection of equipment bidding												
6. Purchase Equipment												
7. Packing/Shipping												
8. Installation												
9. Commissioning												
10. On-site traing												

It is estimated after 12 months, the complete conversion will been have carried out.

PROJECT COVER SHEET

Country :	ALGERIA
Project Title :	Phasing out CFC-11 at MAGHREB MOUSSE flexible polyurethane Foam plant.
Sectors Covered :	Flexible Polyurethane Foam Slabstock
ODS Use in Sector (1996) :	400 MT of CFC-11
Project Impact :	Phase-out of annual consumption of 24 MT CFC-11 in the production of flexible slabstock foams
Project Duration :	12 months
Project Economic Life :	10 years
Export to non-Article 5 countries :	Nil
Foreign ownership :	Nil
Incremental Capital Cost :	US$ 115,200
Incremental Operating Cost :	US$ -29,734
Total Project Cost :	US$ 85,466
Implementing Agency's Support Cost (13%) :	US$ 11,110
Proposed MF Financing :	US$ 96,576
Cost Effectiveness :	3.56 US$/kg
Counterpart Enterprise :	Foam Industries Company
Implementing Enterprise	United Nations Industrial Development Organization (UNIDO)
Coordinating Ministry :	Ministère de l'Intérieur, des Collectivités Locales, de l'Environnement.

PROJECT SUMMARY

This project will phase-out 100% of CFC-11 from the production of flexible slabstock foams used for the production of foam filled mattresses and furniture at Ets MAGHREB MOUSSE. The chosen replacement alternative is Methylene Chloride, a chemical blowing agent used for producing low density flexible polyurethane foam.

I. BACKGROUND

A. SECTOR BACKGROUND

Small and medium scale companies are included by the Government of ALGERIA in the country programme for conversion from CFC-11 to non ODS agent.

The sub-sector for flexible foams in ALGERIA consists of about 40 manufacturers who are responsible for the ODS consumption of CFC-11 in the sector of flexible polyurethane manufacturing. The primary product, flexible polyurethane foam, is consumed mainly in the home market. The product is mainly used in the production of soft furniture, upholstery, mattresses and the clothing industry.

ALGERIA does not produce any CFC-11 used in the flexible foam sector and hence ODS is imported from the European community and INDIA. In 1996, the total consumption was about 400 MT of ODS. Primary chemical companies importing polyurethane chemicals to ALGERIA for the flexible foam market are : Dow Chemicals - Switzerland, Bayer Ag - Germany, Basf - Germany, Rhone-Poulenc - France, Arco Chemicals - France, Air Products - Germany, EMSA - Spain, Ausimont - Italy, ICI - United Kingdom.

The total installed production capacity for flexible slabstock foam in the country is about 40,000 MT per year, but the present production is about 25,000 MT per year. This is largely due to the relative high cost of materials and hence price of the product and the economic situation in ALGERIA.

Maghreb Mousse is prepared to phase out ODS as soon as the new technologies have been acquired, the necessary machinery and equipment installed and the technical staff trained.

Among the technological options currently available on a commercial basis and line with the established policy of ALGERIA to phase out of ODS, the company has chosen to replace CFC-11 by Methylene Chloride.

As a blowing agent for flexible polyurethane foam it is recommended to use Methylene Chloride as a transitional substance rather than other alternative technologies due to cost considerations and it is widely used by European and USA flexible foam manufacturers.

B. COMPANY'S BACKGROUND

Ets MAGHREB MOUSSE is a private company owned 100% by citizens of Algeria and is located in the Industrial Area of ES-SENIA (ORAN).

MAGHREB MOUSSE is a large producer in the flexible foam sector and employs 12 people. MAGHREB MOUSSE started its production in 1985. The installed capacity of the plant is 1 400 MT/year. The production of low density foam (with CFC-11) is 250 MT (based on 1996 figures). The complete production is sold in Algeria.

In 1996, MAGHREB MOUSSE used 24 MT of CFC-11 in production per annum.

The company manufactures flexible foam blocks for the furniture and mattress industries. Block sizes are 1,800 mm in width, and 1,000 mm high and average length is 2,000 mm. Density is between 16 and 18 kg/m^3.

MAGHREB MOUSSE started its production with a continuous production line, type MRF 160E purchased from OMS-Italy. The production line is kept in very good condition and has a life of at least 10 years after conversion.

Summary of Existing Equipment and Function

The Bulk storage facilities are consisting of the following :

- Polyol and TDI are delivered to the factory in drum form and are transferred to a storage room which is conditioned by hot air. The chemicals are kept between 20-25 degrees Celsius. The suppliers are DOW-Switzerland, ARCO-France, EMSA-Spain and ICI (U.K).

- CFC-11 is delivered in drum form and are stored in a room, at ambient temperature. Suppliers are ICI (U.K) and AUSIMONT (Italy).

Run Tanks

- Polyol : 3 000 litres vertical vessel. The pump of about 50lt/min fed the run tank directly from polyol drums. Temperature controlled by a cooling jack around the tank.

- TDI : 2 500 litres vertical vessel, fed by pumps directly from TDI drums.

- CFC : 450 litres vertical pressure vessel fed by a 30 lt/min pump. Temperature is controlled by a cooling jacket around the tank. The CFC-11 is pressured directly to the mixing head, the flows being controlled by means of a valve (13 kg/min).

- Activator : One steel vessel of 200 litres capacity.

- Tin : One steel vessel of 100 litres capacity.

Paper Systems

Three paper system is used ; two side and one bottom paper rewind system is used. The three feeding supports have brake arrangements for keeping an even tension during foaming.

Conveyors

The conveyor is in two sections. The primary conveyor is 17 metres long driven by a variable speed motor (between one and eight metres / minutes). The secondary conveyor is 15 metres long which extends to the cut off saw.

Mixed Head

Consisting of a five component mixing system for polyol, TDI, CFC-11, stannous octoate and activator ; The chemicals are recirculated to an area close to the mixing head. The mixture is discharged at 160 kg/min with a pressure of 2 kg/cm^2

Metering unit

Consisting of the following :

– polyol :	feed pump ; 100 kg/min capacity.
– TDI :	metering pump ; 53 kg/min capacity.
– Stannous octoate :	metering pump ; 8 kg/min capacity.
– Activator :	metering pump ; 8 kg/min capacity.
– CFC-11 :	is pressured directly to the mixing head, the flow being controlled by means of a valve (13 kg/min)

each metering unit has its own tank, piperwork, valves and pressure gauges.

Transfer Conveyor

Installed between the cut saw and part way to the end of building.

Black cut-off

Horizontal knife cut-off unit, synchronised to the main conveyor.

Ventilation enclosure

The line is enclosed in sheet steel (Tunnel) from about one metre for the mixing head to the end of primary conveyor. The mixing head and secondary conveyor between the end of the main conveyor to the cut-off saw and beyond to the cure area is not ventilated. This is inadequate for use with methylene chloride.

Converting Equipment

Consisting of the following :

- vertical band knife.
- horizontal wire cutter.
- vertical slitter.
- granulator for pillow filling.

Modifications to the existing equipment

Methylene chloride has been identified as the preferred replacement for CFC-11 in slabstock foam blowing operations. The technology is commercially available. Its will require some modifications.

The following is an assessment of those changes to the existing plant which need to be carried out for conversion to the methylene chloride system.

The project budget includes :

- an international foams process expert to assist MAGHREB MOUSSE in making the necessary formulation adjustments.
- a metering pump system for methylene chloride.
- the ventilation enclosure around the machine will be improved by extending the enclosure from the end of the primary conveyor to the end of building. Additional ventilation will be required to ensure the fumes generated are extracts sufficiently, this will be done by providing five additional axial flow fans to the top of enclosure: one above the mixing head, one on the main conveyor, one above the secondary conveyor one above the cut off unit and one about the transfer conveyor.
- In addition to this, extraction ducts from the side paper take-off, the bottom paper take off, below the cut off saw and below the transfer conveyor will be required.
- The cure area will require both low and high level ventilation in the form of extraction points fitted with grill diffusers spaced every four metres abort the entire cure area (about 600 m^2).

II. PROJECT OBJECTIVE

The objective of this project is to eliminate the use of ODS such as CFC-II in the production of flexible slabstock foams. The existing machinery will be converted to operate using an auxiliary blowing agent known as Methylene Chloride.

III. PROJECT DESCRIPTION

Through the project, assistance will be provided in :

a) Procurement of new equipment ;

b) Renovation of present equipment wherever technically and economically feasible;

c) Installation, mechanical and electrical commissioning, chemical commissioning and training.

The following sections cover those areas of individual manufacturer's equipment which needs to be either procured, modified or replaced.

A. FOAM SYSTEM

It is envisaged that the following equipment will need to be procured.

Methylene Chloride pump system, for accurate dosing of the materiel into the mixing head. This will include a rotameter and recirculation system.

Additional ventilation equipment consisting of five ventilation fans to be fitted in the following places. One above the mixing head, one on the main conveyor and one above the secondary conveyor; one above the cut off unit, one above the take off conveyor which extends to the end of the production hall.

New electrical control system for the blowing agent metering unit and the recirculation system.

A ventilation enclosure from the end of the primary conveyor to the end of the production hall, inclusive of the cut off unit.

An extension to the take-off conveyer will be required to ensure the blocks are removed off the conveyor outside the production building, this will consist of a driven roller conveyor 6m long with a variable speed drive motor.

Ventilation fans, ducting and grill diffusers for installing in the cure area. This will be estimated on the bases of the current production volume per annum with a 50% contingency.

B. JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGIES

Several other technologies to replace CFC-11 could be considered as alternatives to Methylene Chloride. Their advantages and disadvantages are detailed below.

Alternative Blowing Agent (ABA)

The polyurethane flexible foam industry still uses several auxiliary blowing agents such as, HCFC-141b, HCFC-142b/HCFC-22 combinations, pentane and acetone. Whilst foams similar or even identical to those previously made using CFC-11 can be produced, the use of this group of blowing agents can only be for the short term as either they do not have zero ODP or they contravene local or national emission standards.

Acetone also has the added problems of being extremely volatile (low flash point), and therefore presents a high risk of fire and explosion. Any machinery used in the conversion to acetone, including ventilation, will need extensive modification to be certified as explosion proof, and rigid safety procedures need to be enforced and followed.

Methylene Chloride, the chosen technology is also under environmental pressure due to toxicological result and the fact that it is classed as a VOC (Volatile Organic Compound). It is restricted in its use in some countries in Europe and the USA and is therefore seen in the developed world as a short lived ABA. However, the relative high cost of alternative technologies in relation to the low production volumes and ODS usage means that it is a viable solution until the possible development of alternative technology, or the dominance of one of the alternatives discussed below.

Variable Pressure Foaming.

This process involves the purchase of a completely new machine which is based on the principle of simulating the principle of simulating the production of low density flexible foam at high altitude, as at high altitudes a blowing agent is not required to cool the foam. The process works by totally enclosing a full size production machine and in effect creating a reactor with a machine inside. The enclosure then provides a means of controlling temperature and pressure whilst the foam is being produced. The system was developed and patented by Recticel B.V. and Beamech UK and is subject to a license agreement (in certain countries) for the equipment and technology. According to manufacturers of the equipment, three plants are currently operating using this method with a fourth one under commission. The main advantages of the process include : a reduced amount of ventilated gases to control, thereby reducing the size of scrubbing equipment required (mainly used in Europe and the USA) ; low density foams can be produced without blowing agents ; densities as low as 8 kg/cu m can be produced, thereby opening other interesting markets to the manufacturers.

Disadvantages of the process include : high cost of equipment ; the process is very different from the way operators are used to working ; the operator cannot observe and touch the foam while it is still in machine ; equipment maintenance and reliability need to be good in order to prevent the risk of a breakdown ; an air lock is used to remove the cut block from the machine, this limits the size of the block to be produce, i.e if the block is to be 60 m long, then the airlock needs to be 60 m long, and hence power consumption is high.

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Investment costs will cover capital investment costs (on CIF basis) for modification of existing manufacturing facilities, purchase of new machinery (see Annex A : « Equipment Specification and Cost Breakdown »), training, installation and consultancy services for modifications (see Annex C : « Project Budget »).

- The incremental operating costs associated with this project are as above and detailed in Annex B.
- Implementing Agency's overhead costs are 13 percent.
- For the complete costs breakdown see Annex C : « Project Budget »

Requested funding by the MFMP : US$ 96,576.

Annex A : Equipment Specification and Cost Breakdown

Item	Cost US$ Ex. Com.
MC metering pump system	15,000
Process ventilation system	50,000
Extra ventilation in cure area	12,000
Safety devices	5,000
Transfer technology and training	15,000
Commissioning and start-up.	10,000
Total Ex. Com.	107,000

Annex B : Incremental operating costs

Incremental Operating Costs

Item	Price US$/ton	Ton/year (before)	Consumption (after)
CFC-11	2,000	24	0
MC	900	0	21.6
Amines	7,500	3	3.12
Tin	8,200	4	4.24
Energy (kWh)	0.1		45.000
Production	2,000	1.400	1.400

Investment in equipment : U$ 100,000

CFC / MC Ratio : 1.00/0.90

Yield loss : 3/2/1/0% per year on 15 % production

Maintenance : 5% of equipment investment

Calculations

Cost Item US$ x 1,000	1997	1998	1999	2000	TOTAL US$
Baseline					
CFC-11	48	48	48	48	
Amines	22.5	22.5	22.5	22.5	
Tin	32.8	32.8	32.8	32.8	
Total	103.3	103.3	103.3	103.3	
Post Project					
MC	19.44	19.44	19.44	19.44	
Amines	23.40	23.40	23.40	23.40	
TIN	34.77	34.77	34.77	34.77	
Incr. yield loss	12.60	8.40	4.20	00	
Incr. energy	4.5	4.5	4.5	4.5	
Incr. maintenance	5.0	5.0	5.0	5.0	
Total	99.71	95.51	91.31	87.11	
Incr. Oper. Cost	-3.59	-7.79	-11.99	-16.19	
Discount factor	0.91	0.83	0.75	0.68	
NPV	-3.267	-6.466	-8.992	-11.009	
Total Incremental Operation Costs					(-29,734)

Annex C : Project Budget

Budget line	Description	EXCOM US$
11-01	Technology Transfer and training	15,000
21-00	Subcontract	92,000
51-01	Contingency fund (10%)	8,200
99-01	Incremental capital costs	115,200
99-02	Incremental operating costs	-29,734
	TOTAL PROJECT COST	85,466
	Implementing Agency Overheads	11,110
	TOTAL PROJECT BUDGET	96,576

ODS PHASE-OUT : 24 MT

C/E : 3.56

Annex D : Implementation Schedule

MILESTONES/MONTH	1	2	3	4	5	6	7	8	9	10	11	12
1. Sign the project, receive funding												
2. Elaboration of a detailed project workplan												
3. Draft of plant layout												
Conversion												
4. Detail drawings and engineers study												
5. Selection of equipment bidding												
6. Purchase Equipment												
7. Packing/Shipping												
8. Installation												
9. Commissioning												
10. On-site traing												

It is estimated after 12 months, the complete conversion will been have carried out.