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ORIGINAL: INGLÉS

COMITÉ EJECUTIVO DEL FONDO MULTILATERAL
PARA LA APLICACIÓN DEL
PROTOCOLO DE MONTREAL
Quincuagésima sexta Reunión
Doha, 8 al 12 de noviembre de 2008

PROPUESTA DE PROYECTO: MÉXICO

Este documento contiene los comentarios y la recomendación de la Secretaría del Fondo sobre la siguiente propuesta de proyecto:

Espumas

- Proyecto piloto para la validación del formiato metílico en suelas de poliuretano para zapatos (fase I) — PNUD

HOJA DE EVALUACIÓN DE PROYECTO - PROYECTOS NO PLURIANUALES
MÉXICO

TÍTULO DE PROYECTO	ORGANISMO DE EJECUCIÓN/BILATERAL
(a) Proyecto piloto para la validación del formiato metílico en suelas de poliuretano para zapatos (fase I)	PNUD

ORGANISMO DE COORDINACIÓN NACIONAL	Secretaría del Medio Ambiente y Recursos Naturales, SEMARNAT

DATOS DE CONSUMO MÁS RECIENTES PARA SAO OBJETO DEL PROYECTO

A: DATOS DEL ARTÍCULO 7 (TONELADAS PAO, 2007, A SEPTIEMBRE DE 2008)

HCFC	1 424,7		

B: DATOS SECTORIALES DEL PROGRAMA DE PAÍS (TONELADAS PAO, 2007, A SEPTIEMBRE DE 2008)

SAO				
HCFC	1 440,2			

Consumo de CFC remanente admisible para el financiamiento (toneladas PAO)	0,0

ASIGNACIONES DEL PLAN ADMINISTRATIVO DEL AÑO EN CURSO		Financiamiento (millones de $EUA)	Eliminación (toneladas PAO)
	(a)	De acuerdo con la decisión 55/43 e)	n/c

TÍTULO DEL PROYECTO:	
Uso de SAO en la empresa (toneladas PAO):	
SAO por eliminar (toneladas PAO):	n/c
SAO por agregar (toneladas PAO):	n/c
Duración del proyecto (meses):	7
Monto inicial solicitado ($EUA):	291 500
Costo final del proyecto ($EUA):	291 500
Costo adicional de capital:	265 000
Gastos imprevistos (10 %):	26 500
Costo adicional de explotación:	
Costo total del proyecto:	291 500
Propiedad local (%):	100%
Componente de exportación (%):	0%
Donación solicitada ($EUA):	291 600
Relación de costo a eficacia ($EUA/kg):	n/c
Costos de apoyo del organismo de ejecución ($EUA):	21 862
Costo total del proyecto para el Fondo Multilateral ($EUA):	313 362
Situación de la financiación de contraparte (S/N):	n/c
Hitos de supervisión del proyecto incluidos (S/N):	S

RECOMENDACIÓN DE LA SECRETARÍA	Para consideración individual

DESCRIPCIÓN DEL PROYECTO

1. En nombre del gobierno de México, el PNUD presentó a la consideración del Comité Ejecutivo en la 56ª Reunión un proyecto piloto para la validación del formiato metílico en espumas de poliuretano para suelas de zapatos (fase I) en México. El costo total de la fase I del proyecto piloto es 291 500 $EUA, más los costos de apoyo del organismo de 21 862 $EUA.

2. El proyecto propone primero desarrollar, optimizar y validar el uso del formiato metílico en espumas de poliuretano para suelas de zapatos (fase I), y, posteriormente, aplicar la tecnología (si se ha validado) en siete plantas de elaboración de espumas para suelas de zapatos (fase II). El proyecto será ejecutado en la compañía Zadro, que se dedica a abastecer sistemas únicamente para la industria de suelas de zapatos en México.

3. El formiato metílico es una sustancia química usada en la fabricación de otras sustancias químicas y productos, inclusive productos farmacéuticos e insecticidas. Si bien su uso como agente espumante para los cauchos sintéticos se indica ya en la primera literatura científica, Foam Supplies, Inc., de Estados Unidos, sólo empezó a usarlo en espumas de poliuretano en 2000. El uso se patentó con el nombre de Ecomate®, con licencia exclusiva a las compañías siguientes: Purcom (Brasil) para América Latina, BOC Specialty Gases para el Reino Unido e Irlanda, y Australian Urethane Systems para Australia, Nueva Zelandia y los países de la Cuenca del Pacífico (la compañía de Australia también adquirió la licencia para otros países situados en el norte de África, Oriente Medio, China e India).

4. El costo total de la fase I se estimó en 291 500 $EUA, con el desglose indicado en el cuadro siguiente. El costo preliminar de la fase II se estimó en 532 200 $EUA.

Descripción	**$EUA**
Preparación del proyecto	25 000
Transferencia de tecnologías (incluido derechos de licencia) y capacitación	75 000
Desarrollo de sistemas (7 usos, a 5 000 $EUA cada uno)	35 000
Optimización (7 usos, 3 000 $EUA cada uno)	21 000
Validación (7 usos, 2 000 $EUA cada uno)	14 000
Equipos de laboratorio	50 000
Seguridad en laboratorio	10 000
Evaluación interpares/preparación de la fase siguiente	10 000
Talleres de difusión tecnológica	25 000
Gastos imprevistos (10 por ciento)	26 500
Total	**291 500**

5. Dado que éste es el primer proyecto piloto para demostrar una tecnología alternativa de HCFC en usos de espumas, el PNUD preparó una versión resumida del proyecto que se adjunta a este documento.

COMENTARIOS Y RECOMENDACIÓN DE LA SECRETARÍA

COMENTARIOS

6. La Secretaría examinó el proyecto a la luz del documento sobre criterios relativo al análisis revisado de las consideraciones pertinentes al costo del financiamiento de la eliminación de HCFC presentado a la 55ª Reunión, y la decisión 55/43 adoptada por el Comité Ejecutivo, además del proyecto de validación complementario en Brasil, que el PNUD también presentó a la 56ª Reunión.

7. El documento sobre los costos de HCFC, considerado por el Comité Ejecutivo en su 55ª Reunión, tomó nota de la importancia de comprometer a proveedores de sistemas seleccionados en países del Artículo 5 para validar las tecnologías nuevas o muy revisadas para usar oportunamente en proyectos de eliminación de HCFC de forma que los proyectos de inversión puedan beneficiarse inmediatamente con la validación. La Secretaría tomó nota de que la propuesta presentada por el PNUD trató estas cuestiones, mediante la inclusión de un taller de difusión tecnológica para los proveedores de sistemas interesados en México y en otros países en la región (es decir, Argentina, Brasil, Chile y Colombia) tan pronto como la tecnología se considerase transferible. El PNUD también recibió solicitudes para participar en el taller de proveedores de sistemas en India.

8. Como consecuencia de un pedido de más información sobre los derechos de licencia que debe pagar Zadro por usar la tecnología de Ecomate y hasta qué punto los resultados del proyecto serán transferidos a otros proveedores de sistemas, el PNUD indicó que Purcom (la compañía de Brasil que tiene una licencia exclusiva para el uso de esta tecnología) acordó conceder a Zadro una licencia para el uso de Ecomate. En sus negociaciones con la compañía, el PNUD pidió que fuese una licencia no exclusiva, ya que no se debería privar a otros proveedores de sistemas del uso de esa tecnología en el futuro. Purcom y Zadro convinieron en divulgar los resultados del proyecto piloto entre otros proveedores de sistemas. Además Purcom está dispuesto a otorgar otras licencias no exclusivas a otros proveedores de sistemas en América Latina.

9. Se propuso que los resultados obtenidos de la aplicación de la tecnología sean validados por la Secretaría del Fondo mediante un experto independiente, con la supervisión de dicha validación por el Comité de Opciones Técnicas sobre Espumas Rígidas y Flexibles del PNUMA. La Secretaría tomó nota de las inquietudes del PNUD con respecto a validación de la tecnología por expertos independientes. Sin embargo, indicó que no tiene pericia, presupuesto ni mandato para validar tecnologías. Por lo tanto, la Secretaría sugirió que, durante el proceso de validación, el PNUD se mantenga en contacto con el Comité de Opciones Técnicas sobre Espumas para su examen. El PNUD estuvo de acuerdo con la sugerencia de la Secretaría.

10. La Secretaría y el PNUD también trataron las cuestiones relacionadas con los derechos de patente, el programa de capacitación para Zadro y los compromisos por parte de los proveedores de sistemas para emprender la validación de la tecnología de Ecomate para el uso en suelas de zapatos en México. El PNUD indicó que Zadro tiene que ser entrenado para usar los equipos de validación y la ejecución del programa de validación creado por el experto internacional del PNUD para asegurar el cumplimiento con la validación conforme al Comité de Opciones Técnicas sobre Espumas Rígidas y Flexibles.

RECOMENDACIÓN

11. Tomando nota de que con su decisión 55/43 e) el Comité Ejecutivo invitó a organismos de ejecución y bilaterales, con urgencia, a que preparasen y presentasen un número limitado de proyectos específicos y relativos a proveedores de sistemas y/o a abastecedores de productos químicos para el desarrollo, la optimización y la validación de los sistemas químicos para el uso con agentes espumantes sin HCFC, y a la luz de los comentarios hechos por la Secretaría, el Comité Ejecutivo podría aprobar el proyecto piloto para la validación del formiato metílico en espumas de poliuretano para suelas de zapatos (fase I) en México, con un costo de 291 500 $EUA, más los costos de apoyo del organismo de 26 500 $EUA, para el PNUD.

COUNTRY:	**Mexico**	**IMPLEMENTING AGENCY: UNDP**
PROJECT TITLE:	**Pilot project for validation of Methyl Formate in Polyurethane Shoesole Applications (Phase-I)**	
PROJECT IN CURRENT BUSINESS PLAN:		**Based on ExCom Decision 55/43 (e i-iii)**
SECTOR:		**Foams**
Sub-Sector:		**Integral Skin/Shoesoles**
ODS USE IN SECTOR		
Baseline:		**Not yet determined**
Current		**3,024 t ODS/298 t ODP** (as per Government reporting)
BASELINE ODS USE:		**N/A**
PROJECT IMPACT (ODP targeted):		**N/A**
PROJECT DURATION:		**7 months**
PROJECT COSTS (Phase-1 only):		**US$ 291,500 (Phase I only)LOCAL OWNERSHIP: 100 %**
EXPORT COMPONENT:		**0 %**
REQUESTED MLF GRANT:		**US$ 291,500**
IMPLEMENTING AGENCY SUPPORT COST:		**US$ 21,860** (7.5%)
TOTAL COST OF PROJECT TO MLF:		**US$ 313,360**
GRANT-EFFECTIVENESS:		**N/A**
PROJECT MONITORING MILESTONES:		**Included**
NATIONAL COORDINATING AGENCY:		**Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT)**

PROJECT SUMMARY

Mexico ratified the Vienna Convention and accepted the Montreal Protocol, including the London, Copenhagen, Montreal and Beijing amendments. The objective of this project is to develop, optimize, and disseminate the use of methyl formate in polyurethane shoesole applications. In case of a positive outcome, and the way be clear, the technology will be applied in a limited amount of downstream operations that cover all formulations for which it is validated. It is designed in close cooperation with a similar project in Brazil that covers other PU applications but could not include shoesoles because of lack of know-how.

The project is divided in two distinct phases:

- Phase I: development, optimization, validation and dissemination
- Phase II: implementation in 7 downstream enterprises

The project includes, in addition to costs for system development, validation and dissemination of the technology to other interested systems houses, retrofit costs to adjust current equipment to the use of methyl formate and incremental operating costs for a limited period. If successful, the validated technology will contribute to the availability of low-investment options needed to implement HCFC phaseout at small and medium-sized enterprises

IMPACT OF PROJECT ON COUNTRY'S MONTREAL PROTOCOL OBLIGATIONS

This project is a pilot project aimed to validate a new HCFC phaseout technology and not to contribute directly to Mexico's Montreal Protocol obligations. However, in case Phase-II will be successful, the project will contribute 35.7 t ODS or 3.9 t ODP to the country's efforts to meet its HCFC phaseout obligations under the Montreal Protocol.

Prepared by: Bert Veenendaal **Date: September 2008**

GLOBAL PROJECT/PROJECT OF THE GOVERNMENT OF MEXICO

VALIDATION OF THE USE OF METHYL FORMATE IN POLYURETHANE SHOESOLE APPLICATIONS

1. PROJECT OBJECTIVES

The objectives of this project are TO:

1. Develop, optimize and validate the use of methyl formate in PU shoesole applications;
2. Apply the technology in a limited amount of downstream operations;
3. Disseminate the technology to interested system houses

2. INTRODUCTION

Current validated technologies for replacing HCFC-141b in foams are restricted to water/MDI, hydrocarbons and HFCs. With water non-performing in most applications, HFCs being high in GWP and hydrocarbons high in investment costs, it is important to validate other options. ExCom Decision 55/43 reflects this by promoting pilot projects aimed to validate technologies. UNDP completed two related pilot proposals, for the validation of methyl formate (ecomate®) in all relevant foam applications. Technology validation is a global task. However, it has to be executed in a particular country and UNDP has therefore requested endorsement letters from the countries involved. Because of the global impact complete deduction from the national aggregate HCFC consumption would not be fair.

3. INFORMATION ON PARTICIPATING COMPANIES

This pilot project is designed around Quimiuretanos Zadro S.A. de C.V. ("Zadro"). Contact information is as follows:

Company:	Quimiuretanos Zadro S.A. de C.V.
Contact:	Mr. Jose Luis Ordaz Perez
Address:	Prolongiation Morelos 902, San Francisco del Rincon, GTO, Mexico
Ph/Fx:	+52-476-743-6290/7625

Zadro was founded 1996 and is 100% Mexican owned. The company supplies the shoesole industry, which is concentrated around the Leon/San Francisco area. Annual sales were:

2005 US$ 3,240,000 2006 US$ 3,960,000 2007: US$ 3,840,000

There are no exports. The company employs 12. Base chemicals are purchased from

Name	Type of Chemical	Consumption (t)		
		2005	2006	2007
POLIOLES S.A	POLYOLS	684	836	810
BASF	ISOCYONATES	360	440	426
QUIMICA MARCAT	BLOWING AGENT 141B	36	44	42

HCFC-141b is used in ~98 % of the systems while all water-based systems make up the rest.

4. PROJECT DESCRIPTION

This project is divided into two phases:

- Phase-I: development, optimization, validation and dissemination
- Phase-II: implementation at recipients covering all formulations

4.1 PHASE-I

PU foams are used in applications that have different formulation requirements. Around 16 main applications use currently HCFC-141b. 15 of these will be validated for the use of methyl formate as HCFC replacement through a pilot project in Brazil. Shoesoles will be covered by this project—but in close cooperation with the implementers of the Brazilian project. The use of methyl formate is patented and marketed under the name "ecomate®". Zadro will be granted a non-exclusive sub-license for Mexico. The development, optimization and validation of methyl formate as replacement technology for the use of HCFC-141b in shoesoles will in this phase involve the system house only and will consist of:

- Acquisition of an "ecomate®" license and the necessary testing/prototyping equipment;
- Development of the systems (there are different ones, depending on customer requirements);
- Optimization and Validation of all formulations;
- Dissemination of the information through a workshop.

Zadro has already prototyping equipment but lacks testing equipment needed for validation. Shoesole companies and their suppliers do not conduct currently regular testing on the properties of their foams nor do they set standards. Therefore, the acquisition of suitable testing equipment and the determination of baseline data on critical properties is a precondition for a successful validation program. The necessary testing equipment is described in the budget explanations. The outcome of this part of the project will be a list of specific product requirements and tests to measure these. After this, optimization and validation can start in earnest. Based on the outcome of this program, the technology will be cleared for industrial application under Phase-II which will be submitted for approval at that time.

Past experience in MLF-supported CFC phaseout efforts has shown how important it is to assure commercial availability and local technical support. Therefore, the project will include a technology transfer workshop as soon as the technology is deemed transferable and will be open for any system house. While this may be not the immediate most profitable course for a commercial operation like Zadro, it is the price to be paid for MLF support.

4.2 PHASE II

After the formulations have successfully passed their evaluation, commercial application in manufacturing operations will follow. 7 companies, covering all formulations, will apply the technology in their operations. Product and process testing will be conducted by the system house. UNDP will contribute to this evaluation by conducting safety audits that included workers exposure testing (the monitoring equipment is available from a global MLF project). Process adaptations will be made as needed to meet the pre-determined requirements

4.3 SUPERVISION ARRANGEMENTS

Decision 55/43 requires the Agencies to report accurate project cost data as well as other data relevant to the application of the technologies through *"a progress report after each of the two implementation phases"*. UNDP suggests **in addition** the ExCom to consider supervision of the validation through the UNEP Foams technical Options Committee.

5. TECHNICAL OPTIONS FOR HCFC REPLACEMENT IN FOAMS

5.1 GENERAL OVERVIEW

Annex-3 provides an overview of all HCFC-141b replacement technologies that are currently available or proposed. Based on these data, it appears that

- Straight conversion of HCFCs to HFCs will always increase GWP
- This may be diminished by optimizing climate performance of the formulations
- HCs, CO_2 (LCD or derived from water) and methyl formate will be options in PU foams that decrease—virtually eliminate—GWP in PU foams
- Emerging technologies such as HBA-2, AFA-L1 and FEA 1100 will require at least two more years before commercialization

PU validation may therefore include following technologies:
- Carbon Dioxide
- Optimized Hydrocarbons
- Methyl Formate
- Optimized HCs

5.2 METHYL FORMATE AS REPLACEMENT TECHNOLOGY FOR HCFC-141b

Annex-3 provides an extensive overview of the properties and use of methyl-formate, also called methyl-methanoate, or (trade name) ecomate©. Foam Supplies, Inc. (FSI) has pioneered its use in PU foams from 2000 onwards. The application has been patented in several countries. 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 countries such as India, China and several MENA countries.

Technical and commercial claims made by FSI imply that the technology actually may 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. However, these claims need to be verified and validated by an independent body before the technology can be applied in MLF projects. Where insufficient data have been provided, additional data will have to be developed.

Validation will be conducted enlarge in Brazil by Purcom, which is currently the only A5 country where ecomate® is blended and in commercial use. Because Purcom is not involved in shoesoles, the validation of this application will be conducted in Mexico through Zadro.

Zadro will obtain a sub-license from Purcom and be instructed in the basic facts and formulation of ecomate in PU foam systems before developing, optimizing and validating its own shoesole systems.

6. PROJECT COSTS

6.1 Project Costs

UNDP used in this cost estimate guidance provided by the Secretariat in Document 55/47 Annex III, Appendix II.

#	ACTIVITY	COSTS (US$)		
		INDIVIDUAL	SUB-TOTAL	TOTAL
PHASE-I – DEVELOPMENT/OPTIMIZATION/VALIDATION/DISSEMINATIOON				
1	Preparative work Project Preparation Technology Transfer, Training*	 25,000 75,000	100,000	
2	System Development (7 applications) @ 5,000 Optimization (7 applications) @ 3,000 Validation (7 applications) @ 2,000	35,000 21,000 14,000	70,000	**291,500**
3	Laboratory Equipment Laboratory Safety	50,000 10,000	60,000	
4	Peer review/endorsement of next phase		10,000	
5	Technology Dissemination Workshop (s)		25,000	
6	Contingencies (10%)		26,500	

*includes license fee

PHASE-II – HCFC PILOT PHASEOUT PROJECTS COVERING ALL FORMULATIONS (these costs are tentative and not part of the current funding request)				
1	System House adaptations 1 Blender 1 Tank for MeF Safety measures Contingencies (10%)	 50,000 20,000 25,000 9,500	 104,500 	
2	Downstream User Operations (7) 7 Retrofits @ 15,000 7 Trial Programs @ 3,000 Contingencies (10%)	 105,000 21,000 12,600	 138,600 	**532,200**
4	Peer review/safety audits		20,000	
5	Incremental Operating Costs		269,100	

Annex-4 provides details and justifications. UNDP requests a grant for phase-I of this project amounting to

US$ 291,500

7. ANNEXES

Annex 1: Implementation/Monitoring Plan
Annex 2: Overview of PU Applications
Annex 3: Overview of HCFC Replacement Technologies in Foams
Annex 4: Participating Enterprises
Annex 5: Detailed Cost Calculations
Annex 6: Transmittal Letter

ANNEX-1

IMPLEMENTATION/MONITORING

Following implementation schedule applies:

TASKS	2008	2009				2010			
	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Project Start-up									
MF Project Approval	X								
Receipt of Funds		X							
Grant Signature		X							
Management activities									
-Monitoring/oversight activities in place		X							
Phase-I									
-Procurement		X							
-Installation		X							
-System development		XX							
-System optimization		XX							
-System validation at system house		X	XX						
-Peer review/detailed design of phase- II			X						
-Approval phase-II				X					
- Technology Dissemination Workshop(s)				XX					
Phase-II									
-Prepare individual Implementation plans				X					
-Procurement				X					
-Installation/start-up					XX				
-Trials					XX				
-Certificates of Technical Completion (COCs)					XX				
-Handover Protocols (HOPs)						XX			
-Completion Report (PCR)							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

ANNEX-2

IDENTIFICATION OF ODS USERS IN THE FOAM INDUSTRY

Foundation and at the same time one of the largest challenges for a successful ODS phaseout program is a successful identification program of the users. There are different avenues to do so:

- **The use of customs information –** In countries that do not produce HCFCs, these substances have to pass by definition the border and are subject to customs registration and inspection. The problem with HCFCs for foam applications is that not all HCFCs are imported as such but frequently preblended into polyol. Inclusion of these substances in customs registration and mandatory disclosure of HCFC content is therefore a precondition for an effective identification program through customs. It is emphasized that identification of the importer alone is not sufficient. The importer may use distributors. Identification of distributors as well as the HCFC-containing system users is required. This requires convincing the importer/distributor that such identification is in the best interest of itself and its customers.

- **The use of trade associations –** In many countries trade associations represent the interests of producers of certain application groups. Their cooperation has been crucial, for instance in Brazil, India, Indonesia and Pakistan. Cooperation of trade associations allows the use of existing data bases and has proven particularly successful for group projects.

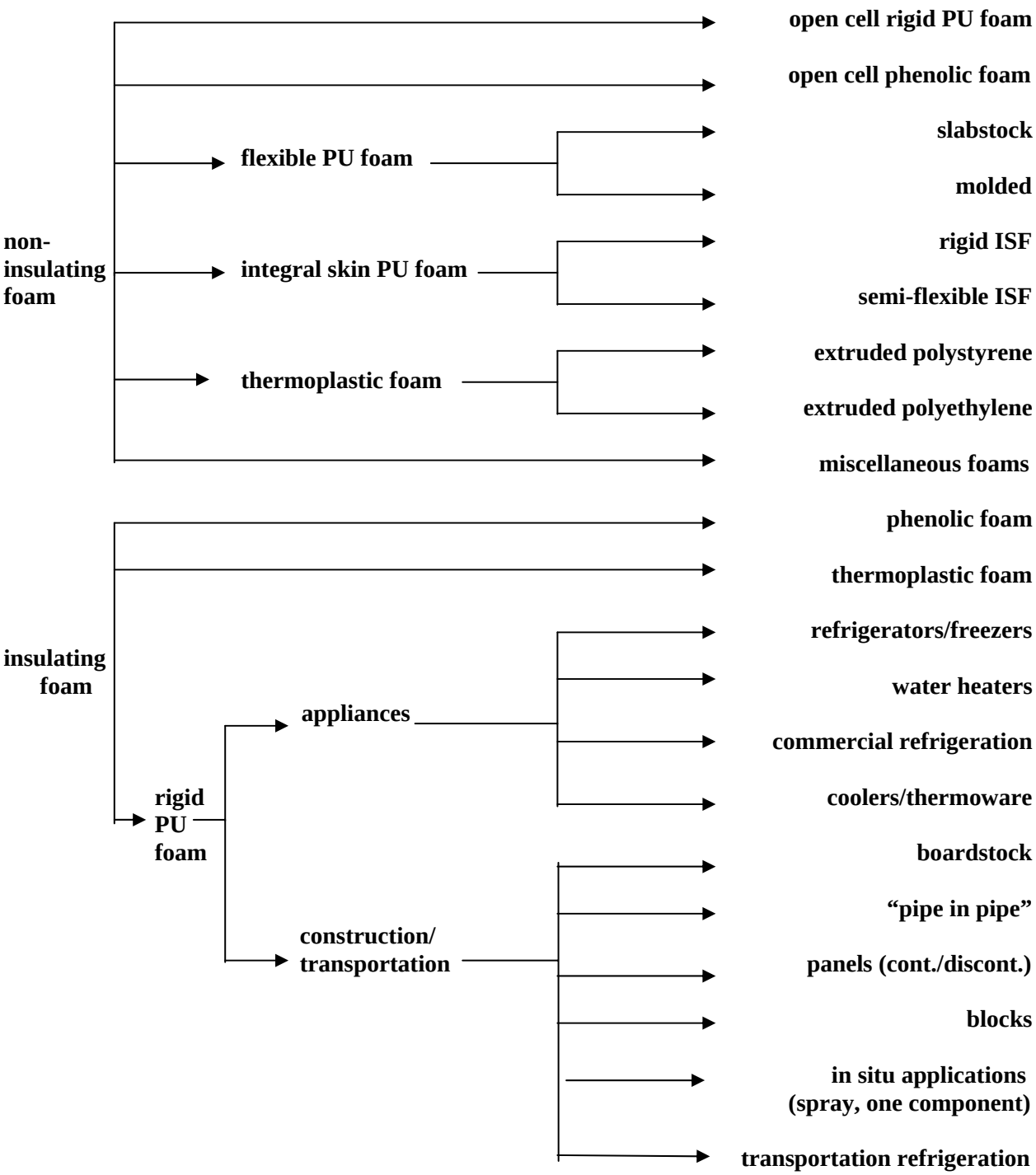
- **The use of local experts –** A person who is familiar with the local foam industry could accelerate and improve data collection. However, such person, after "picking his own recollection" is dependent on the same sources as any other data collector and dependent on persistence, ingenuity and organizational skills.

- **The use of already identified users –** This is an unstructured but amazingly effective method of identification. Many users are not interested in identification or even actively avoid meeting with Ozone Officers, mostly because of not knowing the benefits it may receive from joining the ODS phaseout program. The—positive—experience of a colleague/competitor may turn this opinion

- **The use of suppliers –** any foam producer needs chemicals for its production. Identifying the suppliers and their agents/distributors and enlisting their cooperation has proven to be one of the most successful tools in ODS user identification. Combined with a custom identification program and cooperation from other ODS users, it virtually assures a virtually complete user identification.

IT WILL BE A BENEFIT FOR THE OZONE OFFICER TO KNOW THE DIFFERENT FOAM APPLICATIONS. BY KNOWING THE STRUCTURE OF THE INDUSTRY AS WELL AS THE DIFFERENT APPLICATIONS THE CHANCE TO FINDS USERS AS WELL AS THE QUALITY OF THE PRE-ASSESSMENT INFORMATION CAN BE IMPROVED CONSIDERABLY.

Foamed plastics that are produced with HCFCs can be classified on the basis of composition, chemical and physical characteristics, manufacturing process or application. They can be consolidated into **Non-Insulating Foams** and **Insulating Foams.** Insulation is understood in this context as thermal insulation. These main categories can then be further divided and subdivided into functional groups as follows:



The most prevalent use of **open cell rigid PUR foam** is for packaging applications ("pour in place" foam), mostly when small lots are involves, such as in the return of repaired items. Another application is "back-foaming" of crash panels, such as automotive dashboards.

Open cell phenolic foam is mainly used for flower arrangements.

Flexible PUR foam constitutes the largest group of non-insulating foams. Comfort applications, such as bedding and furniture, dominate in the use of **slabstock—continuous or boxfoam**—followed by lining for textiles. **Molded** foam is used in the automotive industry and, in much smaller amounts, for office furniture.

Rigid integral skin foams (ISFs) are used for recreational purposes, such as surf boards, and in imitation wood.

Semi-flexible ISFs are used in the automotive industry for arm rests and steering wheels, in office furniture and in shoe soles (micro-cellular).

Extruded polystyrene foam sheet is used for food packing applications (meat trays, egg cartons, plates, cups, etc). **Extruded polyethylene foam sheet and plank** is mostly used for packaging purposes.

Examples of **miscellaneous foams** are floor mats and one component foams, such as in spray canisters.

Closed cell **Phenolic foam** is used for building insulation.

Thermoplastic foams for thermal insulation purposes consist mostly of **extruded polystyrene insulation board** in construction applications and of **extruded polyethylene tubing** for pipe insulation.

Rigid PUR foams for thermal insulation are by far the most significant group of insulating foams. Its insulation value exceeds any other foam by a significant margin. There are numerous applications in appliances as well as construction.

In appliances, refrigerators dominate, but specifically in commercial refrigeration and small appliances, there is a diverse and frequently unexpected large use of foam. Examples are:

- Thermos bottles
- Water containers, cool boxes (fish industry!)
- Boilers
- Milk containers
- Casseroles/hot pots
- Vendor carts (ice cream, drinks)
- Insulated trucks
- Mortuary coolers

Examples of applications in construction are:

- Sprayfoam (chicken/hog farms, commercial buildings, cold storage)
- Roof panels
- Cold storage structural panels
- Pipe insulation

Examples of miscellaneous applications are:

- Floatation devices (buoys, surf planks)
- Boat filling (floatation as well as insulation)
- Bus insulation (thermal, sound)

ANNEX-3

HCFC PHASEOUT TECHNOLOGIES IN IN FOAM APPLICATIONS

I. INTRODUCTION

HCFCs are currently used in A2 countries as blowing agents in polyurethane (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 with 25^0C being the target,
- Low thermal conductivity in the 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.

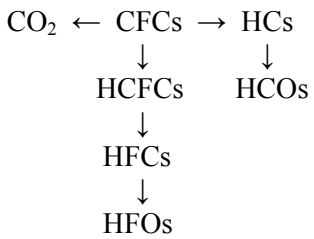
Not all replacement technologies that are currently available meet these criteria. Following assessment has been divided into the two applicable foam polymer groups: polyurethanes (PU) and (extruded) polystyrene (XPS) foams.

II PU FOAMS

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, in turn have already been replaced in many industrial 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 compound, 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. But which 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 GWP and molecular data 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	MOLECULAR WEIGHT	INCREMENTAL GWP[2]	COMMENTS
HCFC-141b	713	117	Baseline	
CO_2	1	44	-712	Used direct/indirect (from water)
Hydrocarbons	11	70	-710	Extremely flammable
HFC-245fa	1,020	134	455	
HFC-365mfc	782	148	276	Mostly used 95% pure
HFC-134a	1,410	102	516	
Methyl formate	0[1]	60	-713	97.5% pure (supplier information)
Methylal	0[1]	76	-713	Only reported for co-blowing
Acetone	n/k	58	n/k	Only used in flexible slabstock
FEA-1100	5	n/k	~700-710	Under development
HBA-1	<15	<125	<697	Under development
HBA-2	n/k	n/k	n/k	No published data yet
AFA-L1	<15	<134	>696	

[1]Zero GWP is not possible. Negligible would be a better description

[2]It should be noted that the incremental GWP is the effect expected based on 100% HCFC 141b replacement by just one alternative on an equimolecular base. In practice this will not always be the case. Formulators may increase water, reducing in this way the GWP impact—but also decreasing the foam quality—or use a blend of physical blowing agents. In addition, replacements are not always equimolecular as solvent effects, volatility and even froth effect (HFC-134a and to a lesser extent HFC-245fa) may impact the blowing efficiency. The table therefore provides a guideline rather than an absolute assessment.

These technologies are described in more detail below.

CARBON DIOXIDE

The use of carbon dioxide derived from the water/isocyanate chemical reaction is well researched. It is used as co-blowing agent in almost all PU foam applications and as sole blowing agent in many foam applications that have no 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 as a physical. This is mostly the case in flexible foam and 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 US$ with some exceptions for domestic refrigeration. Smaller projects were discouraged. 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. 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 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

UNDP has initiated a study of these options. After a feasibility study on each option, validation projects may be formulated with recipients that are capable and willing to participate. After completion of this preliminary study the costs of validation project can be calculated.

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 its environmental impact has to be based on actual, validated, commercial blends. UNDP has initiated a "clima proof" study based on blends proposed by chemical suppliers of HFC-245fa and HFC-365mfc. A recently developed "functional unit" approach—a simplified life cycle test will be applied in this study.

This approach has been described in some detail in UNEP/Ozl.Pro/ExCom/55/47. It is robust enough to meet Decision XIX requirements—addressing both energy and GWP—but does not require the individualized approach of full life cycle analyses. It would not only provide for a fair assessment of optimized HFC formulations but also demonstrate the use of the "Functional Unit" approach and facilitate the Secretariat's evaluation as requested by the ExCom in decision 55/43 (h). The assessment will be a desk study. It has not to be tied to a specific country and will be universally (globally) applicable.

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 urgently required if this technology is to be used in MLF projects.
Following data on physical properties have been taken from the FTOC-2006 and from a BOC MSDS:

Property	Methyl Formate	HCFC-141b
Appearance	Clear liquid	Clear liquid
Boiling point	31.3 °C	32 °C
LEL/UEL	5-23 %	7.6-17.7
Vapor pressure	586 mm Hg @ 25 °C	593 mm Hg @ 25 °C
Lambda, gas	10.7 mW/m.k @ 25 °C	10.0 mW/m.k @ 25 °C
Auto ignition	>450 °C	>200 °C
Specific gravity	0.982	1.24
Molecular weight	60	117
GWP	0	630
TLV (USA)	100 ppm TWA/150 ppm STEL	500 ppm TWA/500 ppm STEL

According to information from FSI, ecomate® has the following advantages compared to HCFC-141b when used in foam manufacturing (only those important under A5 conditions are listed):

- Liquid at ambient process conditions
- Zero ODP
- Zero GWP
- Lower IOCs
- Good solubility
- Low volatility
- Good system stability
- Good foam properties
- Good thermal insulation properties
- Good flammability resistance
- Safe handling

FSI does not mention actual system costs; it claims the technology being "*economically advantageous*". It relates this to being more effective—51% of HCFC-141b. Total costs are indicated as follows:

Blowing Agent	Mol Wt	Factor	US$/Lb	US$/mole
HCFC-141b	117	1.00	++	Ref
HFC-245fa	134	1.15	+++++	+350%
HFC-365/227	149	1.27	++++	+380%
cC5	70	0.60	++	- 45%
nC5	72	0.62	+	- 70%
ecomate®	**60**	**0.51**	++	- 65%

In the USA, Ecomate® is not treated as a volatile organic component (not a smog generator) and SNAP approved. In Europe it is compliant with the RoHS and WEEE directives. Acute toxicity is reported low with no special hazards. The MSDS mentions R12 (extremely flammable but not explosive); R20/22 (harmful by inhalation and if swallowed) and R36/37 (irritating to eyes and respiratory system).

The IPCS profile mentions in addition that "*vapor/air mixtures can be explosive".* FSI reports a case study that shows process emissions to be lower than 100 ppm, which is less than the STEL and TWA and therefore would require no special precautions in the manufacturing area. Ecomate® is normally sold as a system, which would restrict flammability issues to the supplier. Shipping of systems is possible without "flammable" tags.

As applications for ecomate®, FSI is mentioning

- Rigid pour and spray foams,
- Integral skin foams, and
- Flexible molded and slabstock foams.

Reportedly, Brazil is the only A5 country where ecomate® is used. The licensee for Latin America, a large system house, was contacted for more information. The company stated that they have spent much efforts in system development for ecomate® which has by now replaced about one third of their HCFC business. Current commercial applications (which indicates mature product) are in integral skin foam (steering wheels), panels (discontinuous) and commercial refrigeration (bottle coolers; refrigerator doors). Because the technology is more costly than HCFC-141b (about 10%), customers use it only when the market demands it. This is the case for international corporations such as Coca Cola and for construction on behalf of international corporations (Wall Mart, Carrefour, …).

Following information was provided and verified through customer visits:

Health, Safety, Environment – The licensee has not developed any data in addition to what FSI provides. It has not encountered HSE problems in its manufacturing plant or at customer level. This was confirmed through the two customer visits.

Performance in Thermal Insulation Foams – The licensee has measured (through independent testing) some deterioration in insulation value. Amazingly, one of its main customers—a major bottle cooler manufacturer—did not find any increase in power consumption and the product has been approved by Coca Cola. However, the customer produces ecomate® on its only high-pressure dispenser to take advantage of increased thermal performance provided by the smaller, more regular cells. The customer mentioned as positive point that ecomate® does not attack the refrigerator liner and that it could return to its pre-HCFC-141b, liner (an operational benefit!). Adhesion to metal liners is markedly improved. A refrigerator cabinet could not be stripped from foam without leaving considerable material on the liner. This is an improvement in particular to HC-blown foams. Purcom had to considerably reformulate by changing polyols, catalyst package and stabilizer. The amount of methyl formate that can be used is limited, which results in the need to increase water levels. The costs of ecomate® is US$ 3.00/kg compared to US$ 2.00/kg for HCFC-141b but its use is 1/3-1/2 less (the use of HCFC-141b actually reduces system costs as the price is lower than the polyol price). The resulting system costs about 10% more and produces foams that are slightly higher in density (1-2 kg/m^3). Because of the price/density impact (about 10%), companies use ecomate® only when customers demand replacement of HCFC-141b. 3They all use HCFC-141b in other cases.

Performance in Integral Skin Foams – the licensee initially faced stability problems in the polyol side of the system and inferior skin that made the application for steering wheels—which requires low friability—a problem. The reason was the addition of formic acid to counter hydrolysis. Without stabilization, the polyol system is stable for just one day. It identified two options for improvement:

- Direct injection of methyl formate
- Incorporation of methyl formate in the MDI side

As most equipment is not equipped for a third stream it concentrated on the MDI option and was able to develop a stable system providing good skin, same density BUT, a considerably decrease in viscosity of the MDI side of the system. This is no issue for high-pressure dispensing equipment but causes ratio changes on low-pressure equipment. The ecomate® use is about two third of HCFC-141b and the polyol blend had to be changed drastically.

Performance in Other Applications – There is currently no use of ecomate® in other applications. Its use is at the moment customer rather than supplier driven. Large, international, image-sensitive corporations demand ODS-free, low GWP products. Consequently, the licensee has only pursued ecomate® when and where customer pressure has been exercised and will continue to do so unless some MLF-sponsored introduction program would be initiated.

Naturally, the physical properties of ecomate®, being nothing else than the long existing and well researched chemical methyl formate, are not controversial. UNDP has compared information provided by the owner of the technology, FSI, with actual (limited) experience from customers and its LA licensee. Following are detailed comments on the advantages claimed by FSI for ecomate®:

- **Zero ODP** – true, but so area all other listed alternatives
- **Zero GWP** – true, although negligible would be a better description
- **Liquid at ambient process conditions** – true, but so are most other listed alternatives

- **Good solubility** – this claim is appears correct and is confirmed for most polyols and MDI. However, why is the MSDS mentioning "*not miscible or difficult to mix*" (MSDS)?
- **Low volatility** – the volatility is about in the middle between other alternatives, with HFC-245fa being the highest (bp 15.3 ^{o}C) and cyclopentane the lowest (bp 49 ^{o}C)
- **Good foam properties** – this statement is too broad and, as yet, unproven for major applications. Based on results from applications where intensive formulation optimization has been performed, there should be some confidence that most property issues can be resolved given time and dedication
- **Good thermal insulation properties** – this is as of yet unproven. Tests on foam insulation values in Brazil are not good but product testing will be decisive in final determination
- **Good flammability resistance** – this statement has not yet been verified. However, information provided (Utech, 2006) lacks information on comparative testing
- **Safe handling** – handling issues at the system house—where industrially pure methyl formate (97.5%) is processed needs further investigation. Information on the handling of systems indicates safe processing conditions with <22%LEL @ 30-32 ^{o}C; <100 ppm LEL
- **Good system stability** – while rigid foam systems appear to be stable, polyol/ecomate systems for ISF are instable in Brazilian tests
- **Lower IOCs** – this claim cannot be confirmed. From experience in ISF and rigid insulation foams in Brazil, 10-15% increase in system costs at current level of development can be expected compared to HCFC-141b. Compared to hydrocarbons, the difference is even larger. And, this statement even has to be qualified as preliminary because it pertains only to certain applications within the broader range of products and formulation optimization proves to be rather individually

While one cannot emphasize enough that ecomate® should be considered a highly interesting, potential financially beneficial, zero ODP and virtually zero GWP technology for MLF-sponsored HFCF phaseout projects, the information provided by the technology provider does not always match field experience and is, in addition, incomplete. UNDP intends to collect further validation information through:

- HSE testing
- Validation of ecomate® in all relevant applications

METHYLAL

METHYLAL

Methylal, also called dimethoxymethane, belongs to the acetyl family. It is a clear colorless, chloroform-like odor, flammable liquid with a relatively low boiling point. Its primary uses are as a solvent and in the manufacture of perfumes, resins, adhesives, paint strippers and protective coatings. It is soluble in three parts water and miscible with the most common organic solvents.

Property	Methylal	HCFC-141b
Appearance	Clear liquid	Clear liquid
Boiling point	42 ^{o}C	32 ^{o}C
LEL/UEL	2.2-19.9 %	7.6-17.7
Vapor pressure	400 mm Hg @ 20 ^{o}C	593 mm Hg @ 25 ^{o}C
Lambda, gas	Non available	10.0 mW/m.k @ 25 ^{o}C
Auto ignition	235 ^{o}C	>200 ^{o}C
Specific gravity	0.821 @ 20 ^{o}C	1.24
Molecular weight	76.09	117
GWP	Negligible	630
TLV (USA)	1000 ppm TWA	500 ppm TWA/500 ppm STEL

The use of Methylal as a co-blowing agent in conjunction with hydrocarbons and HFCs for rigid foam applications (domestic refrigeration, panels, pipe insulation and spray) has been described in the literature. 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.

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

Despite all literature references, 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. Following parameters should be carefully monitored:

- Fire performance in actual operating conditions (considering flammability of the pure chemical)
- Polyol miscibility, an advantage claimed in the literature
- Foam flow (taking into account the relatively high -compared to other blowing agents- boiling point)
- Foam thermal conductivity (Gas conductivity value is not reported)
- Skin formation. (A cited US patent suggests a clear benefit)
- Diffusion rate in the polyurethane matrix (in view of its high solvent power)

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:

	HBA-1	HBA-2	FEA-1100	AFA-L1
Chemical Formula	n/k	n/k	n/k	n/k
Molecular Weight	<125	n/k	161-165 (estimated)	<134
Boiling point (^{0}C)	<-15	n/k	>25	>10 <30
Gas Conductivity (mWm^{0}K at 10 ^{0}C)	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)	0	0	0	0
ODP	6	n/k	5	Negligible

Except HBA-1, all chemicals still have to undergo substantial further toxicity testing and will therefore not appear in the market within two years. That may be too late in the A5 context where foam conversion is prioritized. As to HBA-1, this will be targeted as a replacement of HFC-134a in one component foams. There are only few OCF manufacturers in developing countries.

III XPS BOARDSTOCK

Extruded polystyrene foam can be divided into sheet and boardstock applications. In virtually all sheet applications CFCs have been replaced by hydrocarbons—butane, LNG and LPG. In boardstock, most of the replacement has been a blend of HCFC-142a and HCFC-22 in a 70-80%/30-20% ratio. The use of HCFC-22 was aimed at countering HCFC-141b's (modest) flammability. With the prices of HCFC-22 ever decreasing, many manufacturers—mainly in China—have converted to HCFC-22 alone. This has exacted an as of yet undetermined toll on the product quality as HCFC-22 escapes relatively quick from the foam, causing shrinkage and deteriorating insulation values.

The 2008 FTOC update reports that the phaseout of HCFCs in non Article 5 countries has been—and continues to be—a problem. North American XPS boardstock producers are on course to phaseout HCFC use by the end of 2009. Phaseout choices will be HFC blends, CO_2 (LCD) and hydrocarbons. The significant variety in products required to serve the North American market (thinner and wider products with different thermal resistance standards and different fire-test-response characteristics) will result in different solutions than in Europe and Japan, who have already phased out HCFCs. In Europe, this has been achieved with HFC-134a, HFC-152a and CO_2 (or CO_2/alcohol) while in Japan there has also been significant use of hydrocarbons. Recently introduced so called F-Gas regulations in Europe may change the scenario in that region.

Most XPS boardstock manufacturing in Article 5 countries appears to be in China (60,000t) and Turkey (10,000 t). There is at least one plant in Argentina and one in Egypt. This application has not been well researched by the TEAP because it was traditionally a non-A5 market. But now only in China, approximately 350 small-scale XPS plants have been installed since 2001.

Options for HCFC replacement are:

SUBSTANCE	COMMENTS
HFC-134a	Considered expensive
HFC-152a	Moderately flammable and considered expensive
(Iso)butane	Highly flammable; high investment
CO_2	As gas only capable to replace 30% of the BA. As liquid, high investment. Considered in combination with other technologies (HCs, ethanol)
HBA-1	Non-flammable, ideal boiling point, but still experimental

There may be different solutions for different baselines. In view of the fact that Chinese manufacturers are reported using only HCFC-22 as blowing agent, it is expected that 100% replacement by a hydrocarbon would be possible without (further) deterioration of quality. This would provide the Chinese market with a truly non-ODS, virtually non-GWP option. However, the emission of hydrocarbons over an extended period is of concern, being different from XPS sheet. Therefore, as part of a validation, a thorough safety assessment will need to be performed.

Very important will be to evaluate the possible use of HBA-1. This substance appears to offer the same advantages of hydrocarbons without the fire risk and to offer improved insulation value compared with other HCFC replacements. But, with no diffusion data available, this is a very preliminary statement. UNDP is in contact with its manufacturer, Honeywell, which has in principle agreed to support a validation project. Details need to be worked out.

Using GWP and MW data as provided by the FTOC (2006), following indicative GWP changes are to be expected for the replacement of HCFC-141b in PU foam applications:

SUBSTANCE	GWP	MOLECULAR WEIGHT	INCREMENTAL GWP	COMMENTS
HCFC-142b/-22	2,148	95	Baseline	
HCFC-22	1,780	87	-518	Used in China only (lower cost) Non flammable
HFC-134a	1,410	102	-634	Non flammable
HFC-152a	122	66	-2,063	Moderately flammable
(Iso)butane	4	58	-2,156	Flammable
CO_2 (LCD)	1	44	-2,148	Used in Japan only Non Flammable
HBA-1	6	<115	~ 2,100	In development Non flammable

Based on these data, it appears that

- HCs, CO_2 (LCD) and HBA-1 are by far the lowest GWP—indeed virtually zero ODP—options
- HFC-152a's GWP is below the EU threshold of 150. It may therefore be an acceptable alternative from a clima change perspective

The XPS boardstock program may therefore include:

- HFC-152a
- Hydrocarbons
- Carbon Dioxide (gas or liquid)
- HBA-1

ANNEX-4

INDICATIVE LIST OF PARTICIPANTS AND BASELINE DATA

This is a condense list of the information provided by each preliminary participant. A final list of participants will appear in the grant request for Phase-II of the project which will be prepared after—and with technology and cost input from—Phase-I. All data are subject to Government review prior to final submittal

ENTERPRISE	APPLICATION	CONSUMPTION (t/y)							
		SYSTEMS				HCFC-141b			
		2005	2006	2007	AVG	2005	2006	2007	AVG
Client-01	Shoesoles	119	87	107	104	4.0	2.9	3.5	3.5
Client-02	Shoesoles	120	130	120	124	4.0	4.3	4.0	4.1
Client-03	Shoesoles	154	160	136	150	5.1	5.3	4.5	5.0
Client-04	Shoesoles	120	130	121	124	4.0	4.3	4.0	4.1
Client-05	Shoesoles	240	220	180	213	8.0	7.3	5.9	7.1
Client-06	Shoesoles	96	100	102	99	3.2	3.3	3.4	3.3
Client-07	Shoesoles	300	240	240	260	10.0	7.9	7.9	8.6
Total Consumption		**1,149**	**1,067**	**1,006**	**1,074**	**38.3**	**35.3**	**33.3**	**35.7**

ANNEX-5
DETAILED COST CALCULATIONS

#	ACTIVITY	INDIVIDUAL COSTS	EXPLANATIONS
PHASE-I – DEVELOPMENT/OPTIMIZATION/VALIDATION			
1	Preparative work		
	Project Preparation	25,000	Partially retroactive
	Technology Transfer, Training	75,000	Include license for 2 years
2	System Development		
	Development (7 applications) @ 5,000	35,000	Does not include labor—just
	Optimization (7 applications) @ 3,000	21,000	chemicals and external testing
	Validation (7 applications) @ 2,000	14,000	
3	Laboratory Equipment	50,000	See below
	Laboratory Safety	10,000	For explosion proofing
4	Peer review/endorsement of next phase	20,000	
5	Contingencies (10%)	24,000	

PHASE-II – HCFC PILOT PHASEOUT PROJECTS COVERING ALL FORMULATIONS			
1	System House adaptations		
	1 Blender	50,000	)
	1 Tank for MeF	20,000	)
	Safety measures	25,000	)Taken from previous projects
	Contingencies (10%)	9,500	)
2	Downstream user Operations (7)		
	7 Retrofits @ 15,000	105,000	)
	7 Trial Programs @ 3,000	21,000	)As per MLFS template
	Contingencies (10%)	12,600	)
4	Peer review/safety audits	20,000	1 visit/travel/per diem/reporting
5	Incremental Operating Costs	267,100	See below
PHASE III – TECHNOLOGY TRANSFER TO SYSTEM HOUSES			
1	Technology transfer workshop	20,000	
	Instructional booklets	5,000	
	Contingencies	2,500	

Laboratory equipment	Refractometer		5,000
	Brett mold		5,000
	pH tester		5,000
	Abrasion tester		15,000
	Cell gas analyzer		20,000
	Total	**US$**	**50,000**

Incremental operating costs are based on 4.5 % increased system costs as per Purcom information. For two years this amounts to

4.5% of 1,074 t @ 3.200 x 1.74 = US$ 267,099.20 (say 276,100)

This being a pilot project, these costs are a forecast, extrapolated from experience in Brazil. A better forecast can be provided after completion of Phase-I, in the funding request for Phase-II.

ANNEX-6

TRANSMITTAL LETTER SYSTEMS HOUSE (TEMPLATE)

SUBMISSION OF A PILOT PROJECT FOR FUNDING UNDER THE MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL[1]

System house Commitments

ZADRO, represented by Mr. Jose Luis Ordaz, owner/Director having agreed to the preparation of a project for the consideration of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol to validate the use of methyl formate as replacement of HCFC-141b in the manufacture of polyurethane foam shoesoles at the following customers following and in compliance with ExCom decision 55/43 (e), makes the following commitments for the implementation of the project with the assistance and in cooperation with the United Nations Development Programme (UNDP) and with the consent of the Government of Mexico's National Ozone Unit (NOU).

ZADRO:

1. Agrees to implement the project as approved, abiding by relevant decisions relating to change in technology;

2. Is aware that a validation project does not have a secure outcome. In case the validation is successful, it will permanently convert participating customers to the use of methyl formate. In case the validation will be negative, it will undertake conversion of the participating customers to another, validated, non-ODP/low GWP technology in consent with other stakeholders and the Executive Committee for the Implementation of the Montreal Protocol;

3. Is aware and accepts that, with the view to ascertaining that equipment purchased by the Multilateral Fund is being used or is not reverted to the use of HCFCs, the NOU is mandated to monitor closely in cooperation with customs and environmental protection and/or other relevant authorities, the importation and or purchase and use of CFCs by the enterprise, including unscheduled visits to the factory. The enterprise and the NOU may determine the number of such unscheduled visits.

4. Is aware that the implementing agency has the obligation to ensure appropriate use of or refund of unused contingency funds and to keep funding requests for equipment and trials to levels essential for the conversion;

5. Will cooperate in the preparation of regular reports through UNDP and the NOU to the Multilateral Fund on the status of the project's implementation;

6. Agrees to cooperate with the implementing agency to return funds in case of identified serious funding irregularities, such as when project funds were used to purchase non-eligible items and the implementing agency was requested by the Executive Committee to return funding to the Multilateral Fund;

7. Is aware and accepts that the implementing agency in cooperation with the NOU is required to conduct safety inspections where applicable and to prepare a report on accident resulting from conversion projects.

8. Commits to destroy or render unusable any equipment or component of equipment replaced by this project in line with the stipulations that have been drawn up in the project document.

[1] *This note should be prepared on company letter head and attached as Annex I to each project document. A copy should be lodged with the NOU to be appended to its record of the Government's Note of Transmittal of the sector projects.*

9. Commits to provide funds for items that are included in this project but are specifically excluded from funding by the Multilateral Fund of the Montreal Protocol (MLF) as well as for items included in this project and required for a successful completion but that, while eligible, exceed the available budget and contingencies.

Name and Signature of Authorized Enterprise Representative:

Designation: Date:

Address:

Telephone: Fax:

E-mail:

Name and Signature of Representative of NOU Date: