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**PROJECT MP / ALG / 95 / 027**

Preparation of investment project for the phase out of CFC 11 in the  
manufacture of sandwich pannels at BATIMETAL - BENI-MANSOUR.

**PROJECT REPORT**

September 95.

## PROJECT COVER SHEET

<b>Country</b>	: ALGERIA
<b>Project title</b>	: phasing out of CFC 11 in the manufacture of sandwich panels at BATIMETAL Béni Mansour.
<b>Sectors Covered</b>	: Rigid foam
<b>ODS use in sector (1990)</b>	: 650 mt. of CFC 11
<b>Project impact</b>	: phase out of annual consumption of 110 mt. CFC1
<b>Project Duration</b>	: 18 months
<b>Project Economic Life</b>	: 10 years
<b>Total project Cost</b>	: USD 1,565,000 ( Total of capital cost and incremental operating cost for two years of operation )
<b>Capital cost</b>	: USD 715,000.
<b>Incremental Operating Cost</b>	: USD 850,000( two years of operation )
<b>Overheads ( 13 % )</b>	: USD 203,450
<b>Proposed MF Financing</b>	: USD 1,768,450.
<b>Cost Effectiveness</b>	: USD / Kg 5.53
<b>Counterpart Entreprise</b>	: BATIMETAL
<b>Implementing Agency</b>	: UNIDO
<b>National Coordinating Ministry</b>	: Direction Générale de l'Environnement, Ministère de l'Intérieur des Collectivités Locales, de l'Environnement et de la Réforme Administrative.

### PROJECT SUMMARY

This project will phase out 100 percent of the use of CFC 11 ( i.e. 110 tons based on 1994 consumption ) for the production of sandwich panels at BATIMETAL Beni Mansour. The project will include the conversion of the foaming line through the introduction of formulations and procedures for foam injection based upon the use of pentane as blowing agent. The project includes equipment modification, plant conversion, consulting, production trials, testing, training and incremental operating costs for two years.

## I. BACKGROUND :

### **A. Sector Background :**

The Algerian industry used in 1991, 650 tons of CFC which correspond to 650 tons of ODP.

The foam sector represents 9 % of the total consumption of CFC ( 2, 144 Tons in 1991).

The rigid foam field uses the CFC and is mainly represented by the following national public enterprises:

- ENIEM, for the manufacturing of domestic refrigerators and freezers.
- PROSIDER, for the manufacturing of insulating panels which are used in industrial buildings, leisure and industrial refrigeration.
- BATIMETAL Beni Mansour

Many private factories manufacture flexible foam from the CFC processes. This foam is mainly used for furniture manufacturing.

### **B. BATIMETAL's background :**

The BATIMETAL's plant, which manufactures sandwich panels, is located 170 Kilometres East of Algiers.

It produces, since January 1986, products under the form of panels for the barding and roofing. The panels are made of polyurethane rigid foam and linked with two steel sheets galvanised or lacquered. The aim is to obtain rigidity and lifting capacity, two important elements of prefabricated building.

The building service, which has a capacity of 410,000 m<sup>2</sup>, is modern and operates continuously with accuracy and constant quality.

The products are mainly bound to the industrial building which consumes 90 % of the products.

The remaining 10 % concern the refrigeration industry and bungalows. The products are intended for local market and are occasionally exported ( Russia, Tunisia ).

BATIMETAL produces 90%of the local needs of PU foam.

The turnover of the last three years is as follows :

- 1992 : 325,272 000 DA
- 1993 : 172,758 000 DA
- 1994 : 287,636 000 DA

BATIMETAL's complex of Berrahal employs 153 people with 13 persons in the manufacturing section of panels. The section functions in a rhythm of one shift. In 1994, a second shift was set in order to meet the growing needs.

The production during the last three years was as follows :

- 1992 : 326,967 m<sup>2</sup>
- 1993 : 151,486 m<sup>2</sup>
- 1994 : 280,770 m<sup>2</sup>

Batimetal's aim is to reach 300,000 m<sup>2</sup> by 1995 whereas the nominal capacity is 471,328 m<sup>2</sup>.

The range of products is made of covering and barding sandwich panels which are mainly intended for the utilisation in industrial buildings :

In general, the covering of sandwich panels is made of sheet irons of galvanised or pre-lacquered steel. The covering can be gliding, slightly grooved or with trapezoidel waves.

The density of the foam goes between 38 and 42 kg / m<sup>3</sup> and the chemicals used for this reaction are the following :

- Polyol PE 1438 A / O
- CFC 11
- Isocyanate MDI 44 V20
- Activator

The cleaning solvent is CH<sub>2</sub> Cl<sub>2</sub>.

The raw materials are delivered in drums ( 5 to 10 tons ) with different sizes for the manufacturing.

The traveling crane picks up the drums from the storage area and puts them on forklifts which direct them on the winders. The two sheet irons are then put into the shaping machine where the final sheet is shaped.

The shaping tools are conceived in accordance with the programmed profile . A lipguide ensures the regular shaping of the sheet.

The two sheets are, then introduced in a kiln ( preheating compartement) under a temperature varying between 35and 40 degrees Celsius in order to ensure an excellent adhesion between the two covers and the foam.

After their pre-heating, the two sheets are put in the injection section.

The delivering of chemicals from the storage tanks to the measuring pumps is done with pumps ( delivery 20 - 40 l /mn )

The polyol, R11 and activator are pre-mixed ( component A ) and delivered by a measuring pump and under a pressure varying between 100 and 180 bars.

the isocyanate is delivered separately because component A and component B cross each other.

At the level mixing area, compressed air is brought under a pressure of three bars in order to obtain a good mixture and avoid foam settling at the level of the injectors.

The injection of the foam is done in a continuous way on the lower covering. While the panel leaves the injection areas, an expansion ( production of foam ) occurs.

The two covers ( coated with the foam ) penetrate continuously in the mobile endless double band ( conformator ).

The lateral watertightness of the sandwich panels is achieved with a system that matches the extreme rollers.

Then, the panel is cut with the cutting machine, equipped with a micro-processor, into different lengths.

At the end of the operation, the cutting machine returns to its initial position.

The panel gets to a conveyor and is evacuated to the empiler. The speed is higher than that of the double band.

When the panel reaches its final destination, it is empiled with a pneumatic system, then sent to the conditioning section where the product is conditioned before it is delivered.

## **II - PROJECT OBJECTIVE :**

The objective of this project is to eliminate the use of CFC- 11 in the production of rigid polyurethane foam sandwich panels through conversion to the use of pentane as blowing agent for the polyurethane insulation foam.

### **III - PROJECT DESCRIPTION :**

BATIMETAL is prepared to phase out ODS as soon as the new technology will be granted, the necessary machinery, equipment installed and the technical staff trained.

Therefore, the following actions will be taken within the framework of the project :

- procurement of the equipment,
- re-design, re-construction and testing of sandwich panels,
- installation, commissioning, trial operation and start up,
- technical assistance ( safety ),
- training.

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

1. storage tank facility for storing pentane:

by means of double walled steel tank, installed below ground, contents about 25 m<sup>3</sup> with 2 feed pumps pipe line system, all necessary fittings and safety equipment.

2. Metering unit for metering pentane :

by the means of special membrane high pressure metering pumps, pipe line system, all necessary fittings and safety equipment, static mixer for the installation into the polyol mixture high pressure

3. safety cabin:

including extractor with pipe line, guided over the roof for the above pentane metering unit. All components within the safety cabin are explosion proof in order to obtain additional safety.

4. extractor:

in the area of the foaming portal and raw material mixture dispenser with explosion-proof exhaust fan and pipe line guided over the roof.

5. safety equipment :

according to the HENNECKE PPT System, Pentane Process Technology with differential pressure switches for the exhaust air pipe as well as pentane sensors at all relevant places.

#### **Justification for selection of alternative technologies.**

As a new blowing agent for the polyurethane, the major alternatives are :

- |                         |     |
|-------------------------|-----|
| - Blowing agent         | ODP |
| - 100 % CO <sub>2</sub> | 0   |

- HCFC- 141 b	0.11
- HCFC- 22	0.065
- HCFC- 142b + HCFC- 22	0.06
- HCFC- 134 a	0
- Cyclopentane	-0
- HFC- 356	0

- The main advantages and disadvantages of the various alternatives are as follows

( Source : M.J Cartmell, workshop on CFC substitutes, 24 February 1993, Polymer Institute, University of Detroit Mercy.)

### **100 % CO<sub>2</sub>**

#### **Advantages :**

Environmentally attractive.

#### **Disadvantages:**

- Poorer physical properties.
- Poorer foam adhesion.
- 20 - 25 % increase in initial k-factor ( thermal conductivity ) .
- Fast foam aging, due to a gas diffusion, if foam no protected.
- Higher exotherm may limit cure in thick sections.
- Significant cost increase ( + 30 % ) .
- Polyol viscosity limitations.

### **HCFC- 141b**

#### **Advantages**

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

#### **Disadvantages**

- Transitional substance.
- Higher solvency effect.



## **HCFC- 22**

### **Advantages:**

- Lower ODP than HCFC-141b.
- Non-Flammable.
- Low cost.

### **Disadvantages:**

- Lower boiling point requires significant changes to pressing and handling equipment.
- Frothing effect at higher levels.
- Higher initial k-factor.
- Without impermeable facers k-factor will increase rapidly due to gas diffusion

## **HCFC-22/ HCFC-142 blends ( 40 : 60 ) .**

### **Advantages:**

- Low ODP
- Non-Flammable
- Frothing effect less than HCFC- 22
- Slower rate of gas diffusion than HCFC- 22

### **Disadvantages:**

- Low boiling point
- Higher cost than HC FC- 22 alone

## **Pentane**

### **Advantages**

- Zero ODP.
- Halogen free.
- Low cost.
- Liquid at room temperature.
- Good foam aging characteristics.
- Foam properties.

### **Disadvantages**

- Highly flammable

- Plant modifications required
- Low solubility in polyols.
- 5 - 10 % increase in initial k-factor.

### **HFC- 134a**

#### **Advantages :**

- Zero ODP
- No-Toxicity.
- Non-Flammable
- k-factor aging similar to CFC- 11

#### **Disadvantages :**

- Expensive
- Higher initial k-factor.
- Lower solubility in polyols.
- Frothing effect worse than HCFC- 22
- Requires significant changes to processing and handling equipment.

### **HCFC- 356**

#### **Advantages :**

- Environmentally attractive.
- Boiling point 24 C.
- Non-flammable.
- Relatively soluble in standard PU raw materials.
- k-factor similar to CFC- 11.
- Good foam aging characteristics.

#### **Disadvantages:**

- Toxicity unknown,
- Cost unknown,
- Availability uncertain,

Although 100 % CO<sub>2</sub> is a very attractive solution from environmental point of view it can not be selected as an acceptable technology for the production of sandwich panels due to the poor insulating properties of the foam.

Pentane is an excellent solution and widely used mainly in Europe. The technology however requires extensive precautionary measures due to the flammable and explosive character of pentane.

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

HCFC- 141b, HCFC- 22 and HCFC- 142b + HCFC- 22 blend are transitional substances.

Among all the above solutions HCFC- 141b is the technically and economically most acceptable one, even though it is transitional.

BATIMETAL are not interested by a transitional substance. The pentane solution, though its disadvantages, seems to be the most appropriate solution considering its technical characteristics as blowing agent.

#### **IV. INPUTS :**

##### **1. Capital Goods Replacement:**

The equipment for pentane storage, foaming system and safety as specified, need to be replaced or added:

- pentane tank facility,
- metering unit for pentane,
- safety cabin,
- safety equipment,
- extractor.

##### **2. Training :**

Within the framework of this project, technicians from BATIMETAL - Beni Mansour will be trained in the following fields:

- operation and maintenance of the new machinery and equipment,
- quality control in relation with conversion,
- laboratory tests,
- new technologies for foam,
- specifications for pentane,
- safety regulations for flammable chemicals.

## **V. PROJECT IMPLEMENTATION :**

The project implementation will be carried out by UNIDO in close co-operation with BATIMETAL. After competitive bidding performed according to UNIDO's rules and procedures, a General Contractor will be appointed by UNIDO and BATIMETAL for the implementation of the major project components ( foaming system ). The General Contractor will be responsible for the supply of equipments, installation, commissioning and training of local staff on the premises. The detailed Terms of Reference for the service to be provided by the General Contractor will be elaborated after project approval.

The final equipment specifications and the work plan could 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 with established national standards is to be obtained by BATIMETAL.

Having accepted the conversion of its plant to the use of non- ODS under this Project, BATIMETAL 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 accomodate the new technologies introduced under this project ( the relevant construction work will have to be arranged by BATIMETAL under the supervision of the General Contractor and in line with the established milestones for this project. The costs for construction work are, therefore, not reflected in the project budget. The specifications for construction work needed will be elaborated by the General Contractor after project approval and the necessary site inspection ) ;

- Technical staff as required by the General Contractor ;

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

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

The project implementation, milestones are set in Annex.

## VI - PROJECT COSTS :

### 1 - Incremental operating costs :

The use of pentane blown foam changes the product cost due to :

- the higher foam density using pentane ( about 10 % more )
- the use of less amount of blowing agent,
- the new composition from which the price of the foam is calculated, based on the local price level.

R 11 system				Pentane System			
Chemicals	wt %	Price USD/ Kg	Cost USD	Chemicals	wt %	Price USD / Kg	Cost USD
Polyol	37.8	1.87	0.71	Polyol	36	2.40	0.86
MDI	50.3	1.84	0.93	MDI	57	2.50	1.42
R 11	11.3	2.40	0.27	Pentane	7	2.40	0.17
Activator	0.5	8.55	0.04	-	-	-	
PU Cost			1.95	PU Cost			2.45

**- PU foam production ( base 1994 )**

- TL 75	=153,675 m2
- LL 35	=104,403 m2
- LL 60	= 4,750 m2
- LL 80	= 4,664 m2
- LL 100	= 6,496 m2
<b>TOTAL</b>	<b>=273,988 m2</b>

**- Weight of foam :**

16,500 M3 / year X 40 Kg / M3 = 660,000 Kg PU foam.

Based on above, the incremental operating costs for BATIMETAL are as follows :

Items	CFC 11 system	Pentane system
Price of foam USD /Kg	1.95	2.45
Average foam density ( Kg / m3 )	40	44
Production 1994	16,500	16,500
Cost of foam per year USD	1,287,000	1,778,700
Difference per year	491,700	
Incremental cost ( 2 years ) rounded, 10% discount rate	850,000	

The net present value of these incremental costs, over a period of two years, at 10% discount rate, amounts to USD 850,000.

The cost of transport and insurance of capital goods are included in the budgeted allocation for the respective items.

## **2- Contingency fund :**

A contingency fund ( 10 percent of the total investment cost ) is calculated , based on the total capital cost. 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.. .

## **3- Total costs :**

Investment costs will cover capital investment costs ( at CIF basis ) for the modification of existing manufacturing facilities, purchase of new machinery, training, installation and consulting services for plant and product modifications.

- the incremental operating costs associated with this project are as above.
- implementing Agency's overhead costs are 13 percent.
- for the complete costs breakdown see Annex "Project budget ".
- for the calculation of the unit abatement costs see Annex " unit abatement cost "
- the requested funding by the MFMP is USD 1,768,450.

## **ANNEX A: Equipment Specifications and Cost Breakdowns**

<b>Item</b>	<b>Total Cost ( USD )</b>
1. Pentane storage tank facility	165.000 USD
2. Metering unit for metering pentane 3. Safety cabin including extractor with pipe-line 4. Extractor 5. Safety equipment SUB - TOTAL	360.000 USD
6. Electrical modification 7. Fire protection modification 8. Production trials 9. International consultant assistance( Safety ) 10. Technology transfer 11. Training SUB - TOTAL	30.000 USD 25.000 USD 20.000 USD 10.000 USD 20.000 USD 20.000 USD 125.000 USD
12. Contingency ( 10 % )	65.000 USD
<b>INCREMENTAL CAPITAL COST</b>	<b>715.000 USD</b>



## **ANNEX B : PROJECT BUDGET**

<b>Budget line</b>	<b>Cost USD</b>
- Capital costs	650,000
- Contingency	65,000
- Incremental operating cost ( 2 years )	850,000
	1,565,000
- Sub - total	203,450
- Implementing Agency overhead ( 13 % )	
<b>Project total</b>	<b>1,768,450</b>

### ANNEX.C: CALCULATION OF UNIT ABATEMENT COST

A	ODS phase out	Unit	Total project
A1	Average use of CFC 11 per year	mt	110
A2	ODP of CFC 11	-	1
A3	Total ODP weighted CFC 11 phase out (A1* A2 )	mt	110
B	Annualized capital cost	unit	total project
B1	Total investment cost ( model redefinition + production conversion )	USD	715,000
B2	Equipment life	year	10
B3	Discount rate	%	10
B4	Annualized capital cost ( B1 * 0.1627 )	USD	116,330
C	Annual incremental operating cost	USD	491,700
D	Unit abatment cost		
D1	Annualized capital cost per Kg ODS phase out ( B4 / A3 / 1000 )	USD / Kg	1.06
D2	Annual incremental operating cost per Kg ODS phase out ( C / A3 / 1000 )	USD / Kg	4.47
D3	Unit abatment cost ( D1 + D2 )	USD / Kg	5.53

## ANNEX - IMPLEMENTATION SCHEDULE

MILESTONES/MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1- Sign the project, receive funding	—																		
2- Appointment of General Contractor site inspection		—																	
3- Elaboration of detailed project work-plan			—																
4- Draft of plant layouts			—																
5- Training						—				—									
6- Selection of equipment - bidding			—	—	—														
7- Modification of existing equipment							—	—	—										
8- Purchase, installation, commissioning					—	—	—	—	—	—	—								
9- Testing												—	—						
10- Start production with pentane													—	—	—	—	—	—	—

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