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执行蒙特利尔议定书
多边基金执行委员会
第五十六次会议
2008 年 11 月 8 日至 12 日，多哈

项目提案：墨西哥

本文件包括多边基金秘书处对以下项目提案的评论和建议：

泡沫塑料

• 在聚氨酯鞋垫应用中验证使用甲酸甲酯的试点项目（第一阶段）	开发计划署

项目评价表 — 非多年期项目

墨西哥

项目名称	双边/执行机构
(a) 在聚氨酯鞋垫应用中验证使用甲酸甲酯的试点项目（第一阶段）	开发计划署

国家协调机构	环境和自然资源秘书处

最新报告的项目所涉消耗臭氧层物质的消费数据

A:第 7 条数据（ODP 吨，2007 年，截至 2008 年 9 月）

氟氯烃	1,424.7		

B：国家方案行业数据（ODP 吨，2007 年，截至 2008 年 9 月）

0DS				
氟氯烃	1,440.2			
仍符合供资条件的氟氯化碳消费量（ODP 吨）				0.0

本年度业务计划拨款		供资百万美元	淘汰 ODP 吨
	(a)	根据第 55/43(e)号决定	暂缺

项目名称:	
在企业使用的消耗臭氧层物质（ODP 吨）：	
要淘汰的消耗臭氧层物质（ODP 吨）：	暂缺
要使用的消耗臭氧层物质（ODP 吨）：	暂缺
项目期限（月）：	7
最初要求提供的数额 (美元)：	291,500
最终项目费用（美元）：	291,500
增量资本费用：	265,000
应急费用（10%）：	26,500
增量经营费用：	
项目费用总额：	291,500
本地所有权（%）：	100%
出口百分比（%）：	0%
要求提供的款额 (美元)：	291,600
成本效益(美元/公斤)：	暂缺
执行机构支助费用（美元）：	21,862
向多边基金申请的项目费用总额（美元）：	313,362
对等供资的现况（有/无）：	暂缺

是否列入项目监测阶段目标（有/无）：	有
秘书处的建议	供个别审议

项目说明

1. 开发计划署代表墨西哥政府向执行委员会第五十六次会议提出墨西哥在聚氨酯鞋垫应用中验证使用甲酸甲酯的试点项目（第一阶段）。试点项目第一阶段的经费总额为 291,500 美元，外加机构支助费用 21,862 美元。

2. 本项目预备首先研发、优化和验证在聚氨酯泡沫鞋垫应用中使用甲酸甲酯（第一阶段），然后将此技术（如果得到验证）用于 7 个下游鞋垫泡沫工厂（第二阶段）。本项目将在 Zadro 公司执行，该公司专门只向墨西哥鞋垫行业供应制作系统。

3. 甲酸甲酯是一种用于制造其他化学品和包括药品和杀虫剂等产品的化学物质。虽然它在早期文献中已有作为合成橡胶发泡剂的记载，但美国泡沫塑料供应公司（Foam Supplies, Inc.）在 2000 年首次将其试用于聚胺脂泡沫塑料。这项应用作为 Ecomate®得到专利，并对下列公司颁发了独占性许可证：拉丁美洲 Purcom 公司（巴西）、联合王国和爱尔兰 BOC 特殊气体公司和澳大利亚、新西兰和太平洋周边国家的澳大利亚尿烷配方厂家（设于澳大利亚的公司也已取得在中东其他国家和北美国家以及中国和印度使用技术的许可证）。

4. 第一阶段经费总额为 291,500 美元，细目列表如下。目前估计第二阶段需要初步经费 532,200 美元。

说明	美元
项目筹备	25,000
技术转让（包括许可证费用）和培训	75,000
系统研发（7 项应用，每项 5,000 美元）	35,000
系统优化（7 项应用，每项 3,000 美元）	21,000
系统验证（7 项应用，每项 2,000 美元）	14,000
化验室设备	50,000
化验室安全保障	10,000
同行审查/下一阶段工作的筹备	10,000
技术散发讲习班	25,000
应急开支（10%）	26,500
共计	291,500

5. 鉴于这是泡沫塑料应用中示范使用氟氯烃代用技术的首次试点项目，本文件附有开发计划署编制的项目摘要。

秘书处的评论和建议

评论

6. 秘书处根据提交第五十五次会议环绕氟氯烃淘汰供资的相关费用审议的订正分析政策文件和执行委员会通过的第 55/43 号决定以及开发计划署提交第五十六次会议的巴西补充验证项目审议了这个项目。

7. 执行委员会第五十五次会议审议的氟氯烃费用文件注意到，应选定第 5 条国家一些配方厂家验证新的或经过大量改动的技术依次用于氟氯烃淘汰项目使投资项目能立即从验证工作获益。秘书处注意到，开发计划署提交的提案已经考虑到此事，预备在认为技术可以转让时，立即为墨西哥和该地区内其他国家（阿根廷、巴西、智利和哥伦比亚）感兴趣的配方厂家提供技术散发讲习班。开发计划署还收到印度配方厂家希望参加讲习班的申请。

8. 关于提供进一步资料的要求，即要求说明 Zadro 公司使用 Ecomate 技术应该支付多少许可证费用以及将有多少这个项目的成果会转让给其他配方厂家，对此，开发计划署表示，目前 Purcom 公司（巴西拥有使用这项技术独占性许可证的公司）已经同意向 Zadro 公司提供一个使用 Ecomate 专利的许可证。开发计划署在与该公司进行的谈判中，要求将这个许可证定为非独占性许可证，因为其他配方厂家不应被剥夺今后使用这项技术的权利。Purcom 公司和 Zadro 公司都同意将试点项目的成果散发给其他配方厂家。此外，Purcom 公司还愿意向拉丁美洲其他配方厂家提供非独占性许可证。

9. 目前建议在环境规划署泡沫塑料技术选择委员会对验证工作进行监督的情况下，使用这项技术取得的成果由基金秘书处通过合格的独立专家加以验证。秘书处注意到，开发计划署对独立专家验证这项技术表示关切。不过，秘书处并无验证任何技术的专门知识、预算经费和任务权限。因此，秘书处建议，在验证期间，开发计划署与泡沫塑料技术选择委员会就其审查保持密切联系。开发计划署同意秘书处的建议。

10. 秘书处和开发计划署还讨论了有关许可证费用、对 Zadro 公司进行的培训方案以及墨西哥配方厂家对验证 Ecomate 专利技术用于鞋垫应用的承诺的一些问题。开发计划署指出，Zadro 公司必须得到使用验证设备和执行开发计划署国际专家拟定的验证方案的培训，以确保它得到泡沫塑料技术选择委员会的验证。

建议

11. 鉴于执行委员会根据第 55/43(e)号决定已经邀请双边执行机构作为紧迫事项编制和提出涉及研发、优化和验证使用非氟氯烃起泡剂的化学系统的配方厂家和/或化学剂供应商的几个具体项目，并根据秘书处作出的评论，谨建议执行委员会核准墨西哥在聚氨酯鞋垫应用中验证使用甲酸甲酯的试点项目（第一阶段），供资 291,500 美元，外加 26,500 美元机构支助费用给开发计划署。

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.

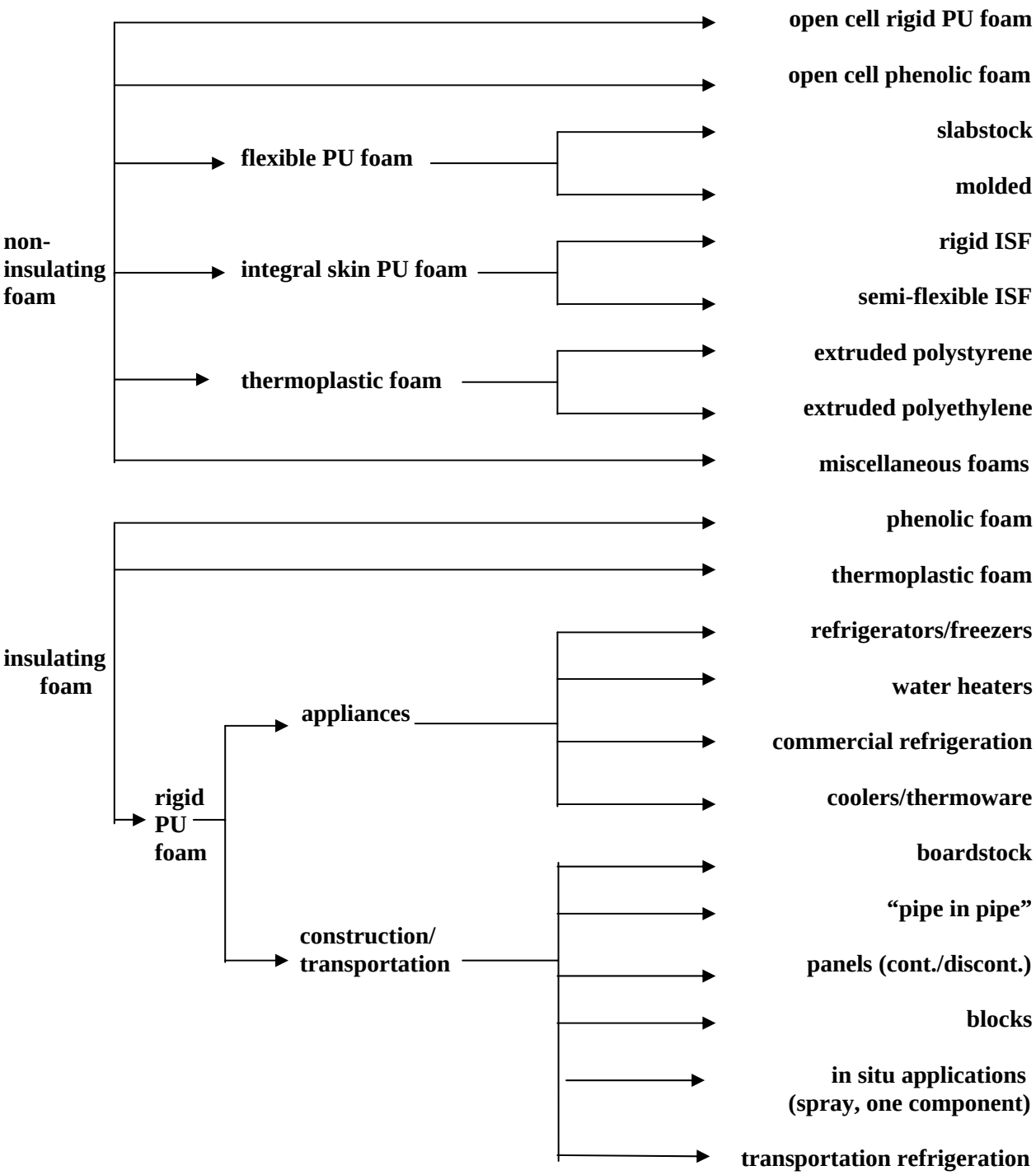
- **The use of local experts –** A person who is familiar with the local foam industry could accelerate and improve data collection. However, such person, after "picking his own recollection" is dependent on the same sources as any other data collector and dependent on persistence, ingenuity and organizational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

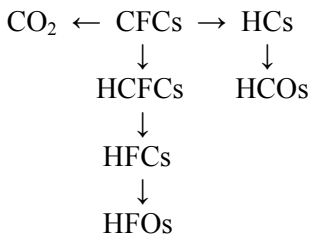
Not all replacement technologies that are currently available meet these criteria. Following assessment has been divided into the two applicable foam polymer groups: polyurethanes (PU) and (extruded) polystyrene (XPS) foams.

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: