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11 October 2008

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ORIGINAL: ENGLISH



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ورقة تقييم المشروع - مشروعات متعددة السنوات البرازيل

الوكالة:	ولا - عنوان المشروع:
Germany, UNDP	CFC phase out plan

عام: 2007	تاليا - آخر معطيات المادة 7:	هالونات: 1.6	بروميد الميثيل: 100.4
0 :TCA	318.1 :CFC	50.3: CTC	

عام: 2007											تاليا - آخر المعطيات القطاعية للبرنامج القطري:											
المجموع	نصف النسخ	بروميد الميثيل		استعمال مخبري	أجهزة الاستنشاق المرودة بمقاييس للجرعات	عوامل التصنيع	مذيبات	تبريد	هالونات	رغاوي	ايروسول	المواد	الخدمات		الصناعة		CFC	CTC	Halons	Methyl Bromide	TCA	
		Non QPS	QPS										الخدمات	الصناعة								
279.3					279.3																	CFC
50.3						50.3																CTC
1.6									1.6													Halons
100.4			100.4																			Methyl Bromide
0																						TCA

رابعاً - معطيات المشروع:		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	المجموع
حدود استهلاك بروتوكول مونتريال	CFC	10,525.8	10,525.8	10,525.8	10,525.8	10,525.8	5,262.9	5,262.9	1,578.9	1,578.9	1,578.9	0.	
الحد الأقصى للاستهلاك المسموح به (اطنان من القدرات المستفدة للأوزون)	CFC	9,276.	9,276.	8,280.	6,967.	5,020.	3,070.	2,050.	1,000.	424.	74.	0.	
تكاليف المشروع (دولار أمريكي)	Germany			577,137.	1,062,863.	1,000,000.	1,000,000.	243,600.					3,883,600.
	UNDP			51,942.	95,658.	90,000.	90,000.	21,924.					349,524.
مجموع الأموال الموافق عليها مينييا (دولار أمريكي)	تكاليف المشروع			7,860,000.		5,420,000.	4,270,000.	2,856,400.	1,190,000.	870,000.	250,000.	100,000.	22,816,400.
	تكاليف الدعم			687,700.		473,000.	369,500.	242,276.	92,300.	63,500.	12,500.	5,000.	1,945,776.
مجموع الأموال التي سرحتها اللجنة التنفيذية (دولار أمريكي)	تكاليف المشروع			8,437,137.	1,062,863.	6,420,000.	5,270,000.	3,100,000.	1,190,000.	870,000.	250,000.	100,000.	26,700,000.
	تكاليف الدعم			739,642.	95,658.	563,000.	459,500.	264,200.	92,300.	63,500.	12,500.	5,000.	2,295,300.
مجموع الأموال التي سرحتها اللجنة التنفيذية (دولار أمريكي)	تكاليف المشروع			8,437,137.	6,420,000.	1,062,863.	6,826,400.	2,733,600.	870,000.	0.	0.	0.	26,350,000.
	تكاليف الدعم			762,727.8	563,000.	95,658.	584,776.	231,224.	63,500.	0.	0.	0.	2,300,885.8
مجموع الأموال المطلوبة للعام الجاري (دولار أمريكي)	تكاليف المشروع										250,000.		250,000.
	تكاليف الدعم										12,500.		12,500.

موافقة شمولية	خامساً - توصية الأمانة:
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تعليمات الحجر الصحي السابق للتصنيف: QPS

تعليمات غير خاصة بالحجر الصحي السابق للتصنيف: Non-QPS

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436,315	38.66%	274,985	117,807	26,773
650,973	83.15%	3,211,426	700,406	535,268
651,000	95.54%	13,939,230	2,070,590	6,853,164
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61,090	105.32%	4,552,065	599,351	320,000
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77,130	61.44%	122,870	106,748	10,987
405,534	73.44%	2,199,466	488,596	556,100
2,282,042	91.10%	24,358,959	4,083,498	8,305,269

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COUNTRY:	Brazil	IMPLEMENTING AGENCY:	UNDP
PROJECT TITLE:	Pilot project for validation of Methyl Formate as a blowing agent in the manufacture of polyurethane foam (Phase-I)		
PROJECT IN CURRENT BUSINESS PLAN:	Based on ExCom Decision 55/43(e i-iii)		
SECTOR:	Foams		
Sub-Sector:	All sub-sectors (except shoe soles)		
ODS USE IN SECTOR			
Baseline:	Not yet determined		
Current (2007):	6,403 t (HCFC 141b imported as per Government reporting)		
BASELINE ODS USE:	N/A		
PROJECT IMPACT (ODP targeted):	N/A		
PROJECT DURATION:	7 months		
PROJECT COSTS:	US\$ 368,500 (Phase-I only)		
LOCAL OWNERSHIP:	100 %		
EXPORT COMPONENT:	0 %		
REQUESTED MLF GRANT:	US\$ 368,500		
IMPLEMENTING AGENCY SUPPORT COST:	US\$ 27,638 (7.5 %)		
TOTAL COST OF PROJECT TO MLF:	US\$ 396,138		
COST-EFFECTIVENESS:	N/A		
PROJECT MONITORING MILESTONES:	Included		
NTL. COORDINATING AGENCY:	Ministry of Environment - MMA/PROZON		

PROJECT SUMMARY

Brazil became a Party to the Vienna Convention and Montreal Protocol on 19 March, 1990. Brazil also ratified the London, Copenhagen, Montreal and Beijing Amendments. The country is fully committed to the phaseout of HCFCs and willing to take the lead in assessing new HCFC phaseout technologies

The objective of this project is to develop, optimize, validate and disseminate the use of methyl formate in PU foam applications. The project is divided in two distinct phases:

Phase-I: development, optimization and validation and technology dissemination

Phase-II: implementation in 15 downstream enterprises covering all relevant applications

At this stage funding only for Phase-I is requested. The costs Phase-II are included as a preliminary indicative estimate. The Phase-II costs will be updated after completion of Phase-I and submitted for approval in 2009.

IMPACT OF PROJECT ON COUNTRY'S MONTREAL PROTOCOL OBLIGATIONS

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

Prepared by: Bert Veenendaal

Date: October 2008

PROJECT OF THE GOVERNMENT OF BRAZIL

**PILOT PROJECT FOR VALIDATION OF METHYL FORMATE AS A
BLOWING AGENT IN THE MANUFACTURE OF POLYURETHANE FOAM**

1. PROJECT OBJECTIVES

The objectives of this project are to:

1. Develop, optimize and validate the use of methyl formate in polyurethane foam applications;
2. Apply the technology in a limited amount of downstream operations;
3. Transfer 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 reflect 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. However, 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 Purcom Quimica LTDA (“Purcom”). Contact information is as follows:

Company: Purcom Quimica LTDA
Contact: Mr. Gerson Silva, Technical Director
Address: Rua Aeroporto 83/115, 06419 260 Barueri, SP, Brazil
Ph/Fx: +5511-416-18902/+5511-416-84683
Email: gerzon@purcom.com.br

Purcom was founded May 2002 and is 100 Brazilian owned. The company is the largest independent system house in Brazil and specializes in tailor-made PU systems covering virtually all applications except shoesoles. Annual sales have developed as follows (rounded):

2005 US\$ 10,000,000 2006 US\$ 14,000,000 2007: US\$ 26,000,000

Export amounts to less than 3% (Argentina, Chile, Colombia and Mexico). The company employs about 50. Base chemicals are purchased from Air products, Bayer, Dow, Evonic, and Huntsman. The company processes following auxiliary blowing agents (2007):

- HCFC-141b 70 % 940 t all rigid and integral skin applications
- Methyl Formate 15 % 200 t steering wheels, bottle coolers
- Methylene Chloride 10 % 130 t packaging foams
- HFCs 5 % 65 t specialty applications

Methyl formate systems are sold under the name “ecomate[®]” and based on a license from FSI, USA. Purcom has developed these systems further and applied so far for 4 patents on new applications.

Purcom has identified companies covering 15 applications that address virtually all HCFC-consuming PU applications in Brazil. **Annex-3** lists the applications involved, and preliminary estimates of chemical consumption of PU systems as well as the HCFC-141b they contain. Verification of data and more information will be collected during the preparation of phase II.

4. PROJECT DESCRIPTION

The project is divided into two phases:

- Phase-I: development, optimization, validation, technology dissemination
- Phase-II: implementation at recipients covering all applications

4.1 PHASE-I

PU foams are used in applications that have different formulation requirements. Around 16 applications use currently HCFC-141b and 15 of these are produced by Purcom (shoesoles, will be a separate pilot project in Mexico). Development, optimization and validation of methyl formate as replacement technology for HCFC-141b will involve the systems house only. Purcom has already developed the technology for 8 applications (ref. **Annex-3**). It commercialized their use in three applications—steering wheels, discontinuous panels and bottle coolers. However, testing programs were hampered by insufficient testing equipment. Phase-I therefore will consist of:

- Acquisition of the necessary testing/prototyping equipment;
- Development of the remaining 7 applications;
- Optimization and Validation of all formulations except steering wheels on prototyping equipment that can simulate process conditions;
- Dissemination of the experience gained through a workshop.

Changing the blowing agent, which is an essential element in the formulation, requires the determination of baseline values for critical properties. While some, such as density, are general in nature, others are specific such as the following list shows:

Foam type	Application	Status	Critical Properties	Action
Integral Skin	Steering wheels	Partially proven	Friability, surface Skin adhesion	No action
	Shoe soles	Not developed	Surface	Validation
	Structural (rigid)	Developed	Surface	Validation
	Semi-flexible	Developed	Surface	Validation
Rigid Insulation	Domestic refrigeration	Not developed	Insulation, adhesion	Validation
	Commercial refrigeration	Developed	Insulation, adhesion	Validation
	Water heaters	Developed	Insulation, adhesion	Validation
	Trucks	Not developed	Insulation, adhesion	Validation
	Panels-continuous	Not developed	Insulation, adhesion	Validation
	Panels-discontinuous	Developed	Insulation, adhesion	Validation
	Spray	Not developed	Insulation, adhesion	Validation
	Blocks	Not developed	Insulation	Validation
	Thermoware	Not developed	Insulation, adhesion	Validation
	Pipe-in-pipe	Not developed	Insulation, adhesion	Validation
Flexible Foams	Hyper-soft molded	Developed	Appearance, touch	Validation
	Hyper-soft slabstock	Developed	Appearance, touch	Validation
	Low resilience	Developed	Resilience curve	Validation

Companies and their suppliers do not conduct 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. In addition, prototyping equipment is required to limit burdensome and costly downstream production testing to a minimum. The outcome of this part of the project will be a list of application-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 then be technically cleared for industrial application under Phase-II as well for dissemination to interested system houses. Past experience has shown how important it is to assure commercial availability and local technical support. In this project, following action is proposed to achieve this goal to the extent possible:

- UNDP has requested—and Purcom, as exclusive licensee for “ecomate®” technology in the regional area, has agreed to—offering non-exclusive sub-licenses to all regional system houses in good standing (= meeting MLF participation financial and eligibility criteria);
- Technology dissemination workshops will be conducted for interested systems houses as soon as the technology is deemed transferable;
- UNDP has contacted licensees in other A5 regions and proposed the same approach. The response was a tentative “yes”. These companies will attend the dissemination workshops and then decide on a definite commitment.

While this may be not the immediate most profitable course for a system house with an exclusive license, it is the price to be paid for MLF support. It should be emphasized that, while other system houses can be briefed at no cost in MEF technology, they remain independent in their choice of phaseout technologies.

7.2 PHASE-II

After the formulation for a particular application has successfully passed its evaluation, UNDP will apply for approval of the second project phase, which is application in a manufacturing context.

15 companies, covering all applications, will apply the technology in their operations. Product and process testing will be conducted at downstream level by the system house. UNDP will contribute to this evaluation by conducting safety audits that includes workers exposure testing. Process adaptations will be made as needed to meet requirements as indicated in the previous table.

7.4 Supervision Arrangements

1. Decision 55/43 requires 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

8. TECHNICAL OPTIONS FOR HCFC REPLACEMENT IN PU FOAMS

8.1 GENERAL OVERVIEW

Annex-2 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
- HCs, CO₂ (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

It follows that PU validation may include following technologies:

- Carbon Dioxide
- Hydrocarbons
- Methyl Formate

8.2 METHYL FORMATE AS REPLACEMENT TECHNOLOGY FOR HCFC-141b

Annex-2 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.

Reportedly, Brazil is the only A5 country where ecomate[®] is blended. The licensee for Latin America, Purcom, stated that it has spent much effort in system development for ecomate[®] which has by now replaced about 15% of their HCFC consumption. Current commercial applications (which indicate mature product) are in integral skin foam (steering wheels), panels (discontinuous) and commercial refrigeration (bottle coolers). Because the technology is more costly than HCFC-141b (Purcom indicates ~10%), customers use it only when the market demands it. This is the case for international corporations and for construction on behalf of international corporations

9. PROJECT COSTS

Cost forecasts for pilot projects are very difficult to prepare as such projects, by nature, are unpredictable. UNDP has as much as possible used the guidance provided by the Secretariat in Document 55/47 Annex III, Appendix II. Deviations from this document are explained.

One uncertainty is the flammability of methyl formate. The MSDS mention the substance to be “extremely flammable” respectively “explosive in vapor/air mixes”. On the other side, a study shows that emissions from the actual foam process are <100 ppm and therefore below applicable explosion limits.

UNDP considers the process at the system house (prototyping, blending) hazardous and requiring adequate safeguards but the use of pre-blended systems non-flammable. That implies that from the 15 applications only 3 (all continuous operations that direct meter the blowing agent) are deemed to require safeguards. Consequently, the Secretariat’s template for flammable blowing agents is used in four cases and the one for non-flammable substances 12 cases. This has a beneficial impact on the budget and leads to the following summarized cost expectations:

#	ACTIVITY	COSTS (US\$)		
		INDIVIDUAL	SUB-TOTAL	TOTAL

PHASE-I – DEVELOPMENT/OPTIMIZATION/VALIDATION/DISSEMINATION				
1	Preparative work Project Preparation Technology Transfer, Training	30,000 25,000	55,000	368,500
2	System Development (7 applications) @ 5,000 Optimization (15 applications) @ 3,000 Validation (15 applications) @ 2,000	35,000 45,000 30,000	110,000	
3	Laboratory Equipment Laboratory Safety	115,000 10,000	125,000	
4	Peer review/preparation of next phase		20,000	
5	Technology Dissemination Workshops		25,000	
6	Contingencies (10%)		33,500	

PHASE-II – HCFC PILOT PHASEOUT PROJECT COVERING ALL APPLICATIONS (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	104,000	1,916,000
2	Continuous Operations (12) 12 Retrofits @ 15,000 12 Trial Programs @ 3,000 Contingencies (10%)	180,000 36,000 21,600	237,600	
3	Discontinuous Operations (3) 3 ex proof metering systems @ 15,000 3 ventilation units @ 25,000 3 sensor systems @ 15,000 3 grounding programs @ 5,000 Contingencies	45,000 75,000 45,000 15,000 18,000	198,000	
4	Peer review/safety audits		50,000	
5	Incremental Operating Costs		1,326,400	

Annex-6 provides details and justifications.

UNDP requests at this stage a grant for the first phase of this project amounting to

US\$ 368,500

10. 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			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
(l) Compliance Monitoring	17

* As measured from project approval

ANNEX-2

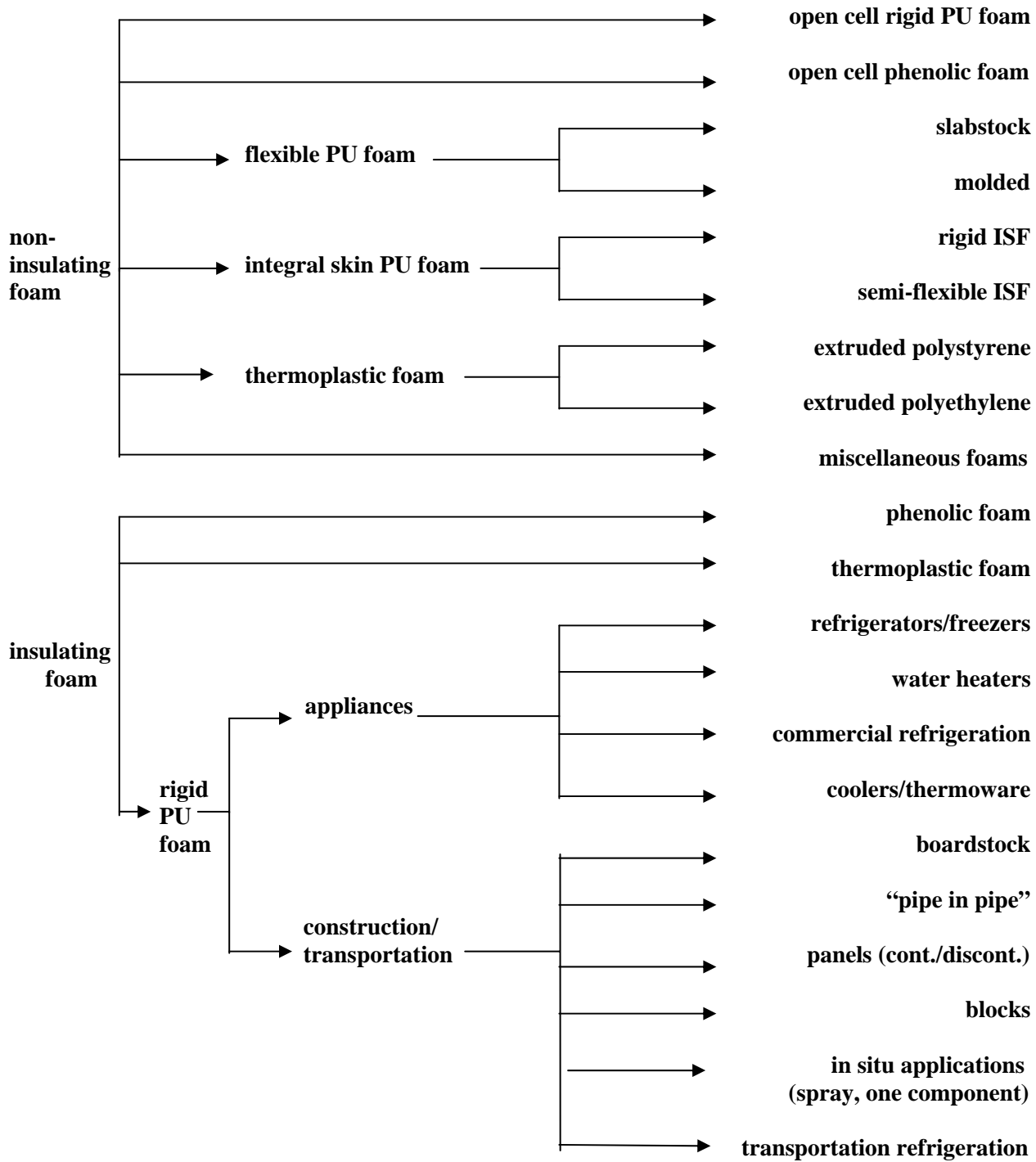
IDENTIFICATION OF ODS USERS IN THE FOAM INDUSTRY

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 CFCs, these substances have to pass by definition the border and are subject to customs registration and inspection. The problem with CFCs for foam applications is that not all CFCs are imported as such but frequently preblended into polyol. Inclusion of these substances in customs registration and mandatory disclosure of CFC 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 CFC-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 CFCs 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 involved, 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 25⁰C 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.

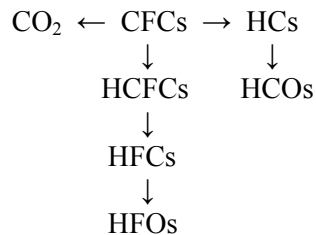
Not all replacement technologies that are currently available meet these criteria. Following assessment has been divided into the two applicable foam polymer groups: polyurethanes (PU) and (extruded) polystyrene (XPS) foams.

II PU FOAMS

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

- Hydrochlorofluorocarbons (HCFCs)
- Hydrocarbons (HCs)
- Carbon dioxide (CO₂), 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	

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

²It 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/m³. While this restriction mostly applies to open-cell flexible foams which do not use HCFCs, another restriction based on the relatively emissive nature of CO₂ 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/CO₂ 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/CO₂ 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 CO₂ 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 ₂ FCF ₃	CF ₃ CH ₂ CHF ₂	CF ₃ CH ₂ CF ₂ CH ₃
Molecular Weight	102	134	148
Boiling point (°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/m³). 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 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 °C) and cyclopentane the lowest (bp 49 °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 °C; <100 ppm LEL
- **Good system stability** – while rigid foam systems appear to be stable, polyol/ecomate systems for ISF are unstable 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 °C	32 °C
LEL/UEL	2.2-19.9 %	7.6-17.7
Vapor pressure	400 mm Hg @ 20 °C	593 mm Hg @ 25 °C
Lambda, gas	Non available	10.0 mW/m.k @ 25 °C
Auto ignition	235 °C	>200 °C
Specific gravity	0.821 @ 20 °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 (°C)	<-15	n/k	>25	>10 <30
Gas Conductivity (mWm ⁰ K at 10 °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, CO₂ (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 CO₂ (or CO₂/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, CO₂ (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 climate change perspective

The XPS boardstock program may therefore include:

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

ANNEX-4

PARTICIPANTS AND BASELINE DATA TEMPLATE

APPLICATION	ENTERPRISE	CONSUMPTION (t/y)					
		SYSTEMS			HCFC-141b		
		2005	2006	2007	2005	2006	2007
FLEXIBLE FOAMS (FPF)							
Hyper-soft Slabstock	Client 1	16	20	24	2.4	3.0	3.6
Hyper-soft Molding	Client 2	7	7	7	1.1	1.1	1.1
Low Resilience Slabstock	Client 3	120	120	120	7.2	7.2	7.2
INTEGRAL SKIN FOAMS (ISF)							
Rigid ISF	Client 4	150	160	165	16.5	17.6	14.0
Flexible ISF	Client 5	120	142	150	14.0	17.0	18.0
RIGID INSULATION FOAMS (RPF)							
Domestic Refrigeration	Client 6	94	100	110	14.0	15.0	16.0
Commercial Refrigeration	Client 7	1,000	1,100	1,200	150.0	165.0	180.0
Water Heaters	Client 8	30	32	35	4.5	4.8	5.2
Panels, Continuous	Client 9	900	1,000	1,200	125.0	130.0	160.0
Panels, Discontinuous	Client 10	150	150	168	20.8	22.2	23.0
Trucks	Client 11	180	200	280	25.0	27.8	39.0
Blocks	Client 12	30	30	36	4.2	4.2	5.0
Pipe-in-Pipe	Client 13	120	150	180	16.8	21.0	25.0
Thermoware	Client 14	90	100	110	13.5	15.0	16.5
Spray	Client 15	400	420	450	60.0	63.0	71.0
TOTAL		3,407	3,731	4,235	413.0	513.9	584.6

ANNEX-5

DETAILED COST CALCULATIONS FOR PHASE-1

#	ACTIVITY	COSTS (US\$)	EXPLANATIONS
1	Preparative work Project Preparation Technology Transfer, Training	30,000 25,000	Partially retroactive for UNDP-funded preparation/TTT
2	System Development Development (7 applications) @ 5,000 Optimization (16 applications) @ 3,000 Validation (16 applications) @ 2,000	35,000 48,000 33,000	Does not included labor—just chemicals and external testing
3	Laboratory Equipment Laboratory Safety	140,000 10,000	See below For explosion proofing
4	Technology Dissemination Workshop	25,000	
5	Peer review/endorsement of next phase	20,000	
6	Contingencies (10%)	36,500	

ESTIMATED COST CALCULATIONS For PHASE II

(to be recalculated after technology validation)

1	System House adaptations 1 Blender 1 Tank for MeF Safety measures Contingencies (10%)	50,000 20,000 25,000 15,000)))Taken from previous projects)
2	Continuous Operations (12) 12 Retrofits @ 15,000 12 Trial Programs @ 3,000 Contingencies (10%)	180,000 36,000 21,600))As per MLFS template)
3	Discontinuous Operations (3) 3 ex proof metering systems @ 15,000 3 ventilation units @ 25,000 3 sensor systems @ 15,000 3 grounding programs @ 5,000 Contingencies	45,000 75,000 45,000 15,000 18,000)))From previous projects))
4	Peer review/safety audits	50,000	10 days/15 visits/travel/per diem
5	Incremental Operating Costs	1,326,400	See below

Laboratory equipment	K-factor tester	US\$	10,000
	Refractometer		5,000
	Brett mold		5,000
	HP laboratory dispenser		50,000
	Sprayfoam/PIP dispenser		20,000
	pH tester		5,000
	Abrasion tester		25,000
	Cell gas analyzer		20,000
	Total	US\$	140,000

Incremental operating costs are based on 10% increased polyol system costs, which amounts to ~5% increase in total chemical costs as per Purcom information. For 2 years/net present value base, this amounts to 10% of 4,235 t @ 3,600 x 1.74 = **US\$ 1,326,400.**

ANNEX-6

TRANSMITTAL LETTER

SUBMISSION OF A PILOT PROJECT FOR FUNDING UNDER THE MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL¹

Systems House Commitments

PURCOM, represented by Mr. Gerson Silva, 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 foams 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 Brazil's National Ozone Unit (NOU).

PURCOM:

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 participate in the permanent conversion of participating customers to the use of methyl formate;
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 HCFCs 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:
