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UNITED NATIONS
INDUSTRIAL
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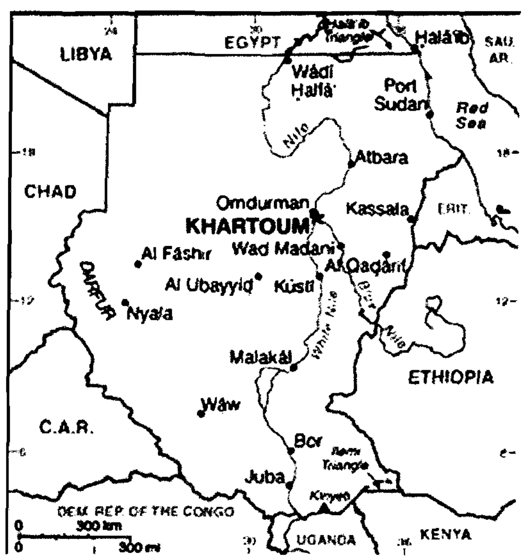
CONTRACT NO. 16001982

PROJECT NO. MP/SUD/09/004

NATIONAL HCFC PHASE OUT MANAGEMENT PLAN (HPMP) IN SUDAN

PROVISION OF CONSULTANCY SERVICES TO PREPARE INVESTMENT COMPONENT OF THE HPMP AND FOUR INDIVIDUAL PROJECTS IN THE FOAM AND REFRIGERATION SECTOR IN SUDAN



FINAL REPORT

MAY 2010

TRANS-MOND ENVIRONMENT LTD.
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EXECUTIVE SUMMARY

This report is the final report compiled according to the Terms of Reference of the contract. The report's purpose is to present the elaborated investment projects for the final approval.

Sudan has successfully phased-out the Annex A and B substances gaining experience from the project implementation regarding institutional strengthening, training, recovery and recycling and industrial investment projects. The basic administrative and institutional structures to manage the imports, consumption and use are in order.

The country is currently consuming some 48 ODP tonnes of HCFCs, out of which 80 % HCFC-141b in PU-foam production and the remaining 20 % HCFC-22 for the maintenance of commercial refrigeration units and air-conditioning equipment.

When preparing the four investment project documents the consultants have carefully noted especially the following ExCom guidelines:

***UNEP/OzL.Pro/ExCom/54/53; DRAFT GUIDELINES FOR THE PREPARATION OF HCFC PHASE-OUT MANAGEMENT PLANS INCORPORATING HCFC SURVEYS (DECISION 53/37)**
***UNEP/OzL.Pro/ExCom/55/47; REVISED ANALYSIS OF RELEVANT COST CONSIDERATIONS SURROUNDING THE FINANCING OF HCFC PHASE-OUT (DECISIONS 53/37(I) AND 54/40)**
***UNEP/OzL.Pro/ExCom/60/46; OUTSTANDING HCFC ISSUES: CUT-OFF DATE, LEVEL OF INCREMENTAL OPERATING COSTS, FUNDING PROVIDED TO THE SERVICING SECTOR, AND INCREMENTAL CAPITAL COSTS (DECISION 59/46)**

The proposed investment projects are as follows:

Beneficiary/Project	Incremental Capital Cost	Incremental Operating Cost	Total Cost
Modern Refrigerator Factory	660,000	57,665	**717,665**
Amin Factory for Insulation Panels	328,000	19,548	**347,548**
Coldair Engineering Co.	468,000	43,567	**511,567**
Akadabi Steel Co.	356,000	49,959	**405,959**
Total	**1,812,500**	**170,739**	**1,983,239**
Contingency	**181,250**	-	**181,250**
GRAND TOTAL			**2,164,489**

The proposed total grant to be requested from the Multilateral Fund is 1,685,896 US$.

PROJECT COVER SHEET

COUNTRY:	Sudan
IMPLEMENTING AGENCY:	UNIDO
PROJECT TITLE:	Umbrella project for the phase-out of HCFC-141b from the PU rigid foam production in the manufacturing of Domestic Refrigerators, Commercial Refrigerators and PU insulated composite panels.

PROJECT IN CURRENT BUSINESS PLAN	Yes
SECTOR	Rigid Polyurethane
SUB-SECTOR	
ODS USE IN SECTOR (2009)	330 MT
ODS USE AT ENTERPRISES (2009)	11.87 MT (ODP tonnes) of HCFC-141b (107.9 MT)
PROJECT IMPACT	11.87 MT (ODP tonnes) of HCFC-141b (107.9 MT)
PROJECT DURATION	30 months
TOTAL PROJECT COST:	
Incremental Capital Cost	US$ 1,812,500
Contingency	US$ 181,250
Incremental Operating Cost	US$ 170,739
Total Project Cost	US$ 2,164,489
LOCAL OWNERSHIP	100%
EXPORT COMPONENT	0%
REQUESTED GRANT	**US$ 1,568,275**
COST-EFFECTIVENESS	US$ 13.76/kg for domestic refrigeration sub-projects US$ 7.83/kg for insulation panels subprojects
IMPLEMENTING AGENCY SUPPORT COST (7.5%)	US$ 117,621
TOTAL COST OF PROJECT TO MULTILATERAL FUND	**US$ 1,685,896**
STATUS OF COUNTERPARTS FUNDING	
PROJECT MONITORING MILESTONES	Included
NATIONAL COORDINATING AGENCY	Ozone Office

Project summary

Under this umbrella project, Modern Refrigerator Factory and Coldair Engineering Co. Ltd. will phase out the use of HCFC-141b in their production of domestic and commercial refrigerators. Amin Factory for Insulation Panels and Akadabi Steel Co. will phase-out the use of HCFC-141b in their sandwich panels and insulation board stock production. The technology chosen for all enterprises is cyclo-pentane. The companies' aim is to accelerate the phase-out of HCFC foaming agents and to develop the production capability to exclusively use low GWP blowing agents.

Impact of project on Country's Montreal Protocol Obligations

Immediate impact of the project is the phase-out of 11,87 MT (ODP tonnes) of HCFC-141b (107.9 MT), thereby, contributing to the country's obligation to freeze the HCFC consumption by 2013 and to reduce by 10% in 2015. The successful implementation of this project makes a substantial contribution to Sudan's ability to meet the 2013 freeze and 2015 10 % reduction obligation at the average of 2009/2010 consumption.

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Prepared by: UNIDO — Date: 1st Umbrella draft 29.05.2010

Reviewed by: — Date:

Chapter 1. Background and project description

1.1 Accelerated HCFC phase-out and to this project relevant Executive Committee Decisions

In September 2007 the Parties to the Montreal Protocol at their Nineteenth Meeting agreed to accelerate the phase-out of production and consumption of hydrochlorofluorocarbons (HCFCs) by 10 years as per Decision XIX/6. The table below shows the accelerated phase out schedule for Article 5 countries.

Revised Phase-out Schedule for HCFCs in Article 5 Countries

Step	Year
Baseline	2009-2010
Freeze	2013
10% reduction	2015
35% reduction	2020
67.5% reduction	2025
97.5% reduction	2030
Average 2.5% for servicing tail only	2030-2039
100%	2040

The September 2007 adjustments to the Montreal Protocol oblige countries to take action as soon as possible to freeze their base line HCFC production and consumption levels (average of the years 2009-2010) in 2013, and reduce by 10 percent their production and consumption of HCFCs by 2015.

The Executive Committee of the Multilateral Fund approved guidelines and provided funding at its ??th Meeting for the preparation of HCFC phase-out management plan in Sudan.

Countries and implementing agencies were encouraged not only to take account of the ozone depleting potential of HCFCs but also the global warming implications of alternative substances and technologies, and exploit any potential financial incentives and opportunities for additional resources.

Furthermore, the Executive Committee, in its decision 54/39, established clear guidance on how to proceed with investment projects addressing HCFC phase out as follows:

Quote
(d) For countries that chose to implement investment projects in advance of completion of the HPMP:

> *(i) The approval of each project should result in a phase-out of HCFCs to count against the consumption identified in the HPMP and no such projects could be approved after 2010 unless they were part of the HPMP;*
> *(ii) If the individual project approach was used, the submission of the first project should provide an indication of how the demonstration projects related to the HPMP and an indication of when the HPMP would be submitted;*

Unquote

At its 55th Meeting, the ExCom approved funds for project preparation for HCFC phase-out management plan and at its 59th Meeting additional funding for HCFC phase-out management plans and project preparation for investment activities in the foam sector. As a result of the project preparation activity, the present umbrella investment project is being submitted to the Executive Committee's consideration at its 62[th] Meeting.

1.2 Project impact

The immediate impact of the project is to phase-out the use of 107.9 MT of HCFC-141b by converting to c-pentane technology at:

1. Modern Refrigerators Factory (Domestic refrigerators and freezers),
2. its sister company, Amin Factory for Insulation panels (PU insulated composite panels)
3. Coldair Engineering Company Ltd. (Domestic refrigerators and freezers) and
4. Akadabi Steel (PU insulated composite panels and insulation slabs).

Phase-out impact per enterprise

Enterprise	Baseline HCFC-141b cons. MT
Modern Refrigerators Factory (Domestic refrigerators and freezers),	30.6
Amin Factory for Insulation panels (PU insulated composite panels)	15.0
Coldair Engineering Company Ltd. (Domestic refrigerators and freezers)	23.5
Akadabi Steel (PU insulated composite panels and insulation slabs)	38.8
Total	**107.9**

Thereby contributing to the country's obligation to freeze the HCFC consumption by 2013 and to reduce by 10% in 2005.

Furthermore, early conversion of these companies will reduce the rate of increase in the banks of HCFC-141b based foams in the country thereby reducing future emissions of HCFCs into the atmosphere.

1.3 Submission of HPMP for Sudan

The full HPMP is intended to be submitted to the 62[nd] ExCom Meeting simultaneously with this umbrella investment project.

Chapter 2. Company baseline data

2.1 Baseline data for Modern Refrigerators Factory

The company was founded in 1982 and is 100% Sudanese owned; however, the production operation was quite seasonal until 1999, when continuous production was commenced. During the time of seasonal production from 1982 until 1999 company used CFC 11. Upon the continuous production started 1999 also company converted to the use HCFC 141b on their own resources. The production site is located in Omdurman, Sudan.

Modern Refrigerator Factory produces domestic refrigerators and freezers of 16 different models. In addition they construct cold stores and refrigerated rooms by using sandwich panels provided by their sister company Amin Factory for Insulation Panels.

The enterprise has a total of 310 employees. The only market is Sudan and all HCFC-141b based products are for Sudan's own consumption.

Modern Refrigerator Factory.
Owner: Mohamed Elamin Hamid Family
Contact person(s)Amgad Zoheir and Abdel Rahim Ali
Phone: +249 187 649452 / 3 /4
Cellular: +249912307800
Email: amgadzoheir@yahoo.com

Basic production equipment is following:

Equipment	Make/Model	S/N	Capacity	Date of Installation	Action Proposed	Disposal plan
HP foam dispenser for refrigerator cabinets	Cannon A system 40 Std - 1996	271008	40 kg/min	2000	Replacement or retrofit	
HP foam dispenser for chest freezers	Hennecke Baseline 720	200681	60 kg/min	2004	Replacement or retrofit	
LP foam dispenser for doors	R.M.P.A. Italy. Model C-60	10033	36 kg/min	2002	Replacement	Scrap
Premixing facility	R.M.P.A	N/A	100 l/batch	2002	Replacement	Scrap

ODS and PU chemicals usage in kgs at Modern Refrigerators Factory

	2006	2007	2008	2009
Polyol	152,563	161,181	161,652	179,740
MDI	228,844	241,772	242,478	270,000
HCFC 141b	25,935	27,400	27,481	30,556
Total	407,342	430,353	431,611	480,296

2.2 Baseline data for company Amin Factory for Insulation Panels

Amin Factory for Insulation panels is a 100% Sudanese owned private family company (same owners as Modern Refrigerator Factory) , which was founded 1 January 2005 and started manufacturing discontinuously produced PU-steel sandwich panels for roof, wall and fascias in the cold room construction, building and container industry for construction and insulation purposes.

The manufacturing plant is in Omdurman Industrial Area, Sudan. The enterprise has grown quickly since inception due to the sister company Modern Refrigerators Factory's experience in the cold room business.

The enterprise has 30 employees including technical and managerial staff for research and development, design, manufacturing, assembly, training, technical support, sales, marketing and after-sales services. Amin Factory for Insulation Panels jointly with Modern Refrigerator Factory has also its own construction teams and offers turnkey services to supply and install insulation.

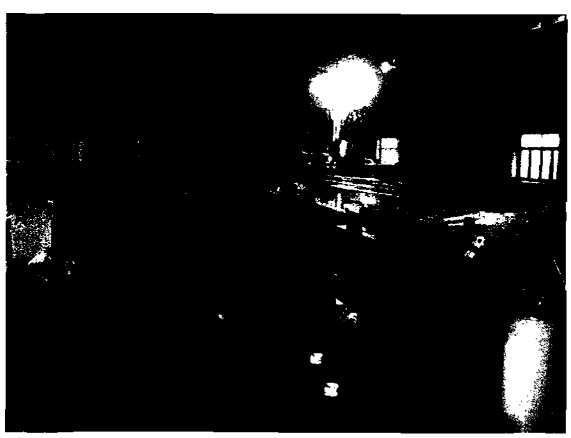
The only market is Sudan and all HCFC-141b based products are for Sudan's own consumption.

Address:
Amin Factory for Insulation Panels.
Owner: Mohamed Elamin Hamid Family
Contact person(s)Amgad Zoheir and Abdel Rahim Ali
Phone: +249 187 649452 / 3 /4
Cellular: +249912307800
Email: amgadzoheir@yahoo.com

The density of the rigid PU foams produced depends on the exact product and ranges between 39 and 45 kg/m³.

The production process is as follows:

Starting with a coil (thickness 0,55 and 0,50 mm) the steel plate is formed with a roll former, which can produce steel plates 12 m in length and of 0.6 to 1m wide.



After forming the steel plates, the upper and lower plates are assembled by hand into a panel on the both tables. Plastic separators are inserted to ensure the correct panel thickness of 40mm, 60 mm, 80 or 100 mm.

After assembly, the panels are loaded into a 2 + 2 press, which holds up to 2 units and the panels are filled one at a time with PU raw material.

Foam is injected using a low pressure Chinese made foam dispenser with an output of 80 kg/min.

Machine tanks of polyol and MDI have 2 x 300 l capacity each.

The de-molding time ranges between 30 minutes and one hour depending on the wall thickness.

For PU steel sandwich panels a two-component PU polyol / MDI system is used with HCFC 141b blowing agent (19-22 parts by weight). A catalyst, flame retardant, foam stabilizer (silicon stabilizer) and a small amount of water are also included. The mixing ratio of polyol and isocyanate is 1 to 1.20. The system is provided by Modern Refrigerator Factory.

Foam is metered and dispensed using a 2005 installed Chinese made low pressure foaming machine with a capacity of 80 kg/min.

The foaming machine is equipped with four day tanks, each with a capacity of 300 liters, which are filled by separate pumps from drums.
The below table summarizes the annual production of PU steel sandwich panels and HCFC-141b consumption at Amin Factory for Insulation panels:

Year	Panels, sqm	PU, MT	HCFC-141b, MT
2007	49,813	151.4	12.9
2008	52,130	151.5	13.5
2009	57,923	176	15.0

2.3 Baseline data for company Coldair Engineering Company Ltd

The company is 100% Sudanese owned and it was founded in 1935 as a workshop for repairing refrigerators, and in 1952 it started production of refrigerators, water-coolers, air-coolers (desert-coolers) and cold stores for vegetables and fruits.

In 1959 company opened their first show room in Khartoum and in 1960 company shifted its operations to Khartoum North industrial area. In the 2004 they started first chest freezers' insulation conversion from glass-wool to polyurethane insulation. And a model by model they converted all their production to HCFC 141b blown polyurethane.

During the year 2009, which is the base line year for considering the Coldair Engineering Company Ltd's ODS consumption; they manufactured 42,000 refrigerators. For producing that they consumed 238.1 tons MDI, 109.6 tons polyol, and 23.5 tons HCFC 141b.

Cold Air Engineering Company Ltd produces domestic refrigerators of 9 models and freezers of 3 different models.

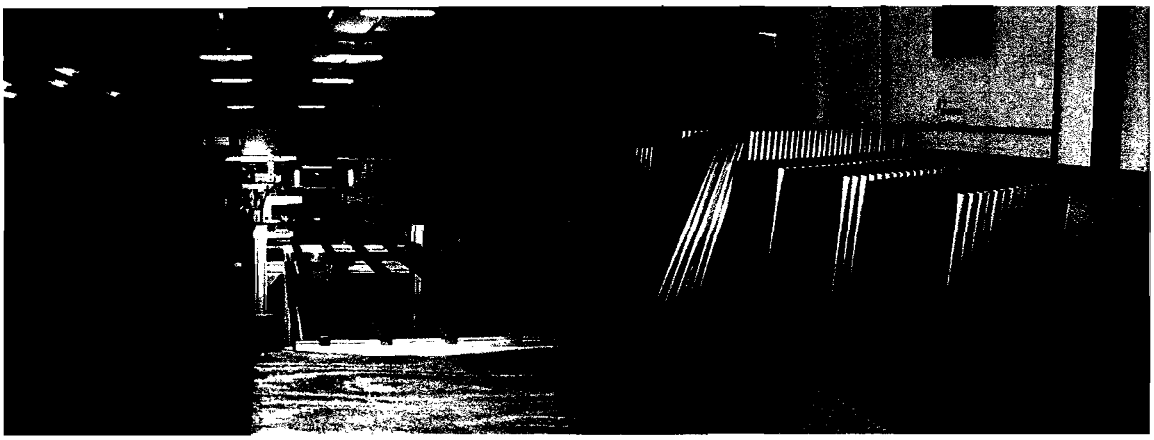
The enterprise has a total of 300 employees. The only market is Sudan and all HCFC-141b based products are for Sudan's own consumption.

Coldair Engineering Company Ltd.
Owner: Haggar Holding
Contact person(s)
Omer Bakri Abu Haraz, General Manager Phone: +249 185 236631, mob: +249 9(0)912170696
Mohammed A. Haroun, Plant Manager: Phone: (85) -333923 Fax: (85)330975 Mob.
mah@haggar-cec.com
www.coldairengineering.com, www.haggarholding.com

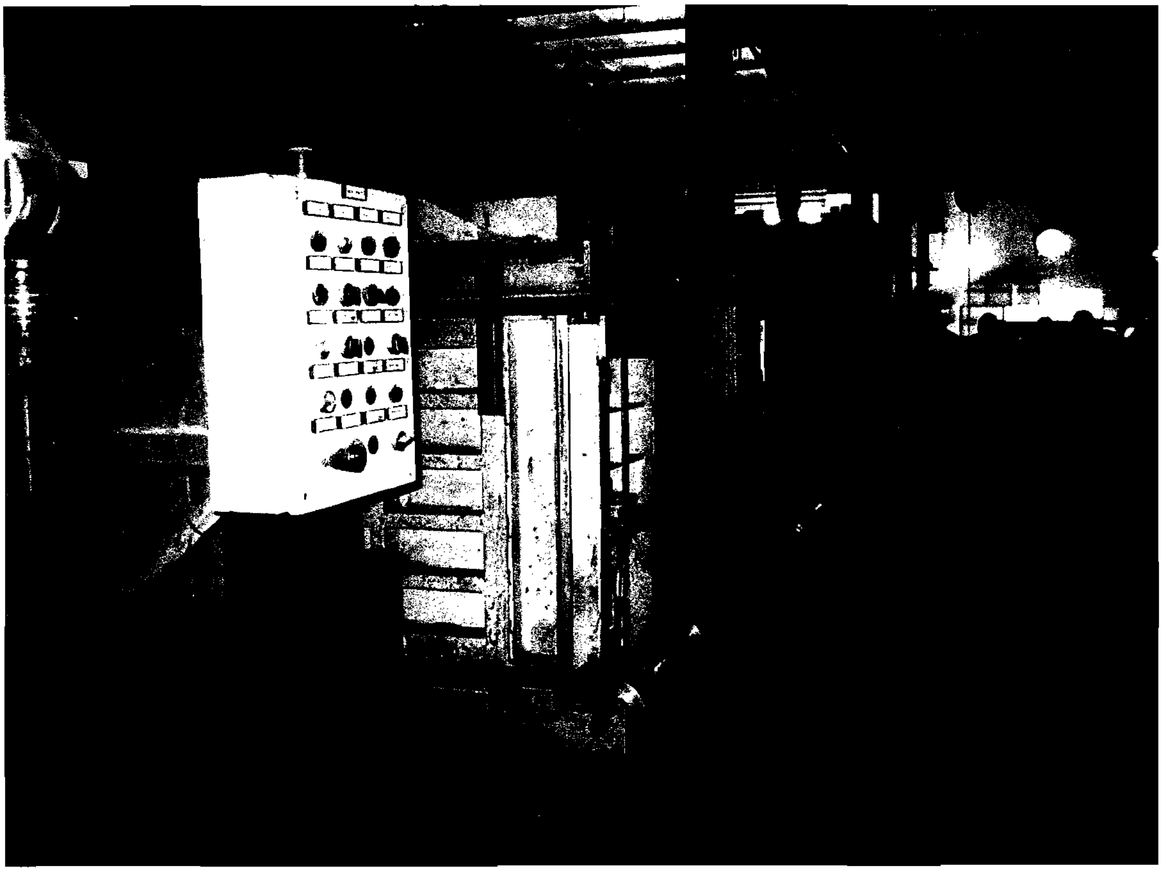
Basic production equipment is following:

Equipment	Make/Model	S/N	Capacity	Action Proposed	Disposal plan
HP foam dispenser for refrigerator cabinets	Cannon CMPT 100	291371	100 kg/min	Retrofit	
HP foam dispenser for doors	Cannon CMPT 100	200681	60 kg/min	Retrofit	
6 jigs for domestic refrigerator cabinets	Cannon			Retrofit	
2 jigs for chest freezers	Cannon			Retrofit	
Door drum for 4 positions	Cannon			Retrofit	

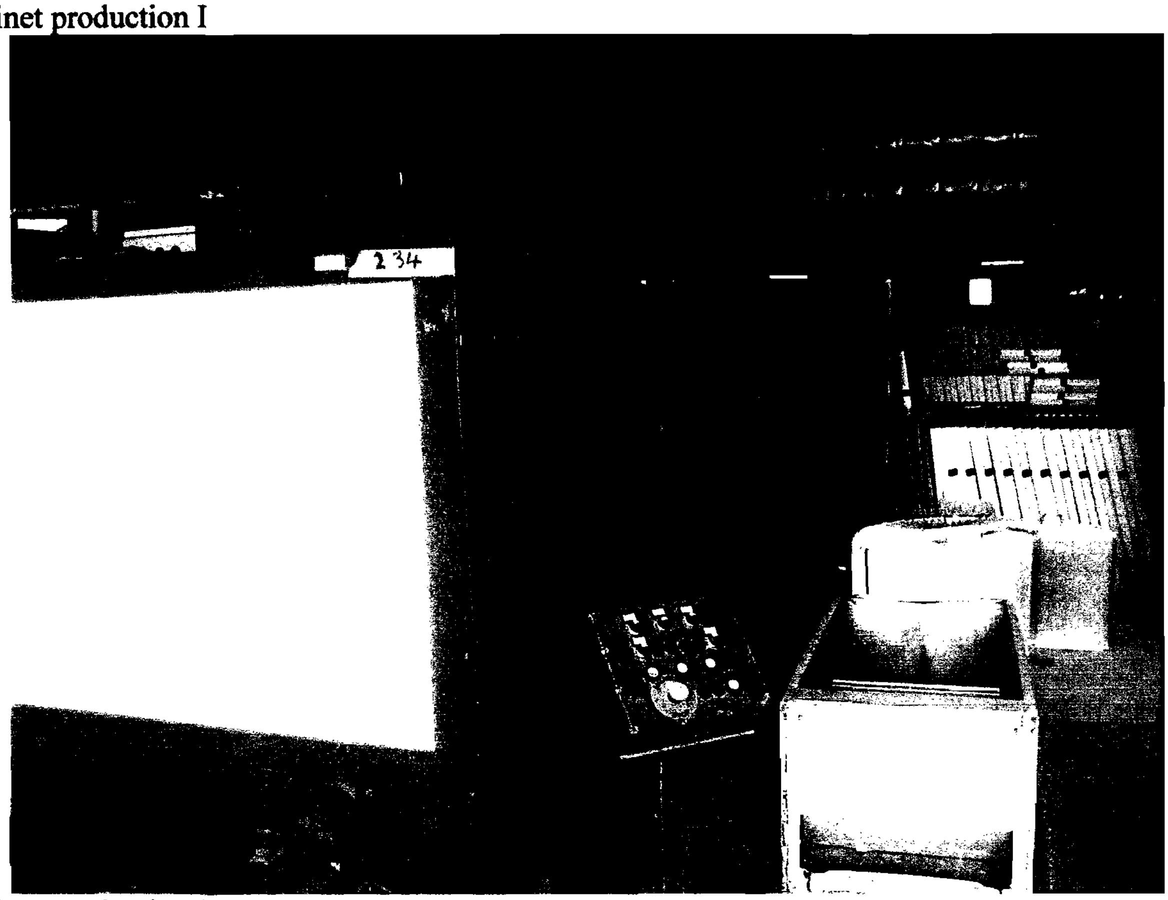
The production process is as follows:



Door production



Cabinet production I



Cabinet production II

Cabinet foaming machine

2.4 Baseline data for company Akadabi Steel

Akadabi Steel was founded 1994. And it started manufacturing operations for steel faced sandwich panels in 1996 on the discontinuous method for roof, walls in the cold room construction, building and container industry for construction and insulation purposes.

Akadabi Steel is a member of 100% Sudanese Al Akadabi Industrial Group. (Akadabi Steel, AIP Akabi Insulated Panels (EPS-concrete core panels), Akadabi for Transportation, Akadabi Manufacturing for Doors, Windows & Furniture from Aluminum, Abu Altayeb Factory for High Rising Building, Akabdabi Factory for Pre-fabricated Units.

Akadabi Steel is situated in Industrial Area of Khartoum North, Sudan

The enterprise has 130 employees from total 450 at the production of sandwich panels including technical and managerial staff for research and development, design, manufacturing, assembly, training, technical support, sales, marketing and after-sales services.

The only market is Sudan and all HCFC-141b based products are for Sudan's own consumption.

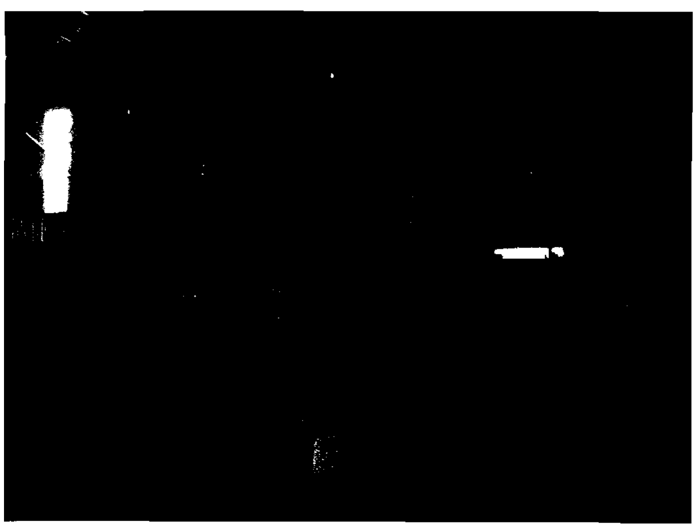
Address:
Akadabi Steel.
P.O Box 13355, Khartoum North
Owner: Al Akadabi Industrial Group
Contact person : Salih Khalid Salih Maglad
Phone: +249 155225870, Fax: +249 85349574

Cellular: +249 912337669
Email: salih_maglad@hotmail.com

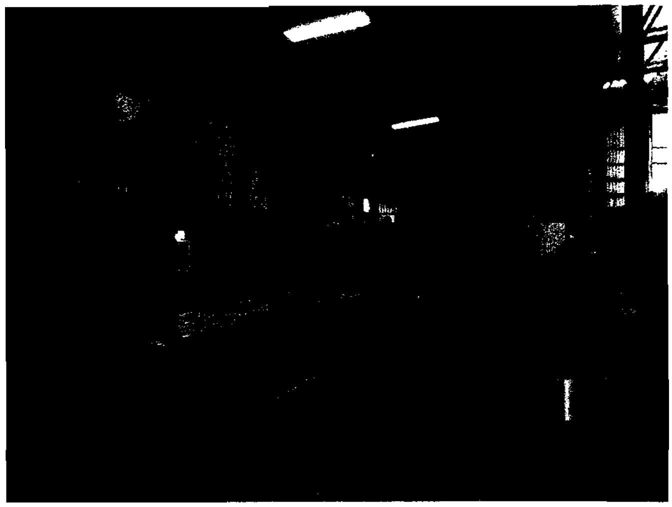
Equipment	Make/Model	S/N	Capacity	Action Proposed	Disposal plan
HP foaming dispenser	Elastogran, Germany	n.a	1,500 g/s 160 kg/min	Replacement	Scrap
HP foaming dispenser	OMS Impianti Ecomaster 200	2268		Retrofit polyol side	N.A.
Sandwich panel press 5 day lights	Paul Ott 300K 120-S 3 m x 1.5 m	7142		Retrofit	N.A.
Sandwich panel press 2 x 2 12.5 m			450 m2/shift	Retrofit	N.A

Akadabi has three sandwich panel production lines, two for PU insulated panels and one for EPS insulated panels. The EPS production line has not yet been in full production due to the technical problems in sheet metal feeding and quality problems of EPS core material.

The production line 1, which was assembled in the year 1997, is utilizing Elastogran GmbH 160 kg / min high pressure foaming machine with Paul OTT 5 daylight press for the production of sandwich panels of size up to width of 1.5 meters, and length up to 3 meters. Main use is for the insulation slabs sandwich panels for the portable cabinets with facing materials of 0.4 – 0.6 pre-painted steel sheets and MDF boards up to 12 mm. One shift (8 hrs) production capacity is about 300 m2.

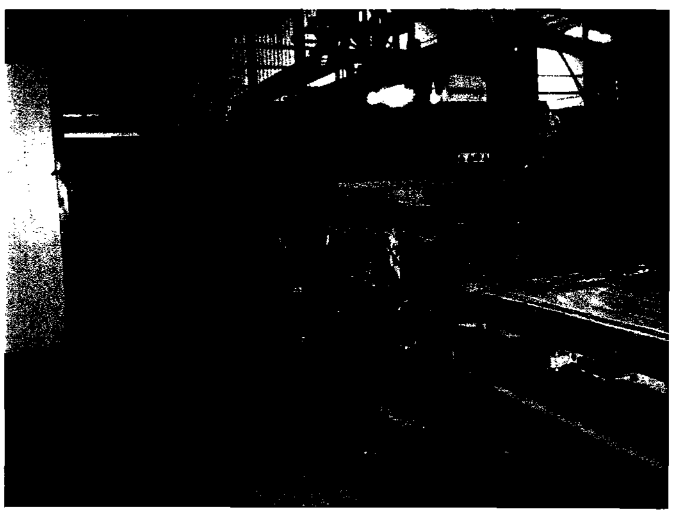


The production line 2, is utilizing OMS Impianti Ecomater 200 foaming machine and 2 by 2 Orto press with two scissor elevator tables.



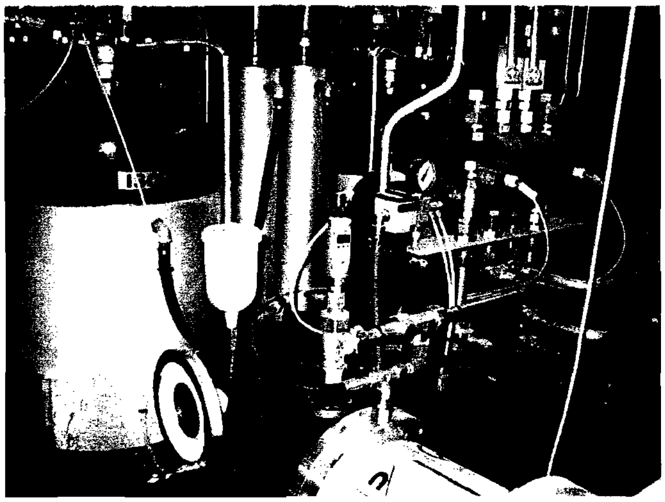
Starting with a roll-forming unit the pre-coated steel sheet (0.4 – 0.65) mm is formed up the required length 12.5 m and of 1.2 m wide.

After forming the steel sheets, the upper and lower sheet metals are conveyed and assembled manually into a panel on 2 + 2 ORMA press. Plastic separators are inserted to ensure the correct panel thickness of 40mm, 60 mm or 80 mm.



After assembly of the sheet metals from the both ends of the press, the empty panels are taxied into a 2 x 2 press, and simultaneously two already cured panels are moved out from the both ends of the press.

Foam is injected using a high pressure Impianti OMS Ecomaster 200 foam dispenser with an output of up to 180 kg/min, and a mixing head pressure of 130-150 bar.



Machine tanks of polyol and MDI have 250 l capacity each.

The de-molding time ranges between 15-20 minutes to one hour depending on the panel thickness.

For PU steel sandwich panels a two-component PU polyol / MDI system is used with HCFC 141b blowing agent (23 parts by weight of polyol). A catalyst, flame retardant, foam stabilizer (silicon stabilizer) and small amount of water are also included. The mixing ratio of polyol mixture and isocyanate is 1 to 1.2.

The foaming machine is equipped with two day tanks, each with a capacity of 250 liters, which are filled by separate pumps from standard drums.

The density of the rigid PU foams produced depends on the exact product and ranges between 39 and 45 kg/m³.

The table below summarizes the annual production of PU steel sandwich panels and HCFC-141b consumption at Akadabi Steel:

	2006 m2	2007 m2	2008 m2	2009 m2
Sandwich panel and insulation slab production	97,436	109,401	143,590	140,000

	2006 Mt	2007 Mt	2008 Mt	2009 Mt	Avg.3 years Mt
Polyol	105.6	118.5	155.5	166	146.7
MDI	155.1	174	228.6	245	215.8
HCFC 141b	24.3	27.2	35.74	38.8	33.91
Total	285.0	320.0	420.0	450.0	396.4

Chapter 3. - Alternative technologies

3.1. Overview of alternative to HCFC-141b for rigid PU foam application

HCFC-141b has been widely used as foam blowing agent for rigid polyurethane insulation foams due to its excellent insulation and foaming properties. For the replacement of HCFC-141b there are several mature alternative foaming technologies. Properties of these alternatives are summarized in the below table

Technology	GWP of agent	Flammability	Insulation performance	Cost of blowing agent	Capital investment	Suitable application
HCFC-141b	700	no	++++	medium	-	all
Cyclo-pentane	=<25	yes	+++-	medium	high	continuous line
Cyclo-pentane/iso-pentane Mixture 60/40	=<25	yes	++--	medium	high	continuous line
n-pentane	=<25	yes	+---	medium	high	continuous line
HFC-245fa	1,030	no	++++	high	-	all
HFC-365mfc/227 mixt.	780	no	++++	Medium to high	-	all
HFC 152a/water	142	yes	++--	medium		all
HFC 134a/water	1300	no	++--	medium		all
Water	0	no	----	low	low	Pour in place

3.2 Hydrocarbon technology

Hydrocarbon technology for the continuous block foam production has been mostly based on cyclopentane/ iso-pentane mixtures.

In the area of domestic refrigerators and discontinuously produced PU-steel sandwich panels there are companies already using pentane as blowing agent. Due to their flammability, extensive, but well established modifications are essential to the foaming part of the factory to meet appropriate safety requirements (ATEX EC-regulation). These include a storage facility for the pentane, pre-mixers, adapted high-pressure dispensers, encapsulated production area (predominantly air tight) plus extensive process exhaust, inerting with [1]Nitrogen before foaming operation, storage tank for nitrogen, hydrocarbon detectors, appropriate classification of electrical equipment, avoidance of static electricity and, above all, training of operating staff.

Furthermore it is necessary to reformulate the PU system concerning certification of fire testing classes.

To extend the use of this technology, precautions would be necessary to comply with the emission limits of volatile organic compounds (VOCs).

[1] In the case of production of domestic refrigerators inerting is required; however, in the sandwich panel's production grounding is essential, but not inertization.

In general, the conventional pentane and cyclo-pentane based foams show an increase of the density, 5-10% above the HCFC 141b foams and, typically, the initial thermal conductivity is increased by 15% - 18 % to about 22 mW/m°K (n-pentane based) and 20,5 mW/m°K (cyclo-pentane based) (at 10°C) (HCFC 141b 19 mW/m°K). Due to the recent advancements in the PU foam blowing technology the participants of this umbrella project expect that an additional increase of the foam density is not an issue.

Further development of hydrocarbon systems involves the use of blends, which reduce the economic density penalty without strongly affecting the insulation performance and may even enhance it. For example, optimized cyclo/isopentane-based foams show the overall density reduced to about 33-35 kg/m^3. By using cyclopentane/isobutane blends, dimension stability can be improved; and the thermal insulation value in low temperatures can also be improved due to the higher gas vapor pressure in the foam cells.

The use of cyclo/isopentane mixtures with HFCs 245fa or HFC 365mfc (so called co-blowing agent for pentane systems) is a further option with the advantage of reducing the density of the rigid foam by about 10% below the HCFC 141b foams with enhanced physical properties related to thermal conductivity and compression strengths.

3.3 HFC Technology

HFC blowing agents were developed as replacements for HCFCs. These agents include HFC 134a, HFC 152a, HFC 245fa, HFC 365mfc and mixtures of HFC 365mfc and HFC 227.

Foams based on HFC-134a/water are seen as a safeguard against the non-availability of liquid HFCs. The main issues are processing items because HFC-134a is a gas and has poor solubility in polyol formulations, increased frothing effect and the initial thermal conductivity of the foam can be increased by 10-20 % compared to HCFC 141b based foam, but it is not flammable.

Foams based on HFC 152a/water have the advantage of higher solubility of HFC 152a in polyol formulations and therefore reduced frothing effect by the production of PU panels. Thermal conductivity is similar to HFC 134a/water. HFC 152a is a flammable gas.

The blowing agents HFC-245fa and HFC 365mfc are technically viable blowing agents for this applications, giving similar densities to those of CFC-11-based foams. The initial thermal conductivity of the foam, at about 19.5 mW/m°K (at 10°C) is equivalent to those of HCFC-141b-based products and up to 10 – 15 % lower than for current hydrocarbon-blown foams. The boiling point of HFC 245fa (15.3°C) means that pressurized blending equipment would be necessary for its use, though evaluations reported to date suggest that HFC-245fa can be processed through foam equipment designed for use with CFC-11 and HCFC-141b in many cases. The good solubility in polyol formulations is a significant factor in its use.

The use of HFC 365mfc with a boiling point of 42°C is a true liquid and is used widely. Pure HFC 365mfc is a flammable liquid with a flash point at <-27°C. Commercially available mixtures contain HFC 227 to overcome the flash point issue. These mixtures are HFC 365mfc/227 with 93% or 87% 365 mfc as well as 7 and 13 % 227 respectively. Both mixtures are non-flammable liquids with a bubble point of about 32°C and 28 °C respectively. The initial thermal conductivity of the PU rigid foam can reach values of about 19 mW/m°K. Furthermore, the density of the foam can be 10% lower than PU foam blown with HCFC 141b. In practice it is important considering that the mixture is non azeotropic and therefore, it is recommended to use HFC 365/227 in a closed production cycle. For 93%/7% mixtures direct injection systems, while for the 87%/13% mixtures premixed polyol systems are recommended.

Current evaluation indicates that processing, insulation, physical property and most flammability requirements would all be met by these blowing agents. Initial insulation properties would be similar to those of HCFC-141b with the advantage of reduced rates of aging.

The key issues relating to the acceptance of these HFC blowing agents are their prices, availability, their GWP and the resulting cost of the boards in an extremely cost sensitive market in which there are several potential substitute products.

For the future there are several proposed low GWP agents such as HFE-245, HFE 254, and very new the HFOs (so called fluorinated olefins e.g. HFO 1234) (however, they are not commercially available yet.

To extend the use of these technologies, precautions are necessary to comply with VOC emission limits.

3.4 CO_2 (water)

CO_2 generated by reaction of the added water with isocyanate can be used in applications where an increase in foam thickness (up to 50%) can be accepted to give equivalent insulation value. There is also a penalty of a density increase of about 30% for the lower density foams with around 32 kg/m^3 but this penalty does not apply to those higher density foams used for example in PU steel sandwich applications. Another negative but very important point is the weak skin formation, which will negatively influence the adhesive properties of the PU foam/steel surface, meaning that normally it is not possible to use such PU-systems for sandwich panels.

3.5 CO_2 (liquid)

Liquid CO_2 technology is possible to use for continuously produced insulation boards. The thermal conductivity of the PU-rigid foam is very similar to pure water blown systems. The benefit for such PU system will be the lower consumption of isocyanate and therefore, a better skin formation in direction to more flexible ones. Negative impact is caused by the strong frothing effect, which often creates holes inside the PU rigid foam panel. Furthermore, high-pressure mixing devices are required.

3.6 Selection of alternative foam blowing agents

3.6.1 Company Modern Refrigerator Factory

Considering above review on alternative technologies, it is possible to select HFC 245fa, HFC 365/227 mixtures as well as pentane. It is unlikely that present technology developments such as HFEs and HFOs would appear in the market before 2012

In the case of HFC 245fa the possibility of the use of premixed polyol systems is given. The selection of this alternative would result only in limited changes in the production line.

The option HFC 365/227 as blowing agent will have the same terms and conditions as HFC 245fa, however, there is a need to install a closed polyol storage tank. Attention must be paid to the fact that HFC 365/227 mixtures are non azeotropic.

The selection of pentane technology has the main advantage that pentane is a natural substance with far lower GWP than 141b and any other HFC-based alternatives. There are already about 200 Million refrigerators and freezers manufactured during the past 18 years, so importation of c-pentane blown foam insulated refrigerator will be major challenge to Modern Refrigerator Factory, if not converting to the same production method as imported refrigerators in the future. Therefore, the company owner decided to convert to pentane technology in order to avoid any transitional substances.

3.6.2 Company Amin Factory for Insulation Panels

Considering above review on alternative technologies, it is possible to select HFC 245fa, HFC 365/227 mixtures as well as pentane. It is unlikely that present technology developments such as HFEs and HFOs would appear in the market before 2012

In the case of HFC 245fa the possibility of the use of premixed polyol systems is given. The selection of this alternative would result only in limited changes in the production line.

The option HFC 365/227 as blowing agent will have the same terms and conditions as HFC 245fa, however, there is a need to install a closed polyol storage tank. Attention must be paid to the fact that HFC 365/227 mixtures are non azeotropic.

The selection of pentane technology has the main advantage that pentane is a natural substance with far lower GWP than 141b and any other HFC-based alternatives. In European countries as well as in many developing counties there are already discontinuous production lines for the manufacturing of PU steel sandwich panels with pentane as blowing agent. Selection of pentane technology will result in additional investment costs. However, the company owner decided to convert to pentane technology in order to avoid any transitional substances.

3.6.3 Company Coldair Engineering Company Ltd.

Considering above review on alternative technologies, it is possible to select HFC 245fa, HFC 365/227 mixtures as well as pentane. It is unlikely that present technology developments such as HFEs and HFOs would appear in the market before 2012

In the case of HFC 245fa the possibility of the use of premixed polyol systems is given. The selection of this alternative would result only in limited changes in the production line.

The option HFC 365/227 as blowing agent will have the same terms and conditions as HFC 245fa, however, there is a need to install a closed polyol storage tank. Attention must be paid to the fact that HFC 365/227 mixtures are non azeotropic.

The selection of pentane technology has the main advantage that pentane is a natural substance with far lower GWP than 141b and any other HFC-based alternatives. There are already about 200 Million refrigerators and freezers manufactured during the past 18 years, so importation of c-pentane blown foam insulated refrigerator will be major challenge to Coldair Engineering Company, if not converting to the same production method as imported refrigerators in the future.

Therefore, the company owner decided to convert to pentane technology in order to avoid any transitional substances.

3.6.4 Company Akadabi Steel

Considering above review on alternative technologies, it is possible to select HFC 245fa, HFC 365/227 mixtures as well as pentane. It is unlikely that present technology developments such as HFEs and HFOs would appear in the market before 2012

In the case of HFC 245fa the possibility of the use of premixed polyol systems is given. The selection of this alternative would result only in limited changes in the production line.

The option HFC 365/227 as blowing agent will have the same terms and conditions as HFC 245fa, however, there is a need to install a closed polyol storage tank. Attention must be paid to the fact that HFC 365/227 mixtures are non azeotropic.

The selection of pentane technology has the main advantage that pentane is a natural substance with far lower GWP than 141b and any other HFC-based alternatives. In European countries as well as in many developing counties there are already discontinuous production lines for the manufacturing of PU steel sandwich panels with pentane as blowing agent. Selection of pentane technology will result in additional investment costs. However, the company owner decided to convert to pentane technology in order to avoid any transitional substances.

Chapter 4. Activities required for conversion

4.1 Modification of production process

All companies participating to this Umbrella project have decided to select c-pentane as a foam blowing agent in order:

1. to obtain better insulation properties, thus having positive influence to the energy savings;
2. to have same source and supply of c-pentane and
3. to minimize safety concerns related to the n-pentane's relatively low boiling point of 36°C. It has been experienced by the industry that in the similar hot countries (UAE)like Sudan soil temperature is reaching 40 °C, thus creating very strong outflow of pentane gas and sometimes pentane is coming out also as a liquid phase from the venting pipe.

4.1.1 Company Modern Refrigerator Factory – c-Pentane as blowing agent

C-Pentane is normally mixed in-situ at the factory, as pre-mixed polyol with c-pentane is not available due to safety reasons for transportation.

Underground double-wall storage tank for c-pentane (35 m^3) has to be installed. Enclosure of the PU production area is required in order to avoid pentane emission diffuse in other parts of the production hall. Ventilation should be accompanied with sensors as well as alarm system to avoid higher concentration of pentane than 10% of the lower explosion limit of pentane.

On-site mixing device for polyol and pentane mixture is necessary. Furthermore, a machine tank of premixed polyol is required, which is equipped with recirculation system to maintain homogeneity, as the miscibility of pentane with polyol is lower than polyol/141b. This tank needs a nitrogen blanket and it has to be conditioned.

Installation of a gas sensing and alarm system is necessity.

Electrical grounding and other electrical safeguarding of all relevant equipment must be provided.

In addition, a nitrogen storage tank is also required. Nitrogen is also to be injected in the foaming cavity before foaming.

Appropriate fire fighting tools are to be installed and safety training is essential for factory personnel (development of adequate safety procedures).

After conversion, the foaming line must be certified by a safety inspection institute.

4.1.2. Company Amin Factory for Insulation Panels – c-Pentane as blowing agent

Pentane is normally mixed in-situ at the factory, as pre-mixed polyol with c-pentane is not available due to safety reasons for transportation.

Underground double-wall storage tank for c-pentane (35 m^3) has to be installed. Enclosure of the PU production area is required in order to avoid pentane emission diffuse in other parts of the production hall. Ventilation should be accompanied with sensors as well as alarm system to avoid higher concentration of pentane than 10% of the lower explosion limit of pentane.

On-site mixing device for polyol and pentane mixture is also necessary. Furthermore, a machine tank of premixed polyol is required, which is equipped with recirculation system to maintain homogeneity, as the miscibility of pentane with polyol is lower than polyol/141b. This tank needs a nitrogen blanket and it has to be conditioned.

Installation of a gas sensing and alarm system is necessity.

Electrical grounding and other electrical safeguarding of all relevant equipment must be provided.

Appropriate fire fighting tools are also to be installed and safety training is essential for factory personnel (development of adequate safety procedures).

After conversion, the foaming line must be certified by a safety inspection institute.

4.1.3. Company Coldair Engineering Company Ltd – c-Pentane as blowing agent

C-Pentane is normally mixed in-situ at the factory, as pre-mixed polyol with c-pentane is not available due to safety reasons for transportation.

Underground double-wall storage tank for c-pentane (35 m^3) has to be installed. Enclosure of the PU production area is required in order to avoid pentane emission diffuse in other parts of the production hall. Ventilation should be accompanied with sensors as well as alarm system to avoid higher concentration of pentane than 10% of the lower explosion limit of pentane.

On-site mixing device for polyol and pentane mixture is necessary. Furthermore, a machine tank of premixed polyol is required, which is equipped with recirculation system to maintain homogeneity, as the miscibility of pentane with polyol is lower than polyol/141b. This tank needs a nitrogen blanket and it has to be conditioned.

Installation of a gas sensing and alarm system is necessity.

Electrical grounding and other electrical safeguarding of all relevant equipment must be provided.

In addition, a nitrogen storage tank is also required. Nitrogen is also to be injected in the foaming cavity before foaming.

Appropriate fire fighting tools are to be installed and safety training is essential for factory personnel (development of adequate safety procedures).

After conversion, the foaming line must be certified by a safety inspection institute.

4.1.4. Company Akadabi Steel – c-Pentane as blowing agent

Pentane is normally mixed in-situ at the factory, as pre-mixed polyol with c-pentane is not available due to safety reasons for transportation.

Underground double-wall storage tank for c-pentane (35 m^3) has to be installed. Enclosures of the PU production areas are required in order to avoid pentane emission diffuse in other parts of the production hall. Ventilation should be accompanied with sensors as well as alarm system to avoid higher concentration of pentane than 10% of the lower explosion limit of pentane.

On-site mixing device for polyol and pentane mixture is also necessary. Furthermore, a machine tank of premixed polyol is required, which is equipped with recirculation system to maintain homogeneity, as the miscibility of pentane with polyol is lower than polyol/141b. This tank needs a nitrogen blanket and it has to be conditioned.

Installation of a gas sensing and alarm system is necessity.

Electrical grounding and other electrical safeguarding of all relevant equipment must be provided.

Appropriate fire fighting tools are also to be installed and safety training is essential for factory personnel (development of adequate safety procedures).

After conversion, the foaming line must be certified by a safety inspection institute.

Chapter 5. Project cost

5.1 Incremental capital cost

5.1.1 Company Modern Refrigerator Factory

Foaming line modification (c-pentane)

The foaming operations shall be converted to the use of c-pentane from HCFC-141b. Funds are requested to cover the modification of existing foaming machine and the provision of necessary safety equipment, accessories as well as technology transfer, training, trials and commissioning.

The below table shows the estimated Incremental Capital Costs (ICC) required for conversion at Modern Refrigerator Factory:

	Item	Unit Cost US$	Quantity	Sub-total
	Production			
1.1	Cannon foaming machine retrofit	78 000	1	78 000
1.2	Hennecke foaming machine retrofit	78 000	1	78 000
1.3	Replacement of R.M.P.A.	150 000	1	150 000
1.4	Replacement of pre-mixing unit	85 000	1	85 000
1.5	Hydrocarbon storage and accessories (piping and pumps, ventilation)	30 000	1	30 000
	Total Production			**421 000**
	Plant Safety			
2.1	Heating, ventilation and enclosure for cabinet plant (domestic refrigeration) (19 cabinet fixtures), ventilation 14,000 m3/h		1	50 000
2.2	Heating, ventilation and enclosure for door plant (domestic refrigeration) (24 door fixtures), ventilation 9,000 m3/h		1	42 500
2.3	Gas sensors, alarm, monitoring system for entire plant (1 base console and 5 sensors)		1	35 000
2.4	Fire protection/control system for the plant and	2 000	1	2 000
2.5	Lightning protection and grounding	10 000	1	10 000
2.6	Nitrogen Generator	40 000	1	40 000
2.7	Safety audit/Safety inspection & certification	10 000	1	10 000
	Total Plant Safety			**189 500**
	General			
3.1	Civil works	15 000	1	15 000
3.2	Training and International Technical Support	20 000	1	20 000
3.3	Trials	10 000	1	10 000
	Testing	5 000	1	5 000
	Total General			**50 000**
				660 500
4.0	**Contingencies (~10%)**			**66 050**
	TOTAL CAPITAL INVESTMENT COSTS			**726 550**

5.1.2 Company Amin Factory for Insulation Panels

Foaming line modification (c-pentane)

The foaming operations shall be converted to the use of c-pentane from HCFC-141b. Funds are requested to cover the modification of existing foaming machine and the provision of necessary safety equipment, accessories as well as technology transfer, training, trials and commissioning. Retrofitting of the existing equipment is not possible since no spare parts are available for 10 years old Chinese made low-pressure equipment. Furthermore, provision of necessary safety equipment, accessories as well as technology transfer, training, trials and commissioning are required.

The table below shows the estimated Incremental Capital Costs (ICC) required for conversion at Amin Factory for Insulation Panels company:

	Item	Unit Cost US$	#	Sub-total
	Production			
1.1	Replacement of Chinese made foaming machine	78,000	1	78,000
1.2	Premixing unit	85,000	1	85,000
1.3	Hydrocarbon storage and accessories (piping and pumps, ventilation)	30,000	1	30,000
	Total Production			**193,000**
	Plant Safety			
2.1	Ventilation and enclosure for panel plant, ventilation 18,000 m^3/h		1	28,000
2.2	Gas sensors, alarm, monitoring system for entire plant (1 base console and 5 sensors)		1	35,000
2.3	Fire protection/control system for the plant	2,000	1	2,000
2.4	Lightning protection and grounding	10,000	1	10,000
2.5	Safety audit/Safety inspection & certification	10,000	1	10,000
	Total Plant Safety			**85,000**
	General			
3.1	Civil works	15,000	1	15,000
3.2	Training and International Technical Support	20,000	1	20,000
3.3	Trials	10,000	1	10,000
	Testing	5,000	1	5,000
	Total General			**50,000**
				328,000
4.0	**Contingencies (~10%)**			**32,800**
	TOTAL CAPITAL INVESTMENT COSTS			**360,800**

5.1.3 Company Coldair Engineering Company Ltd

Foaming line modification (c-pentane)

The foaming operations shall be converted to the use of c-pentane from HCFC-141b. Funds are requested to cover the modification of existing foaming machine and the provision of necessary safety equipment, accessories as well as technology transfer, training, trials and commissioning.

The below table shows the estimated Incremental Capital Costs (ICC) required for conversion at Coldair Engineering Company Ltd:

	Item	Unit Cost US$	Quantity	Sub-total
	Production			
1.1	Cannon foaming machine retrofit	78 000	1	78 000
1.2	Hennecke foaming machine retrofit	78 000	1	78 000
1.3	Replacement of pre-mixing unit	85 000	1	85 000
1.4	Hydrocarbon storage and accessories (piping and pumps, ventilation)	30 000	1	30 000
	Total Production			**271 000**
	Plant Safety			
2.1	Heating, ventilation and enclosure for cabinet plant (6+2 cabinet fixtures), ventilation 14,000 m3/h		1	30 000
2.2	Heating, ventilation and enclosure for door plant (4 door fixtures), ventilation 9,000 m3/h		1	20 000
2.3	Gas sensors, alarm, monitoring system for entire plant (1 base console and 5 sensors)		1	35 000
2.4	Fire protection/control system for the plant and	2 000	1	2 000
2.5	Lightning protection and grounding	10 000	1	10 000
2.6	Nitrogen Generator	40 000	1	40 000
2.7	Safety audit/Safety inspection & certification	10 000	1	10 000
	Total Plant Safety			**147 000**
	General			
3.1	Civil works	15 000	1	15 000
3.2	Training and International Technical Support	20 000	1	20 000
3.3	Trials	10 000	1	10 000
	Testing	5 000	1	5 000
	Total General			**50 000**
				468 000
4.0	**Contingencies (~10%)**			**46 800**
	TOTAL CAPITAL INVESTMENT COSTS			**514 800**

5.1.4 Company Akadabi Steel

Foaming line modification (c-pentane)

The foaming operations shall be converted to the use of c-pentane from HCFC-141b. Funds are requested to cover the modification of existing foaming machines and the provision of necessary safety equipment, accessories as well as technology transfer, training, trials and commissioning.

	Item	Unit Cost US$	#	Sub-total
	Production			
1.1	Replacement of Elastogran foaming machine	78 000	1	78 000
1.2	Retrofit of OMS foaming machine	35 000	1	35 000
1.3	Premixing unit	85 000	1	85 000
1.4	Hydrocarbon drum storage and direct feed from drums and accessories (piping and pumps, ventilation)	30 000	1	30 000
	Total Production			**228 000**
	Plant Safety			
2.1	Ventilation and enclosure for panel plant, ventilation 18,000 m^3/h		2	16 000
2.2	Gas sensors, alarm, monitoring system for entire plant (1 base console and 8 sensors)		1	40 000
2.3	Fire protection/control system for the plant	2 000	1	2 000
2.4	Lightning protection and grounding	10 000	1	10 000
2.5	Safety audit/Safety inspection & certification	10 000	1	10 000
	Total Plant Safety			**78 000**
	General			
3.1	Civil works	15 000	1	15 000
3.2	Training and International Technical Support	20 000	1	20 000
3.3	Trials	10 000	1	10 000
	Testing	5 000	1	5 000
	Total General			**50 000**
				356 000
4.0	**Contingencies (~10%)**			**35 600**
	TOTAL CAPITAL INVESTMENT COSTS			**391 600**

Retrofitting of the existing Elastogran equipment is not possible since no spare parts are available for 13 years old Elastogran made high-pressure equipment. Furthermore, provision of necessary safety equipment, accessories as well as technology transfer, training, trials and commissioning are required.

The table below shows the estimated Incremental Capital Costs (ICC) required for conversion at Akadabi Steel company:

5.2 Incremental Operating Cost

In calculating the Incremental Operating Costs it has been assumed that:

- The use of c-Pentane is about 60% of the use of HCFC 141b.

Incremental operating cost related to the conversion of the foaming technology was calculated based on standard formulations. Current prices in the region are as follows:

- HCFC-141b:$ 1.60/metric kg
- c-Pentane: $2.20/metric kg

5.2.1 Company Modern Refrigerator Factory (IOC)

	R-141b system			c-pentane system		
Chemicals	Amount	Price	Cost	Amount	Price	Cost
	kg	US$/kg	US$	kg	US$/kg	US$
Polyol	0.374	3.15	1.178	0.420	3.20	1.344
Isocyanate	0.562	3.15	1.770	0.526	3.15	1.657
B.A	0.064	1.60	0.102	0.054	2.20	0.119
Total	**1.000**		**3.051**			**3.120**
				Difference per kg		**0.069**

It is assumed that the density of the foam would not increase. The net present values are considered with the annual inflation rate of 10%, as this is an established methodology for the foam IOC calculation. The result of the foam IOC calculation is shown in the table below.

	Before conversion	Year I	Year II
Foam production [kg]	480,296	480,296	480,296
Total annual cost of chemicals used	1,465,383	1,498,524	1,498,524
Cost difference per annum		33,141	4,803
Discount factor		0.91	0.83
NPV		30,158	27,507
Total IOC, US$			**57,665**

5.2.2 For Company Amin Factory for Insulation Panels

	R-141b system			c-pentane system		
Chemicals	Amount	Price	Cost	Amount	Price	Cost
	kg	US$/kg	US$	kg	US$/kg	US$
Polyol	0.370	3.15	1.166	0.373	3.20	1.194
Isocyanate	0.545	3.15	1.717	0.597	3.15	1.881
B.A	0.085	1.60	0.136	0.030	2.20	0.066
Total	1.000		3.018			3.140
					Difference per kg	0.122

It is assumed that the density of the foam would not increase. The net present values are considered with the annual inflation rate of 10%, as this is an established methodology for the foam IOC calculation. The result of the foam IOC calculation is shown in the table below.

	Before conversion	Year I
Foam production - [kg]	176,086	176,086
Total annual cost of chemicals used (US$)	531,428	552,910
Cost difference per annum		21,482
Discount factor		0.91
NPV		19,548
Total IOC, US$		**19,548**

5.2.3 Company Coldair Engineering Company Ltd (IOC)

	R-141b system			c-pentane system		
Chemicals	Amount	Price	Cost	Amount	Price	Cost
	kg	US$/kg	US$	kg	US$/kg	US$
Polyol	0.374	3.15	1.178	0.420	3.20	1.344
Isocyanate	0.562	3.15	1.770	0.526	3.15	1.657
B.A	0.064	1.60	0.102	0.054	2.20	0.119
Total	1.000		3.051			3.120
					Difference per kg	0.069

It is assumed that the density of the foam would not increase. The net present values are considered with the annual inflation rate of 10%, as this is an established methodology for the foam IOC calculation. The result of the foam IOC calculation is shown in the table below.

	Before conversion	Year I	Year II
Foam production [kg]	371,200	371,200	371,200
Total annual cost of chemicals used	1,132,531	1,158,144	1,158,144
Cost difference per annum		25,613	25,613
Discount factor		0.91	0.83
NPV		23,308	21,259
Total IOC, US$			**43,567**

5.2.4 Company Akadabi (IOC)

	R-141b system			c-pentane system		
Chemicals	**Amount**	**Price**	**Cost**	**Amount**	**Price**	**Cost**
	kg	**US$/kg**	**US$**	**kg**	**US$/kg**	**US$**
Polyol	0.370	3.15	1.166	**0.373**	**3.20**	**1.194**
Isocyanate	0.545	3.15	1.717	**0.597**	**3.15**	**1.881**
B.A	0.085	1.60	0.136	**0.030**	**2.20**	**0.066**
Total	**1.000**		**3.018**			**3.140**
					Difference per kg	**0.122**

It is assumed that the density of the foam would not increase. The net present values are considered with the annual inflation rate of 10%, as this is an established methodology for the foam IOC calculation. The result of the foam IOC calculation is shown in the table below.

	Before conversion	Year I
Foam production [kg]	450,000	450,00
Total annual cost of chemicals used	1,358,100	1,413,000
Cost difference per annum		54,900
Discount factor		0.91
NPV		49,959
Total IOC, US$		**49,959**

5.3 Summary of the total project cost

The table below provides the summary of the total project cost in US$. The total costs of US$ 2,164,489 exceed the maximum eligible costs based on the cost-effectiveness criteria as defined in the ExCom

No.	Item	Cost,	Max. Funding per C.E	
		US$	US$	
1	**Incremental Capital Cost**			
1.1	MRF	660 500		
1.2	Amin	328 000		
1.3	Coldair Refrigeration Company	468 000		
1.4	Akadabi Steel	356 000		
	Sub-total	1 812 500		
	Contingency	181 250		
	Total ICC	1 993 750		
2	**Incremental Operating Cost,**			
2.1	MRF, for 2 years operation	57 665		
2.2	Amin, for 1 year operation	19 548		
2.3	CRC, for 2 years operation	43 567		
2.4	Akadabi Steel, for 1 year operation	49 959		
	Total IOC	170 739		
3	Total project cost	2 164 489	Max. available funding per C.E	
3.1	Total cost MRF incl. contingency	784 215	30.6x13.76x1.25	526 320
3.2	Total cost Amin incl. contingency	380 348	15x7.83x1.25	258 000
3.3	Total cost Coldair Refrigeration incl. contingency	558 367	23.5x13.76x1.25	404 200
3.4	Total cost Akadabi incl. contingenc	441 559	38.8x7.83x1.25	379 755
4	Project cost by MLF			1 568 275
5	IA Cost (7.5%)			117 621
6	**Total Grant requested**			**1 685 896**

Chapter 6. Project implementation modalities

6.1 Implementation structure

The National Ozone Office, _______, is responsible for the overall project coordination and assessment. Under the supervision by the NOU, UNIDO as an implementing agency is responsible for the financial management of the grant. UNIDO is also to assist the enterprise in equipment procurement, technical information update, monitoring the progress of implementation, and reporting to the ExCom. The enterprise is responsible to achieve the project objective by providing financial and personnel resources required for the success of the project implementation. Financial management will be administered by UNIDO following UNIDO's Financial Rules and Regulation.

6.2 Working arrangement for implementation

After the approval of the project by the Executive Committee, the working arrangement will be signed by the above parties, where the roles and responsibilities of each party are detailed.

6.3 Modification of production process

Procurement of equipment required for the production line modification will be done through an international bidding process organized by UNIDO. Smaller equipment and parts may be procured locally, if local procurement is found to be more economic. Local procurement will also be done based on UNIDO's Financial Rules and Regulations. This applies also for contracting with contractors for provision of technical services. Terms of references and technical specifications for the procurement of contracts and equipment will be prepared by UNIDO in consultation and agreement with the enterprise and the NOU.

6.4 Project monitoring

Project monitoring is done by UNIDO through regular missions to the project sites and continuous communications through e-mails and telephone. Occasional visits and communication by the NOU are also to be done to ensure adequate project implementation.

6.5 Project completion

Project completion report will be submitted by UNIDO within 6 months after project completion. Necessary data and information for the preparation of the project completion report is to be provided by the enterprise.

6.6 Timetable for implementation

The project is planned to be implemented according to the below timetable. It is important to note that the project will be completed before end 2012 to ensure its contribution to the 2013 country obligation to freeze the HCFC consumption.

	2010 Nov-Dec	2011 H1	2011 H2	2012 H1	2012 H2
Approval					
Working arrangement					
Preparation of TORs					
Bidding					
Modification of foaming line, installation					
Staff training					
Safety certificate					
Project completion					