GOVERNMENT OF EGYPT

MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL FOR THE PILOT PROJECT FOR THE VALIDATION OF LOW COST OPTIONS FOR HYDROCARBONS AS FOAMING AGENT IN THE MANUFACTURE OF POLYURETHANE FOAMS

UNITED NATIONS DEVELOPMENT PROGRAMME

Project Title

Pilot project for the Validation of Low Cost Options for Hydrocarbons as Foaming Agent in the Manufacture of Polyurethane Foams.

Brief Description

Egypt is a Party to the Vienna Convention and Montreal Protocol. It also ratified the London, Copenhagen and Montreal amendments. The country is fully committed to the phaseout of HCFCs and willing to take the lead in assessing and implementing new HCFC phaseout technologies, particularly in the foam sector as it did for CFCs in 1992 when it submitted and completed the first foam sector investment projects ever under the MLF. Egypt has local PU system houses that frequently combine importations and distributions for major international chemical and equipment manufactures with local blending for SMEs. In addition, most international PU chemicals suppliers are represented with offices or their own system houses.

Expected Outcome

Sustainable management of environment and natural resource incorporated into poverty reduction strategies/key national development frameworks and sector strategies.

Expected Output

The main output of the project is to validate optimized HC technology and will contribute indirectly to the fulfillment of Egypt's Montreal Protocol obligations. If successfully validated, the optimized technology will contribute to the availability of cost-effective options that are urgently needed to implement HCFC phase-out, particularly at SMEs.

UNDAF Outcome: By 2011, regional human development disparities are reduced, including reducing the gender gap, and environmental sustainability improved.

Country Programme Outcomes: Pollution level reduced

Country Programme Outputs: Appropriate and innovative pollution abatement techniques and approaches introduced including cleaner production systems.

Implementing Partner (Government): Egypt Environmental Affairs Agency (EEAA), Ozone Unit

Proramme Period: September 2009- April 2010

Project Title: Pilot Project for the Validation of Low Cost Options for Hydrocarbons as Foaming Agent in the Manufacture of Polyurethane Foams.

Duration: 8 months

Ref.: EGY/FOA/58/TAS/100

Total Budget: US$508,475

Allocated Resources: Montreal Protocol: US$508,475

Agreed by Government of Egypt

Name: His Excellency
Minister Plenipotentiary
Bassem Khalil
Assistant Foreign Minister and Director
of International Cooperation
MOFA

Signature: ____________ Date: ________

Agreed by the Implementing Partner:

Name: Dr. Mawaheb Abou El-Azm
Chief Executive Officer
Egyptian Environmental Affairs
Agency (EEAA)

Signature ____________ Date: __________

Agreed by United Nations Development Programme

Name: Mr. Mounir Tabet
Country Director.

Signature ____________ Date: 24 Oct 2009

58th Meeting of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol

COUNTRY:	**Egypt**	**IMPLEMENTING AGENCY: UNDP**

PROJECT TITLE: **Validation/Demonstration of Low Cost Options for the Use of Hydrocarbons as foaming agent in the Manufacture of PU Foams**

PROJECT IN CURRENT BUSINESS PLAN:	**Based on ExCom Decision 55/43(e i-iii)**
SECTOR:	**Foams**
Sub-Sector:	**Rigid and Integral Skin PU Foams**
ODS USE IN SECTOR	
Baseline:	**Not yet determined**
Current (2007):	**433 ODP t HCFCs as per Government reporting**
BASELINE ODS USE:	**n/a (pilot project)**
PROJECT IMPACT (ODP targeted):	**n/a (pilot project)**
PROJECT DURATION:	**8 months**
PROJECT COSTS:	**US$ 473,000**
LOCAL OWNERSHIP:	**100 %**
EXPORT COMPONENT:	**0 %**
REQUESTED MLF GRANT:	**US$ 473,000**
IMPLEMENTING AGENCY SUPPORT COST:	**US$ 35,475 (7.5 %)**
TOTAL COST OF PROJECT TO MLF:	**US$ 508,475**
COST-EFFECTIVENESS:	**11.8 US$/kg-ODS**
PROJECT MONITORING MILESTONES:	**Included**
NTL. COORDINATING AGENCY:	**Egypt Environmental Affairs Agency (EEAA) National Ozone Unit**

PROJECT SUMMARY

Egypt is a Party to the Vienna Convention and the Montreal Protocol. It also ratified the London, Copenhagen and Montreal amendments. The country is fully committed to the phaseout of HCFCs and willing to take the lead in assessing and implementing new HCFC phaseout technologies, particularly in the foam sector—as it did for CFCs in 1992 when it submitted and completed the first foam sector investment projects ever under the MLF. Egypt has local PU system houses that frequently combine importations and distributions for major international chemical and equipment manufacturers with local blending for SMEs. In addition, most international PU chemicals suppliers are represented with offices or their own system houses.

The objective of this project is to develop, optimize, validate and disseminate low-cost systems for the use of hydrocarbons in the manufacture of PU rigid insulation and integral skin foams.

IMPACT OF PROJECT ON COUNTRY'S MONTREAL PROTOCOL OBLIGATIONS

This project is a pilot project aimed to validate optimized HC technology and will contribute indirectly to the fulfillment of Egypt's Montreal Protocol obligations. If successfully validated, the optimized technology will contribute to availability of cost-effective options that are urgently needed to implement HCFC phase-out, particularly at SMEs.

Prepared by: Rappa, Inc. **Date: May 2009**

PROJECT OF THE GOVERNMENT OF EGYPT

PILOT PROJECT FOR THE VALIDATION/DEMONSTRATION OF LOW COST OPTIONS FOR HYDROCARBONS AS FOAMING AGENT IN THE MANUFACTURE OF PU FOAMS

1. PROJECT OBJECTIVES

The objectives of this project are to:

1. Develop, optimize and validate low cost options for hydrocarbons as auxiliary blowing agent in polyurethane foam applications; then
2. demonstrate the validated technology in a representative amount of downstream operations, and
3. transfer the technology to interested system houses and other users

2. INTRODUCTION

Current *validated* technologies for replacing HCFC-141b in foams are restricted to water/isocyanate, hydrocarbons and HFCs. With water non-performing in thermal insulation applications, HFCs being high in GWP and hydrocarbons high in investment costs, it is important that, along with the investigation of other, recently developed, but not yet validated options, these technologies will be investigated on approaches to improve their technical, cost and/or e nvironmental performance. ExCom Decision 55/43 reflects this by promoting pilot projects aimed to validate technologies, mentioning specifically the use of low-cost hydrocarbon technologies. UNDP has followed recent developments in the foam industry closely and prepared four pilot projects which, it believes, cover all commercially available products that have potential—or have been proven—as blowing agent in foams but need optimization/validation/demonstration in an A5 context. These technologies are:

Substance	Sub-Sector	Status	Comments
Hydrocarbons	RPF, ISF	to 58th ExCom	Validation/Demonstration of cost saving options
Methyl formate	RPF, ISF, FPF	Approved	Technical validation of a commercial available product
Methylal	RPF, ISF, FPF	to 58th ExCom	Technical validation of a commercial available product
HFO-1234ze	XPS	to 58th ExCom	Technical validation of a commercial available product

This project covers the validation of low cost hydrocarbon technologies. Technology validation is a global task. However, it has to be executed in a particular country and UNDP is therefore preparing the proposals in consultation and with the consent of the relevant countries, and an endorsement letter from the country is included. However, because of the global impact, deduction of the first phase, which deals with development, optimization and validation from the national aggregate HCFC consumption, would not be fair and it is requested to treat phase-1 this way.

3. PROJECT DESCRIPTION

3.1 PROJECT DESIGN

This project is different from other pilot projects concerning HCFC replacements in polyurethane foams. In other projects the technology to be validated is a new one, which requires development of formulations for all applications. In this case the technology is already existing for quite a while—since around 1992—and broadly applied in an A5 context in companies that would meet a critical size and technical proficiency. In praxis this meant that a company should use at least 50t and have in-house engineering capabilities to be eligible.

This would translate in eligibility for a grant of (7.83 x 50,000 =) US$ 391,000 which approximated the costs of such a project. For domestic refrigeration plans, which cost more because of expensive jigs retrofit, a higher threshold was set. This effectively limited the technology to large companies only and led indirectly to wide-spread use of HCFC-141b in SMEs. Therefore, if the cost of hydrocarbon technology is not lowered, SMEs can only hope to fall back on environmentally undesirable HFCs, low performing and expensive water-based systems or hope that the Validation/Demonstration of new technologies—will provide more satisfactory options. The use of hydrocarbon technology has not materially changed over the last 17 years. It requires costly pre-blending equipment, an explosion-free area and special safety procedures. Also, in many countries the systems are unchanged while in Europe significant system optimization has taken place (additives, special polyols, co-blending). UNDP sees options for cost reductions in three areas:

- preblending at supplier level would delete the need for a preblender plus auxiliaries—but cause some increase in the system price;
- direct injection of hydrocarbons would also remove the need for a preblender but increase the equipment cost somewhat;
- the introduction of modern HC blends would allow for lower densities—along with the above-mentioned options and also lower in this way the current operating costs.
- To test the feasibility of these concepts, the development and commercialization of stable pre-blends that can be safely transported and three-component production equipment is required, in addition to the introduction of modern HC blends.

This project is designed in four steps:

1. development, optimization and Validation/Demonstration of premixed, stabilized, modern hydrocarbons systems that can be used directly by foam manufacturers (which means that the blowing agent is incorporated) or used together with direct injection of the blowing agent
2. development of a three component foam dispenser, capable to direct inject hydrocarbons (pentane of cyclopentane blends)
3. placement of the three-component dispenser at a foam manufacturer followed by trials with
    a. direct injection of the blowing agent
    b. using a fully preblended polyol system
4. demonstration of the technology followed by dissemination through an inter-regional workshop

Other PU pilot projects carry a second phase to demonstrate commercial application and include the use of a supplier to develop the necessary systems. There is no need for this in this project. The system part will be an optimization based on knowledge that is already available in Europe and incremental success is virtually assured. Building a three component foaming unit has been before applied in an MLF project through a retrofit so, in this case it will be more of a design optimization than application of a new concept. Also, there is no need to demonstrate the two technology versions in all foam applications. The variations in required formulations are well known to the chemical suppliers that cater HC systems.

Companies do not conduct regular testing on properties of their foams, n or do they set standards. The determination of baseline data on critical properties is a precondition for a successful Validation/Demonstration program. In this case, the supplier of the system will conduct the product testing.

As hydrocarbons are "highly flammable", UNDP considers the process at the system house (blending) AND at user level (processing) hazardous and requiring adequate safeguards. Current safety requirements are described in UNEP/OzL.Pro/ExCom/25/54 (**Annex-2**). UNDP requires an independent safety audit to be conducted prior to commercial operation of a converted plant (**Annex-3**). Emission monitoring will have to be conducted and, based the outcome modifications/simplifications of the safety requirements can be proposed.

PROJECT IMPLEMENTATION

The project will be implemented through four steps. Following concrete actions are planned:

1. **System Development:** UNDP will contract this out following standard procurement procedures to a qualified chemical supplier (competitive bidding).

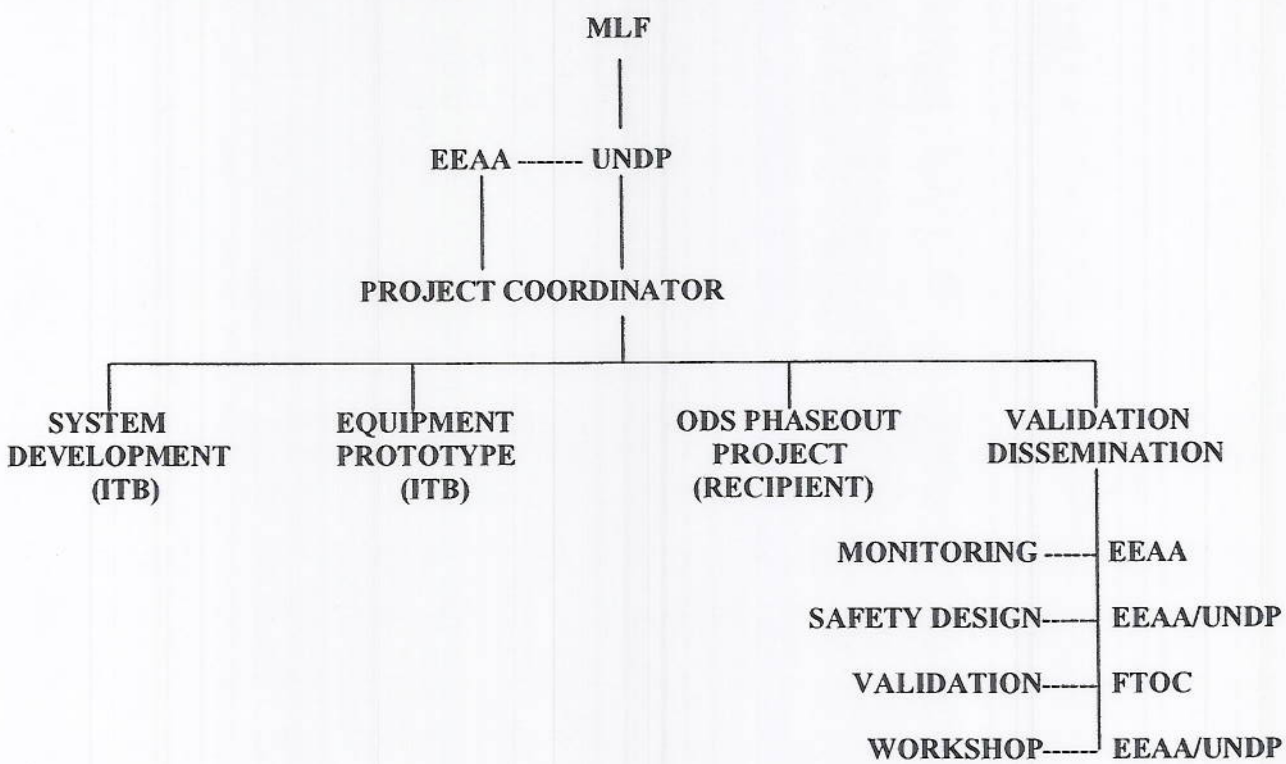
2. **Equipment Development:** as before, UNDP will contract this out to a qualified equipment supplier, following standard procurement procedures.

3. **Trials at a Foam Plant:** A company that is willing to conduct an early phaseout project based on the use of hydrocarbons will be selected as a part of the foam industry survey. The company should have an ODS consumption of around 40 t and have reasonable in-house technical capabilities. 4-5 candidates fit the requirements in Egypt, but here again the Government requested UNDP to select the company through bidding.

4. **Validation:** This will include emission/worker exposure monitoring, design of a safety system and safety procedures, validation of the outcome of the project and holding of an information dissemination inter-regional workshop. These tasks are assigned as follows:

   a. Monitoring - EEAA
   b. Safety design - EEAA/UNDP
   c. Validation - UNEP Foams Technical Options Committee (FTOC)
   d. Workshop - EEAA/UNDP

Following flow chart illustrates the proposed implementation procedure:



4. TECHNICAL OPTIONS FOR HCFC REPLACEMENT IN PU FOAMS

4.1 GENERAL OVERVIEW

Annex-1 provides an overview of all HCFC-141b replacement technologies that are currently available, proposed, or under development. Based on these data, it appears that

- Straight conversion of HCFCs to HFCs will always increase GWP;
- HCs, CO_2 (in its liquid form or derived from water), methylal and methyl formate will be options in PU foams that decrease—virtually eliminate—GWP in PU foams;
- Water-based technologies show serious performance handicaps base on the use of CO_2 as cell gas;
- Technologies such as HBA-2, AFA-L1 and FEA 1100 are not ready for commercialization.

PU validation may therefore be limited to optimized hydrocarbons, methyl formate and methylal.

4.2 HYDROCARBONS AS REPLACEMENT TECHNOLOGY FOR HCFC-141b

HC-based/MLF-supported CFC-phaseout projects have been, along with HCFC-141b, the technology of choice in most refrigeration and in panel applications. The minimum economic size has been typically around 50 ODP t/y or ~US$ 400,000. For domestic refrigeration a handicap was allowed for safety cost, increasing the threshold to ~US$ 600,000. Smaller projects could not pass cost-effectiveness criteria. Consequently, there is no use of HCs in SMEs. In addition, the technology was deemed unsafe for a multiple of applications such as spray and in situ foams. There have been attempts to introduce the use of HCs in those applications—even specially modified equipment was developed for that purpose—but the market has not accepted the use of HCs under what it considers "uncontrolled" conditions. Initially, cyclopentane in different degrees of purity has been used for refrigeration, n-pentane for panels and, not very important in an A5 context, more volatile HCs in one-component foams (OCFs). Fine tuning through HC blends (cyclo/iso pentane or cyclopentane/isobutane) which is now standard in non-A5 countries has not widely spread in A5's. Investment costs are largely the same as at the time of phasing out CFCs. Consequently, the technology would continue to be too expensive for SMEs and restricted to the same applications as before. However, there are options to fine-tune project costs and investigate other applications:

- The introduction of HC blends that will allow lower densities (lower IOCs)
- Direct injection (lower investment)
- Low-pressure/direct injection (lower investment)
- Centralized preblending by system houses (lower investment)
- Application-specific dispensing equipment (lower investment)

Lowering the conversion costs—either by lowering investment or lowering operating costs—will lower the current eligibility barrier of ~50t/y ODS (based on the current applicable threshold) and widen the pool of potentially eligible users. Important in all these considerations, is that for HC, current incremental operating costs are among the lowest of all replacement technologies. Therefore, from an economic standpoint the use of HCs is one of the most important technologies.

5. PROJECT COSTS

Cost forecasts for pilot projects are problematic as these projects are by nature unpredictable. UNDP has used to the extent possible guidance provided by the Secretariat in Doc 55/47 Annex III, Appendix II. Applying this guidance leads to the following summarized cost expectations:

DEVELOPMENT/OPTIMIZATION/VALIDATION/DISSEMINATION			
#	ACTIVITY	BUDGET (US$)	REMARKS
1	Project Management	10,000	Local expert; see also remark 1
2	Technology transfer, training	30,000	International Expert(s)
3	Testing equipment	55,000	See remark 2 hereunder
4	Production equipment development	125,000	Three-stream high pressure pentane dispenser with standardized, built-in and auxiliary, safety features (modular concept preferred)
5	Preblended systems preparation	100,000	Development: 40,000 Optimization: 40,000 Validation: 20,000 (at the recipient)
6	Technology Dissemination Workshop	60,000	See remark 3 here-under
7	Peer review/Safety review/Preparation	50,000	Includes - safety audit - design study for centralized HC blending - review by FTOC
8	Contingencies	43,000	10% of sub-total/rounded
	TOTAL	**473,000**	

Remark-1: because the design of this project did not allow working through a system house that provides local project management, a local project management expert is required.

Remark 2: Air quality testing and cell gas control will be conducted by EEAA's Air Quality Laboratory and the requested equipment stationed there. It can be used subsequent projects as well and can measure air concentration of all HCFC replacements

Testing equipment	Air quality monitor		35,000 (portable, explosion proof)
	Cell gas analyzer		20,000
	Total	**US$**	**55,000**

Remark 3: After consultations with the MLF Secretariat, it is being proposed to expand the scope of the workshop to an inter-regional workshop of 2-3 days which – while focusing primarily on this project result, would also elaborate on the results of UNDP's other technology-validation projects that were approved (eg methyl formate,, methylal). The workshop would thus discuss various findings of this project, and compare them with the results of those other pilot projects. A site visit at the recipient company will be part of the workshop-agenda. Participants at the workshop will include Egyptian stakeholders who would have interest in the project results, but also relevant MLF experts (national and international) who will be involved in writing future MLF project proposals in the foam sector.

7. IMPLEMENTATION/MONITORING

Following tentative implementation schedule applies:

TASKS	2009				2010			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Project Start-up								
MF Project Approval			X					
Receipt of Funds			X					
Grant Signature			X					
Monitoring/oversight activities in place			X					

Phase-I -Equipment development -Equipment construction/installation/start-up -System development -System optimization -System validation at system house -Peer review/detailed design of phase- II -Technology Dissemination Workshop(s)			 X X	 X X X X	 X XX XX X			

MILESTONES FOR PROJECT MONITORING

TASK	MONTH*
(a) Project document submitted to beneficiaries	2
(b) Project document signatures	3
(c) Bids prepared and requested	3, 9
(d) Contracts Awarded	3, 9
(e) Equipment Delivered	4, 11
(f) Training Testing and Trial Runs	4, 12
(g) Commissioning (COC)	14
(h) HOP signatures	15
(1) Compliance Monitoring	17

* As measured from project approval

7. ANNEXES

Annex 1: Overview of HCFC Replacement Technologies in Foams
Annex 2: Applicable Safety Guidelines (current version)
Annex 3: Safety Audit (current version)
Annex 4: Government Transmittal Letter

ANNEX-1

HCFC PHASEOUT TECHNOLOGIES
IN
IN PU FOAM APPLICATIONS

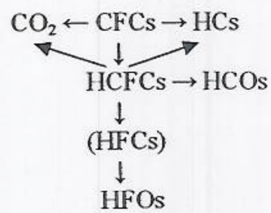
HCFCs are used in A5 countries as blowing agents in PU foams (predominantly rigid and integral skin) and extruded polystyrene (XPS) boardstock foams. To replace these HCFCs, following criteria would ideally apply:

- A suitable boiling point (25^{0}C target),
- Low thermal conductivity in vapor phase,
- Non flammable,
- Low toxicity,
- Zero ODP,
- Low GWP,
- Chemically/physically stable,
- Soluble in the formulation,
- Low diffusion rate,
- Based on validated technology,
- Commercially available,
- Acceptable in processing, and
- Economically viable.

CFC phaseout in rigid and integral skin foams has been mostly achieved by replacement through

- Hydrochlorofluorocarbons (HCFCs)
- Hydrocarbons (HCs)
- Carbon dioxide (CO_2), generated from water/isocyanate or directly as liquid or gas

HCFCs, have already been replaced in many non-A5 countries by hydrofluorocarbons or HFCs which in the near future, in turn, may have to be replaced by other, non-ODS/low GWP alternatives. At the same time, suppliers are looking to reduce flammability and other safety-related issues. In the new compounds, oxygen has been introduced to reduce GWP for HFCs, leading to HFOs (by some called second generation HFCs) or to reduce the flammability of HCs, leading to HCOs (esters, ethers, aldehydes and ketones). The identity of some new developments has not yet been released. This makes the following scenario for now speculative—but compelling:



In each column, the last step is non ODP, low GWP, low toxicity and reduced or eliminated flammability. Using the latest IPCC GWP data and molecular weights as provided by the FTOC (2006), following—Indicative—GWP changes are to be expected for available or emerging replacements of HCFC-141b in PU foam applications:

SUBSTANCE	GWP[1]	MOLECULAR WEIGHT	INCREMENTAL GWP[2]	COMMENTS
HCFC-141b	725	117	Baseline	
CO_2	1	44	-725	Used direct/indirect (from water)
Cyclopentane	11[2]	72	-718	Extremely flammable
HFC-245fa	1,030	134	443	
HFC-365mfc	794	148	279	
HFC-134a	1,430	102	522	
Methyl formate	negligible	60	-725	
Methylal	negligible	76	-725	Reported for co-blowing only
Acetone	negligible	58	-725	Used in flexible slabstock
FEA-1100	5	164[4]	-718	Under development
HFO-1234ze	6	114	-719	Recently introduced
HBA-2	<15	<134	>-708	Under development
AFA-L1	<15	<134	>-708	Under development

[1] Unless otherwise indicated, taken from IPCC's Fourth Assessment (2007)
[2] Derived from comparing GWPs compared to the baseline on an equimolar base. It should be noted that in practice formulators may make changes such as increased water or ABA blends that impact the global warming effect
[3] From UNEP Foams Technical Options Committee's 2006 report
[4] Calculated from published formulations
Green = beneficial GWP effect; red = unfavorable GWP effect

These technologies are described in more detail below. It should be pointed out that comparison between GWPs is an approximation of the clima change effect. A full lifecycle determination or a functional unit approach is a better—but more tedious—approach.

CARBON DIOXIDE

Carbon dioxide derived from the water/isocyanate chemical reaction is used as co-blowing agent in almost all PU foam applications and as sole blowing agent in many foam applications that have none or minor thermal insulation requirements. The exothermic reaction restricts the use, however, to about 5 php and therefore to foams with densities >23 kg/m^3. While this restriction mostly applies to open-cell flexible foams which do not use HCFCs, another restriction based on the relatively emissive nature of CO_2 in closed-cell foam is more serious. To avoid shrinkage, densities need to be relatively high which has a serious detrimental effect on the operating costs up and above the poor insulation value. Nevertheless increased use of water/CO_2 has been and still is an important tool in the HCFC phaseout in cases where HCs cannot be used for economic or technical reasons. There is no technological barrier. However, the use of water/CO_2 alone will be limited to non-insulation foams such as

- Integral skin foams (with restrictions when friability is an issue)
- Open cell rigid foams
- Spray/in situ foams for non/low thermal insulation applications

Carbon dioxide can also be added directly. This is mostly the case in flexible foamand therefore not an HCFC replacement. However, reportedly (FTOC, 2008), there is use of super-critical CO_2 in up to 10% of all sprayfoam applications in Japan. Technical details are not known. Supercritical CO2—as has been the case with LCD in CFC phaseout projects—is a demanding and expensive technology and its usefulness in A5 projects questionable.

HYDROCARBONS

There have been many HC-based/MLF-supported CFC-phaseout projects in refrigeration and in panel applications. The minimum economic size has been typically ~50 ODP t/US$ 400,000. Smaller projects were discouraged. Consequently, there is no use of HCs in SMEs. In addition, the technology is deemed unsafe for a multiple of applications such as spray and in situ foams. Generally, cyclopentane has been used for refrigeration and n-pentane for panels. Fine-tuning through HC blends (cyclo/iso pentane or cyclopentane/isobutane) which are now standard in non-A5 countries is not yet widely spread in A5's. Consequently, the investment costs are the same as at the time of phasing out CFCs and the technology will continue to be too expensive for SMEs and restricted to the same applications as before. However, there are options to fine-tune project costs and investigate other applications:

- The introduction of HC blends that will allow lower densities (lower IOCs)
- Direct injection (lower investment)
- Low-pressure/direct injection (lower investment)
- Centralized preblending by system houses (lower investment)
- Application-specific dispensing equipment

HFCs

There are currently three HFCs used in foam applications. Following table includes their main physical properties:

	HFC-134a	HFC-245fa	HFC-365mfc
Chemical Formula	CH_2FCF_3	$CF_3CH_2CHF_2$	$CF_3CH_2CF_2CH_3$
Molecular Weight	102	134	148
Boiling point (^{0}C)	-26.2	15.3	40.2
Gas Conductivity (mWm^{0}K at 10 ^{0}C)	12.4	12.0 (20 ^{0}C)	10.6 (25 ^{0}C)
Flammable limits in Air (vol. %)	None	None	3.6-13.3
TLV or OEL (ppm; USA)	1,000	300	Not established
GWP (100 y)	1,410	1,020	782
ODP	0	0	0

Current HFC use in A5 countries is insignificant. There is some use of HFC-134a in shoesoles—most notable in Mexico. Apart from the price, its use is complicated by its low boiling point. The use of other HFCs is limited to products for export—and even then sporadic. The low cost of HCFC-141b is just too compelling! On the other hand, these chemicals have played a major role in the replacement of HCFCs in foam applications in non-A5 countries—despite high GWP potentials. Formulations are not straightforward molecular replacements. Generally, the use of water has been maximized and sometimes other co-blowing agents have been added. Therefore, an assessment of their environmental impacts has to be based on actual, validated, commercial blends.

METHYL FORMATE (ECOMATE®)

Methyl-formate, also called methyl-methanoate, is a low molecular weight chemical substance that is used in the manufacture of formamides, formic acid, pharmaceuticals, as an insecticide and, recently, as a blowing agent for foams. While its use as blowing agent for synthetic rubbers is reported in earlier literature, Foam Supplies, Inc. (FSI) in Earth City, MO has pioneered its use as a blowing agent in PU foams from 2000 onwards. The application has been patented in several countries. Presentations by FSI have been made at major PU conferences and to Foam Technical Options Committee (FTOC 2006).

Ecomate®, as FSI calls the product, is exclusively licensed to Purcom for Latin America, to BOC Specialty Gases for the United Kingdom and Ireland and to Australian Urethane Systems (AUS) for Australia, New Zealand and the Pacific Rim. Reportedly, AUS has also acquired the license for other Asian countries such as India and China. Technical and commercial claims made by FSI imply that the technology actually would reduce operating costs when replacing HCFC-141b, at minimum capital investment and comparable or better quality. This, of course would be of utmost interest for the MLF and its Implementing Agencies. However, these claims need to be verified and validated by an independent body before the technology can be applied in MLF projects. In case insufficient data are provided, additional data will have to be developed.

Ecomate® has been mentioned in a preliminary discussion paper for the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol (UNEP/Ozl.Pro/ExCom/54/54). The information, while qualified as being provided by the supplier, is used to develop data on investment cost and operating benefits that are displayed together with data from technologies that have been extensively verified and validated in CFC phaseout projects and generates therefore the appearance of reliability. There is, however, market information that clearly contradicts this information and UNDP's conclusion—apparently shared by the FTOC—is that ecomate® technology is interesting and promising but immature, unproven in many foam applications and at this stage more expensive than HCFC-141b—and for that matter, hydrocarbons. Better, peer-reviewed data are required if this technology is to be used in MLF projects. In this light, the ExCom approved November 2008 a two pilot projects to validate methyl formate over the entire range of potential applications.

METHYLAL

Methylal's primary uses are as a solvent and in the manufacture of perfumes, resins, adhesives, paint strippers and protective coatings. It is claimed that in continuous panels methylal improves the miscibility of pentane, promotes blending in the mixing head, foam uniformity, flow, adhesion to metal surfaces and insulation properties, reducing simultaneously the size of the cells. In discontinuous panels, where most producers use non-flammable agents, the addition of a low percentage of Methylal to HFCs (245fa, 365mfc or 134a) makes it possible to prepare pre-blends with polyols of low flammability with no detrimental effect on the fire performance of the foam. Methylal reduces the cost, improves the miscibility, the foam uniformity and flow and the adhesion to metal surfaces. Co-blown with HFC-365mfc, it also improves the thermal insulation. In domestic refrigeration compared to cyclopentane alone Methylal increases the blowing rate and the compressive strength. In spray foam it reduces the cost of HFC-245fa or HFC-365mfc.

There is no known use of methylal as sole auxiliary blowing agent.

Public knowledge of Methylal's industrial performance as blowing agent is quite limited. To validate its use as a possible replacement of HCFCs for MLF projects in developing countries, peer reviewed evaluations should be carried out to assess its performance in integral skin and rigid insulating foams.

EMERGING TECHNOLOGIES

Since early 2008, a flood of new blowing agents for PU foams have been proposed by major international manufacturers of halogenated compounds. Four of them are worth mentioning. These are all geared towards replacement of HFCs and sometimes called "second generation HFS", although HFOs appears a more distinctive description. They share low/no flammability, zero ODP and insignificant GWPs:

	HFO-1234ze	**HBA-2**	**FEA-1100**	**AFA-L1**
Chemical Formula	$CHF=CHF_3$	n/k	n/k	n/k
Molecular Weight	114	<134	161-165 (estimated)	<134
Boiling point (^0C)	-19	>15 <32	>25	>10 <30
Gas Conductivity (mWm^0K at 10 ^0C)	13	n/k	10.7	10
Flammable limits in Air (vol. %)	None	None	None	None
TLV or OEL (ppm; USA)	1,000 (proposed)	n/k	n/k	n/k
GWP (100 y)	6	<15	5	Negligible
ODP	0	0	0	0

Except HFO-1234ze all chemicals still have to undergo substantial further toxicity testing and will therefore not appear in the market within 2-4 years. That may be too late in the A5 context where foam conversion is prioritized. As to HFO-1234ze, this will be targeted as a replacement of HFC-134a in one component foams (OCF). There are only few OCF manufacturers in developing countries.

ANNEX-2

PROCESS SAFETY GUIDELINES IN THE MANUFACTURE OF PU INSULATION FOAMS WHEN USING HYDROCARBONS AS BLOWING AGENT

The following safety concept is based on internationally recognized and applied standards. In addition, it is possible that local standards or company policies exist that have to be adhered to. The stricter one will prevail in a given situation.

- Classify all identified hazard areas following IEC 79-10, second edition, 1986:
  - Zone 0: Where a constant amount of highly flammable/ explosive liquids or gases may be expected. Material must be explosion- proof and grounded.
  - Zone 1: Where, from time to time, highly flammable liquids or gases may be expected. Material must be Ex-e, -d or -i and grounded.
  - Zone 2: Where only by accident or scheduled maintenance highly flammable/ explosive gases may be expected. Material required is Ex-n or with IP54 sealing. Grounding is required.
- Reclassify or restrict as many areas as possible by the application of engineered solutions such as ventilation, ionized air blowers, other static dissipaters, separation walls, etc.;
- Safeguard areas that cannot be reclassified, through explosion proofing;
- Provide additional safeguarding through the use of a combustible gas monitoring system with sensors at designated potential emission points and a portable gas detector to be used as part of a formal monitoring plan for areas that do not have continuous monitoring;
- Provide adequate emergency response gear such as firefighting equipment;
- Train personnel in safe operating procedures, preventive maintenance, and emergency response. Use formalized procedures through the preparation of a safety manual and an emergency response plan;
- Use an external expert or a technology transfer agreement to supervise all designs, the implementation and the start-up. The initial production start-up after conversion should be attended by experienced operating personnel.

With the help of this safety concept, it is possible to design actual modifications that have to be made to implement the transfer from CFCs to hydrocarbons. Actual implementation can differ, depending on equipment, plant layout, housekeeping and surroundings. A "standard" conversion for a discontinuous process would be along the following lines:

Gas Sensing and Alarm System

- The plant shall have installed gas sensors on locations where the possibility of emissions or leakage of CP exist. The sensors are to be connected to a centralized control panel in a safe area, clear from potential emission sources.
- The system shall be capable to trigger two consecutive visual/acoustical alarm levels, related to the percentage LEL reached. Recommended is a first level alarm on 15% LEL and a second alarm level at 30% LEL.
- The acoustical alarm shall be a minimum of 85 Db, or at least 15 Db over plant noise level.
- The visual alarm shall be in the pouring area.
- The first alarm shall be for warning purposes only.
- The second alarm shall shut down the pouring operation and the pentane supply, while increasing the process exhaust.
- The system shall have an independent power back-up.
- An auxiliary portable gas sensor with calibration unit shall be kept on site.

Exhaust System

- The plant shall have installed centralized or sufficient localized emission extraction systems of sufficient capacity serving locations where the possibility of emissions or ~~leakage of pentane~~ existleakage of pentane exists.
- The system(s) shall have a two stage capacity and back-up power.
- The system(s) shall be interlocked with the sensor and alarm system.
- The system(s) shall have an independent power back-up.

Grounding

- All equipment in areas where CP emissions or leakage can occur shall be connected to a central electrical grounding system.
- The grounding shall conform to internationally accepted specifications e.g. NFPA 77.

Procedures

- The enterprise shall provide the necessary operational safety and emergency response instruction and training to staff and personnel involved in the operations using cyclopentane.
- A Safety Manager shall be appointed in the factory. The manager will receiver appropriate training and education and be properly certified.
- Hazardous areas shall be clearly marked by signs indicating the Area Zoning.
- Piping shall be color coded.
- No smoking shall be allowed in the factory and its immediate surroundings. The no smoking policy shall be properly marked by signs.
- Periodic safety audits shall be effected. Audits shall include measuring of CP concentrations in areas not covered by permanent sensors through the use of portable sensors by a qualified person.
- A Safety Manual shall be developed and maintained. The manual should as a minimum address:
    - Safety Organization and Responsibilities
    - Standard Procedures for Work in Hazardous Areas
        - Response to Emergency Alarms
        - Start-up procedures after Emergency Shutdown

HC Storage and Transfer

- Location and installation of storage systems for hydrocarbons are subject to local regulations..
- Design of tank, piping, valves shall comply with internationally recognized standards, e.g. ISPEL, NFPA 30 and NFPA 58. Recommended design pressure for a HC container is 250 psi.
- Tanks shall have an electrically/pneumatically operated shutoff control valve on the outlet pipe of the tank that can be activated from within the plant. In addition, it shall be possible to shutoff the electrical power supply to the tank from within the plant as well as at the tank.
- Nitrogen blanketing shall be provided.
- All components shall be properly grounded.
- Protection against lightning may be required depending on location.
- All installations within 4 m radius of the tank shall meet Zone 1 requirements.
- Minimal one gas detector, connected to the central gas sensing and alarm system, shall be installed.
- At a minimum two portable fire Extinguishers shall be installed.
- The tank shall be in a concrete (spill) containment of sufficient size in a fenced, locked area, preferable with a cover to protect against direct sunlight.

- The CP transfer pump, if included, shall be explosion proof with backflow protection.

Preblender (only for System House)

- The preblender shall be placed in/on a spill containment of sufficient size.
- It shall be placed in an enclosure, connected to an adequately sized two stage air extraction system that allows 6/10 air replacements/hour.
- One gas detector shall be installed, attached to the central gas sensing and alarm system.
- The preblender shall be connected to a polyol buffer tank through a pump with backflow protection and to the CP storage and transfer system through an explosion proof pump with backflow protection.
- All equipment inside the enclosure shall meet Zone 1 requirements.
- All equipment shall be properly grounded.

Foam Dispenser

- Tanks shall be placed in/on individual spill containment of sufficient size.
- At a minimum, the polyol tank and pump shall be placed in an enclosure, attached to an adequately sized two stage ventilation system that allows 6/10 air replacements/ hour. Placement of the complete dispenser in an enclosure is recommended.
- Drip pans shall be placed under metering pumps.
- All installations in the enclosure shall meet Zone 1 requirements.
- At a minimum one gas detector shall be installed, attached to a central gas sensing and alarm system.
- Minimal two 6 kg ABC portable fire extinguishers shall be installed close to the foam dispenser.
- All equipment shall be properly grounded.

Molds. Fixtures, Presses

- Cavities in closed molds, fixtures and presses shall be inerted by nitrogen prior to the foam pouring operation. IEC 79-10 provides instructions for the calculation of the amount of inertization gas.
- Emissions from molds, fixtures and presses shall be removed through an adequately sized two staged extraction system. Calculation of the lower stage ventilation capacity should be based on the emission of 5% of the CP injected.
- Generation of static electricity should be minimized through proper grounding. In addition, the installation of ionized air blowers is recommended.

ANNEX-3

PROPOSED SAFETY INSPECTION CHECKLIST

Prepared by: (name/credentials of expert) **For: (recipient name)**

Date: **Project:**

1. HYDROCARBON STORAGE AND TRANSFER

REQUIREMENTS		OK	COMMENTS /ACTIONS
1.1	Meets local Specifications		
1.2	Certified by recognized Institution		
1.3	Suitable located		
1.4	Protected against traffic		
1.5	Placed on a pavement		
1.6	Fenced in with locked door		
1.7	Spill basin of adequate size		
1.8	Electrical installation meeting codes		
1.9	Gas sensor installed and operational		
1.10	Nitrogen blanketing		
1.11	Leak detection installed (Only required for underground tanks)		
1.12	Two 9 kg ABC fire extinguishers		
1.13	Connection to the premixer meeting requirements		
1.14	Grounded, with extra cable to connect to drums or tank truck		
1.15	Interconnected with the central safety/alarm system (automatic shut-off valve, gas sensor)		
1.16	Water hydrant in vicinity		
1.17	Easy access for delivery /operation		
1.18	Ex transfer pump with backflow protection and lubrication		

2. POLYOL/HYDROCARBON PREBLENDER (ONLY NEEDED AT SYSTEM HOUSE)

REQUIREMENTS		OK	COMMENTS /ACTIONS
2.1	Placed in a spill containment		
2.2	Placed in an enclosure attached to a two speed exhaust system		
2.3	Gas sensor installed and operational		
2.4	Connected to a polyol service tank with backflow protection		
2.5	Polyol service tank placed in a spill containment of 110%		

2.6	Electrical installation meeting codes		
2.7	One 6 kg ABC fire extinguisher in the direct vicinity		
2.8	Connected to an electrical grounding system		
2.9	Interconnected with the central safety/alarm system (ventilation and gas sensor)		

3. FOAM DISPENSING AREA

REQUIREMENTS		OK	COMMENTS /ACTIONS
3.1	Tanks placed in separate spill containments of 110% each		
3.2	Drip pans under pumps		
3.3	Polyol tank and pump placed in an enclosure attached to a two speed exhaust system		
3.4	Electrical installation meeting codes		
3.5	Two gas sensors installed and operational		
3.6	Connected to an electrical grounding system		
3.7	Two 6 kg ABC fire extinguisher in the direct vicinity		
3.8	Nitrogen blanketing polyol tank		
3.9	No cavities in the floor		
3.10	Interconnected with the central safety/alarm system (ventilation, automatic shut-off, gas sensor)		
3.11	Separated from other operations		

4. POURING AREA (INCLUDING MOLDS AND FIXTURES)

REQUIREMENTS		OK	COMMENTS /ACTIONS
4.1	Installed in a separate area		
4.2	No cavities in the floor		
4.3	Explosion proof electrical fixtures		
4.4	Connected to a two speed exhaust system of sufficient capacity		
4.5	Gas sensors installed/operational at each pouring location		
4.6	Installation of a nitrogen flushing system on the mixing heads		
4.7	Installation of a nitrogen inertization system for the molds/fixtures		
4.8	Electrical installation meeting codes		
4.9	A 6 kg ABC fire extinguisher placed at		

	each mold/fixture		
4.10	Mixheads, fixtures, molds connected to an electrical grounding system		
4.11	Interconnected with the central safety/alarm system (ventilation and gas sensors)		

5. CENTRAL SAFETY/ALARM SYSTEM

	REQUIREMENTS	OK	COMMENTS /ACTIONS
5.1	Placed in a safe, accessible area, separated from hazardous operations		
5.2	Interconnecting all gas sensors, exhaust systems, shut-off valves and any other emergency features into one central management system		
5.3	Capable to trigger alarm on two consecutive LEL percentages		
5.4	Featuring acoustical as well as visual alarm and process shut down		
5.5	Independent power back-up		

6. SAFETY MANAGEMENT PROCEDURES

	REQUIREMENTS	OK	COMMENTS /ACTIONS
6.1	Provision of operational safety and emergency response instruction		
6.2	Appointment of a Safety Manager		
6.3	Marking of all hazardous area's by signs indicating the area coding		
6.4	Installation of non-smoking signs		
6.5	Color coding of piping		
6.6	Institution of pertinent standard operational procedures to assure proper safety		
6.7	Handheld sensor/calibrator		
6.8	Institution of regular safety audits, including measurements with the Handheld sensor		
6.9	Emergency response planning		

ANNEX-4

GOVERNMENT NOTE OF TRANSMITTAL OF AN HCFC PHASE-OUT PILOT PROJECT TO THE EXECUTIVE COMMITTEE OF THE MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL

PROJECT OF THE GOVERNMENT OF EGYPT

The Government of Egypt requests UNDP to submit the project listed in Table 1 below to the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol for consideration at its 58th Meeting.

Section I: ODS Consumption Data

ODS consumption data do not apply to the first phase of this project. Data for the second phase will be provided if and when the second phase will be submitted.

Table 1: Projects Submitted to the 58th Meeting of the Executive Committee

PROJECT TITLE/SECTOR	Type of ODS	Consumption (ODP t/y)	Amount to be Phased Out (ODP t/y)	Implementing Agency
FOAM SECTOR				
Validation of Low Cost Options for the Use of Hydrocarbons as foaming agent in the Manufacture of PU Foams (Phase-I)	HCFC-141b	n/a	n/a	UNDP

Section II: Other Relevant Actions Arising from Decision 33/2

1. It is understood that, in accordance with the relevant guidelines, the funding received for a project would be partly or fully returned to the Multilateral Fund in cases where technology was changed during implementation of the project without informing the Fund Secretariat and without approval by the Executive Committee;
2. The National Ozone Unit undertakes to monitor closely the implementation of this project and to combine this monitoring with occasional unscheduled visits.
3. The National Ozone Unit will cooperate with the relevant implementing agencies to conduct safety inspections where applicable and keep reports on incidences of fires resulting from the implementation of this project.

Name and signature of responsible Officer:

____

Designation: Date:

Telephone:

Fax:

E-mail: