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EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Seventy-sixth Meeting
Montreal, 9-13 May 2016

PROJECT PROPOSALS: SOUTH AFRICA

This document consists of the comments and recommendation of the Fund Secretariat on the following project proposals:

Foam

• Demonstration project on the technical and economic advantages of the vacuum assisted injection in discontinuous panel's plant retrofitted from HCFC-141b to pentane	UNIDO

Phase-out

• HCFC phase-out management plan (stage I, third tranche)	UNIDO

PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT

SOUTH AFRICA

PROJECT TITLE	BILATERAL/IMPLEMENTING AGENCY
(a) Demonstration project on the technical and economic advantages of the vacuum assisted injection in discontinuous panel's plant retrofitted from HCFC-141b to pentane	UNIDO

NATIONAL CO-ORDINATING AGENCY	Ozone Office

LATEST REPORTED CONSUMPTION DATA FOR ODS ADDRESSED IN PROJECT

A: ARTICLE-7 DATA (ODP TONNES, 2014, AS OF MARCH 2016)

HCFCs	238.58

B: COUNTRY PROGRAMME SECTORAL DATA (ODP TONNES, 2014, AS OF MARCH 2016)

HCFC-22	142.36
HCFC-123	1.33
HCFC-141b	93.5
HCFC-142b	1.71
HCFC-225	1.90

HCFC consumption remaining eligible for funding (ODP tonnes)	193.34

CURRENT YEAR BUSINESS PLAN ALLOCATIONS		**Funding US $**	**Phase-out ODP tonnes**
	(a)	n/a	n/a

PROJECT TITLE:	
ODS use at enterprise (ODP tonnes):	4.18
ODS to be phased out (ODP tonnes):	n/a
ODS to be phased in (ODP tonnes):	n/a
Project duration (months):	16
Initial amount requested (US $):	493,366
Final project costs (US $):	
Incremental capital cost:	202,000
Contingency (10 %):	20,200
Incremental operating cost:	n/a
Total project cost:	222,200
Local ownership (%):	100
Export component (%):	n/a
Requested grant (US $):	222,200
Cost-effectiveness (US $/kg):	n/a
Implementing agency support cost (US $):	19,998
Total cost of project to Multilateral Fund (US $):	242,198
Status of counterpart funding (Y/N):	Y
Project monitoring milestones included (Y/N):	Y

SECRETARIAT'S RECOMMENDATION	For individual consideration

PROJECT DESCRIPTION

Background

1. At the 75th meeting, UNIDO submitted on behalf of the Government of South Africa a demonstration project on the technical and economic advantages of the vacuum assisted injection (VAI) in discontinuous panel's plants retrofitted from HCFC-141b to cyclopentane at the amount of US $372,366, plus agency support costs of US $26,066 as originally submitted[1,2]. Further to a discussion at a contact group that was established to consider all projects to demonstrate low-global warming potential (GWP) technologies submitted to the 75th meeting, the Executive Committee decided to defer consideration of the seven demonstration projects including the VAI project for South Africa, to the 76th meeting (decision 75/42).

2. On behalf of the Government of South Africa, UNIDO has re-submitted to the 76th meeting the above-mentioned demonstration project, at the amount of US $493,366, plus agency support costs of US $37,002. The difference in cost between the project proposals submitted to the 75th and 76th meeting is due to a reduction in the cost sharing in the latter and minor differences in costs associated with planned activities.

Project objectives

3. This project aims to evaluate the advantages of VAI in the discontinuous panel production process when using cyclopentane as a foam blowing agent and demonstrate improved safety of foaming operations in an enterprise manufacturing commercial refrigeration equipment. VAI technology is expected to provide an advantage to the use of standard cyclopentane which may result in increased thermal efficiency (i.e., lower lambda values); better foam distribution; reduced foam density (90 per cent compared to HCFC-141b-based formulations); shorter manufacturing time; and reduction of raw material inputs. The technology permits extraction of cyclopentane and isocyanate vapours directly at the point of origin improving safety conditions around the press and thus the production area could be downgraded from zone 1 to zone 2 according to the Appareils destinés à être utilisés en ATmosphères EXplosibles (ATEX) classifications, thereby reducing ventilation and safety requirements.

4. Currently, high safety-related costs are a key impediment to the broader adoption of hydrocarbons as blowing agents, particularly by small- and medium-sized enterprises (SMEs). The project proposal focuses on investigating the safety benefits of VAI technology and the potential for reduced safety-related costs.

Project implementation

5. The project will be implemented at Dalucon Refrigeration Products (DRP), an enterprise that had signified its commitment to undertake the demonstration project using one line of their production process. It has also agreed to phase-out 38.04 mt of HCFC-141b when the VAI technology is demonstrated as being successful. Under stage I of the HPMP, DRP received funding to convert from the use of HCFC141b to methyl formate.

6. At the enterprise level, cyclopentane conversion will include the provision of cyclopentane pre-blended polyol; retrofitting or replacing the dosing unit; retrofitting the presses to vacuum injection

[1] UNEP/OzL.Pro/ExCom/75/66.

[2] Funding for the preparation of this project was approved at the 74th meeting in the amount of US $40,000, plus agency support costs of US $2,800, on the understanding that its approval did not denote approval of the project or its level of funding when submitted (decision 74/33).

technology; safety considerations for the use of flammable blowing agent; technical assistance including trials and testing of the product and training; safety report and certification.

7. The project is expected to be completed in 24 months.

Project costs

8. The summary of the project cost is provided in Table 1.

Table 1. Proposed project costs

Cost component	Estimated cost (US $)
Production	
Retrofit of high pressure foaming machine	80,000
Modification of press for VAI*	80,000
Set of side profiles (60 and 80 mm)	20,000
Pre-mixing unit	84,000
Pentane tank and accessories	20,000
Nitrogen supply system	2,000
Plant safety	
Ventilation and exhaust system	90,000
Gas sensors, alarm, monitoring system	50,000
Safety audit / safety inspection and certification	2,000
Technology transfer / training	25,000
Installation commissioning and trials	75,000
Sub-total	**528,000**
Contingency	52,800
Sub-total	**580,800**
Incremental operating costs	(87,434)
Cost	**493,366**

***** Vacuum unit (U$ 35,000), vacuum plant (U$ 24,000) and vacuum side moulds or profiles (U$ 21,000)

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

9. The Secretariat noted that changes were made to the proposal to provide additional justification for approving the project under decision 72/40. In particular, the re-submitted proposal focuses on investigating the safety benefits of VAI technology and potential for reduced safety-related capital costs. The VAI system will require a greater up-front capital investment; however, it has potential for savings due to improved safety and higher quality of the end product.

10. For ease of reference, the results of the discussions between the Secretariat and UNDP on the demonstration project submitted to the 75th and 76th meetings are summarized below:

(a) Under stage I of the HCFC phase-out management plan (HPMP) for South Africa, funding has been approved for the complete phase-out of HCFC-141b in the country. Accordingly, the Government implemented a ban on the import and export of HCFC-141b, pure or as a component of blended chemicals, in January 2016. In addition, DRP had received funding to phase-out its consumption of HCFC-141b. Therefore, costs associated with the conversion of DRP to cyclopentane would not be eligible for funding. On this basis, the Secretariat emphasized that only the costs related to demonstration of the VAI technology would be eligible for funding. UNIDO adjusted the project costs to

US $222,200 by removing the costs related to the conversion to cyclopentane;

(b) The Secretariat noted that the technology proposed is independent of the blowing agent being used and would appear to constitute a technology upgrade and, as per decision 18/25(a), would not be eligible. UNIDO emphasized that the use of VAI in the project will demonstrate a new technology that will enhance cyclopentane-blown technology, and could reduce exposure to dangerous gases (e.g., isocyanate) and improve containment of the flammable blowing agent;

(c) The Secretariat noted that VAI technology appears to be used by several enterprises in at least one Article 5 country for various applications.

(d) In line with decision 72/40(b)(i)e regarding a preferred short implementation period for all demonstration projects, UNIDO revised the project timelines so that the project is expected to be completed 16 months after approval.

The revised project proposal is attached as Annex I to the present document.

<u>Conclusion</u>

11. The implementation of this project could facilitate the conversion from HCFC-141b to cyclopentane, reduce safety-related costs, as well as reduce foam density and hence operating costs. UNIDO has adjusted the costs of the project related to the introduction of cyclopentane technology; on this basis, the total cost of the project would be US $222,200, plus agency support costs of US $19,998.

RECOMMENDATION

12. The Executive Committee may wish to consider:

(a) The demonstration project on the technical and economic advantages of the vacuum assisted injection (VAI) in discontinuous panels' plant retrofitted from HCFC-141b to cyclopentane in South Africa, in the context of its discussion on proposals for demonstration projects for low-global warming potential (alternatives to HCFCs as described in the document on the Overview of issues identified during project review (UNEP/OzL.Pro/ExCom/76/12);

(a) Approving the demonstration project on the technical and economic advantages of the VAI in discontinuous panel's plant retrofitted from HCFC-141b to cyclopentane in South Africa at the level of funding of US $222,200, plus agency support costs of US $19,998; and

(b) Urging the Government of South Africa and UNIDO to complete the project as planned in 16 months, and submitting a comprehensive final report soon after project completion.

PROJECT EVALUATION SHEET – MULTI-YEAR PROJECTS
South Africa

(I) PROJECT TITLE	AGENCY	MEETING APPROVED	CONTROL MEASURE
HCFC phase out plan (Stage I)	UNIDO (lead)	67th	35% by 2020

(II) LATEST ARTICLE 7 DATA (Annex C Group l)	Year: 2014	239.0 (ODP tonnes)

(III) LATEST COUNTRY PROGRAMME SECTORAL DATA (ODP tonnes)									Year: 2014
Chemical	Aerosol	Foam	Fire fighting	Refrigeration		Solvent	Process agent	Lab use	Total sector consumption
				Manufacturing	Servicing				
HCFC-123					1.3				1.3
HCFC-124									
HCFC-141b		93.5							93.5
HCFC-141b in Imported Pre-blended Polyol									
HCFC-142b		1.7							1.7
HCFC-22					142.4				142.4
HCFC-225					1.9				1.9

(IV) CONSUMPTION DATA (ODP tonnes)			
2009 - 2010 baseline:	369.70	Starting point for sustained aggregate reductions:	369.70
CONSUMPTION ELIGIBLE FOR FUNDING (ODP tonnes)			
Already approved:	176.72	Remaining:	192.98

(V) BUSINESS PLAN		2016	2017	2018	Total
UNIDO	ODS phase-out (ODP tonnes)	35.2	13.5	4.8	53.6
	Funding (US $)	1,393,498	534,585	191,273	2,119,356

(VI) PROJECT DATA			2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Montreal Protocol consumption limits			n/a	369.7	369.7	332.7	332.7	332.7	332.7	332.73	240.31	n/a
Maximum allowable consumption (ODP tonnes)			n/a	369.7	369.7	332.7	332.7	332.7	270.2	270.20	240.31	n/a
Agreed funding (US$)	UNIDO	Project costs	1,960,229	2,592,620	0	1,302,335	499,612	0	6,533,556	0	0	6,533,556
		Support costs	137,216	181,483	0	91,164	34,973	0	457,349	0	0	457,556
Funds approved by ExCom (US$)		Project costs	1,960,229	2,592,620	0	1,302,335	0.0	0.0	0.0	0	0	4,552,849
		Support costs	137,216	181,483	0	91,164	0.0	0.0	0.0	0	0	318,699
Total funds requested for approval at this meeting (US$)		Project costs	0	0	0	0	**1,302,335***	0	0	0	0	1,302,335
		Support costs	0	0	0	0	**91,164***	0	0	0	0	91,164

*Third tranche planned for 2015 but only submitted to the 76th meeting.

Secretariat's recommendation:	For blanket approval

PROJECT DESCRIPTION

13. On behalf of the Government of South Africa, UNIDO as the designated implementing agency, has submitted to the 76th meeting a request for funding for the third tranche[3] of stage I of the HCFC phase-out management plan (HPMP), at the amount of US 1,302,335, plus agency support costs of US $91,164 for UNIDO. The submission includes a progress report on the implementation of the second tranche and the tranche implementation plan for 2016 to 2017.

Report on HCFC consumption

HCFC consumption

14. The Government of South Africa reported a consumption of 238.58 ODP tonnes of HCFC in 2014 and provided a preliminary level of consumption for 2015 of 3,500 metric tonnes (mt). The 2011-2015 HCFC consumption is shown in Table 1.

Table 1. HCFC consumption in South Africa (2011-2014 Article 7, 2015 estimate)

HCFC	2011	2012	2013	2014	2015	Baseline
Metric tonnes						
HCFC-22	3,169.79	3,030.58	3,027.19	2,560.60		3,833.90
HCFC-123	40.18	113.19	97.39	67.20		12.80
HCFC-124	-1.91	-1.31	-0.08	0		-30.80
HCFC-141b	1,112.90	1,553.98	1,081.90	850.00		1,455.00
HCFC-142b	51.83	81.56	21.40	15.30		-12.90
HCFC-225	9.50	6.90	0.00	27.20		0.00
Total (mt)	**4,382.28**	**4,784.91**	**4,227.78**	**3,520.30**	**˜3,500.00**	**5,258.00**
ODP tonnes						
HCFC-22	174.34	166.68	166.50	140.83		210.90
HCFC-123	0.80	2.26	1.95	1.34		0.30
HCFC-124	-0.04	-0.02	-0.00	0		-0.70
HCFC-141b	122.42	170.93	119.00	93.5		160.10
HCFC-142b	3.37	5.30	1.39	0.10		-0.80
HCFC-225	0.66	0.48	0.00	1.90		0.00
Total) (ODP tonnes)	**301.55**	**345.64**	**288.84**	**238.58**		**369.70**

15. After a peak in 2012, HCFC consumption decreased in 2013 and 2014 to 35 per cent of the HCFC consumption baseline due to, *inter alia*, implementation of HPMP activities, increased cooperation with stakeholders, introduction and promotion of alternatives, and the depreciation of the local currency, which has negatively affected imports and economic growth.

Country programme (CP) implementation report

16. The Government of South Africa reported HCFC sector consumption data under the 2014 CP implementation report that is largely consistent with the data reported under Article 7, with small differences in the consumption of HCFC-22 and HCFC-142b as the consumption of these substances contained in blends may not have been accounted in the consumption reported under Article 7 of the Montreal Protocol. This small inconsistency is being verified. The 2015 CP report will be submitted by 1 May 2016.

[3] The third tranche was originally planned for 2015 but was only submitted to the 76th meeting.

Progress report on the implementation of the second tranche of the HPMP

Additional legal instruments to control the supply and demand of HCFCs

17. A summary of the key regulatory measures established during stage I of the HPMP are presented in Table 2 below.

Table 2: Key regulatory measures included in the updated ODS regulation in South Africa

Measure	Date
Quota system for the assignment of import licenses for all HCFCs	1 January 2013
Ban on imports of any new or used refrigeration and air-conditioning systems or equipment containing HCFC-22 or any refrigerant or refrigerant blend containing HCFC	1 September 2014
Ban on the use of HCFC-22, either in pure form or as a component of blended refrigerants, in the construction, assembly or installation of any new refrigeration or air-conditioning system or equipment	1 September 2014
License /certification required for purchasing refrigerants	1 January 2015
Ban on imports of HCFC-141b, either pure or as a component of blended chemicals	1 January 2016

Activities in the polyurethane (PU) foam manufacturing sector

18. The conversion of the following two foam manufacturers to cyclopentane blowing agent technology is underway:

(a) *Defy (domestic refrigerators and freezers) (31.7 ODP tonnes):* The conversion project has been completed. The new plant started HCFC-free manufacturing in December 2015; and

(b) *Aerothane Applications (block foam) (7.2 ODP tonnes):* Foam equipment has been procured and safety equipment to operate with a flammable blowing agent is being installed. The project is planned for completion by mid-2016.

19. The conversions of one systems house and six PU foam downstream users to operate with methyl formate-based polyols have been completed resulting in the phase-out of 400 mt (44 ODP tonnes) of HCFC-141b The conversion of the second systems house has been delayed given the current economic situation in the country, which has affected the capacity of the enterprise to contribute the level of co-financing required for the conversion.

20. The database of PU foam manufacturers has been maintained and technical assistance has been provided to small and medium enterprises (SMEs) to identify and evaluate suitable low-GWP alternatives to HCFC-141b.

21. With regard to the phase-out of HCFC-141b by the two non-eligible enterprises, Whirlpool has completed its conversions to cyclopentane resulting in the phase-out of 69 ODP tonnes of HCFC-141b and Bumbo is still using stocks of HCFC-141b. Bumbo has not informed yet the alternative technology to replace HCFC-141b.

Refrigeration servicing sector

22. A customs manual has been developed and 95 customs officers have received training at seven customs locations. At least one refrigerant identifier has been provided at each training location and

additional units have been provided to a compliance-monitoring unit, which undertakes inspections beyond customs premises.

23. Stakeholder meetings have also taken place on the adoption and enforcement of the HCFC control measures promulgated. The measure to establish mandatory recovery and recycling of HCFCs and other refrigerants originally planned by 1 September 2014 is currently under negotiation with sector counterparts. It is expected to be established during the first half of 2017.

Project implementation and monitoring unit (PMU)

24. The activities under the HPMP are implemented and monitored by the NOU, located in the Department of Environmental Affairs (DEA), with the support of UNIDO's office in Petoria.

Level of fund disbursement

25. As of March 2016, of the US $4,552,849 approved so far, US $2,920,698 (64 per cent) had been disbursed. The balance of US $1,632,151 will be disbursed in 2016.

Table 2. Financial report of stage I of the HPMP for South Africa (US $)

Agency	**First tranche**		**Second tranche**		**Total approved**	
	Approved	**Disbursed**	**Approved**	**Disbursed**	**Approved**	**Disbursed**
UNIDO	1,960,219	1,795,539	2,592,620	1,125,159	4,552,849	2,920,698
Disbursement rate (%)	92%		43%		64%	

Implementation plan for the third tranche of the HPMP

26. The following activities will be implemented:

(a) *Additional legal instruments to control supply and demand of HCFCs (no funds requested):* Continue to work with Revenue Service (SARS) and International Trade and Customs to address modifications required to tariff codes and improve monitoring and reporting;

(b) *Investment projects to phase out the use of HCFC-141b in the foam sector (US $622,437):* Complete conversion of Aerothane (7.2 ODP tonnes) to cyclopentane and conversion of Lake Technologies (systems house) to methyl formate; complete conversion of remaining PU-foam downstream users to methyl formate-based systems;

(c) *Refrigeration servicing sector (US $514,020*): Develop a recovery and recycling (R&R) feasibility study and implement R&R demonstration activities in two locations; establish a training curriculum in consultation with industry stakeholders and other Government departments; update codes of practice and regulations related to servicing; implement a small number of projects to demonstrate the use of low-global-warming potential (GWP) technologies such as carbon dioxide (CO_2) and ammonia in different applications; and

(d) *Non-investment activities (including monitoring) (US $165,878)*: Continue training of customs officers at remaining land ports in South Africa; continue information dissemination and awareness activities addressed to the foam and the refrigeration servicing sectors; and increase the number of industry visits to projects under implementation and potential new projects.

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

HCFC consumption

27. At the 71st meeting, the Government of South Africa informed that due deficiencies in the customs tariff codes for reporting imports and exports of HCFCs contained in blends, a data correction would be necessary for consumption reported from 2008. Accordingly, the Government agreed to submit an official request to the Ozone Secretariat for the revision of reported HCFC consumption by June 2014. The Fund Secretariat was requested, once the revised baseline data were known, to update Appendix 2-A to the Agreement to include the figures for maximum allowable consumption, and to notify the Executive Committee of the resulting change in the levels of maximum allowable consumption (decision 71/30[4]).

28. Upon discussion on this matter, UNIDO informed the Secretariat that the Government of South Africa revised HCFC consumption levels for 2011 (from 379.26 to 301.45 ODP tonnes) and for 2012 (from 461.71 to 345.64 ODP tonnes). However, it decided not to revise HCFC consumption for previous years. Therefore, no changes will be required to the Agreement as the HCFC baseline was not changed.

Verification report

29. By the time of issuance of this document, the verification report of HCFC consumption for the years 2013, 2014 and 2015 was still underway. Therefore, in line with decision 72/19, funds approved under the third tranche will not be transferred to the implementing agencies until the Secretariat has reviewed the verification report and confirmed that the Government of South Africa is in compliance with the Montreal Protocol and the Agreement between the Government and the Executive Committee.

Progress report on the implementation of the second tranche of the HPMP

Legal framework

30. The Government of South Africa has already issued HCFC import quotas of 332.7 ODP tonnes for 2016 in accordance with the Montreal Protocol targets, including a zero quota for the import of HCFC-141b in line with the recently established ban.

PU foam manufacturing sector

31. With regard to the still ongoing conversions in the PU foam sector, UNIDO explained that in the case of the enterprise Aerothane (individual project) there have been delays due to changes in the enterprise's management and difficulties attracting equipment suppliers for a small tender process. In the case of Lake Technologies (systems house) the enterprise is facing difficulties providing the required co-financing due to the current economic situation in the country. Furthermore, UNIDO indicated that if the enterprise decides not to participate in the HPMP, unused funds may be reallocated to provide additional assistance to the SMEs. The Secretariat requested UNIDO to report it *a priori* for consideration as it may potentially be a substantial change in the HPMP.

32. PU foam downstream users have faced technical difficulties phasing in methyl formate. Assistance in developing polyol formulations is being provided through the systems houses, and UNIDO has also appointed a local expert to provide technical support and facilitate the conversion process.

[4] UNEP/OzL.Pro/ExCom/71/64, Annex IX, page 15, blanket approval with condition.

UNIDO expects that ongoing conversions will be completed by the end of 2016; enterprises are currently using stocks of HCFC-141b, as they can no longer import it pure or contained in polyols.

Refrigeration servicing sector

33. In explaining the reason for the limited progress in the implementation of activities related to refrigeration servicing sector, UNIDO explained priority has been given to the regulations and the PU foam conversions. Discussions on updating the existing voluntary technicians' certification scheme have taken place with representatives from the Department of Higher Education and the refrigeration and air-conditioning association. A scale-up of the scheme is being planned to make a substantive impact in the sector.

34. In providing more details about the planned demonstration projects in the refrigeration sector, UNIDO explained that currently the main criteria for the selection of a refrigeration system, is the price of the installation, and that the majority of HCFC alternatives used are HFC blends. The project objective is to promote non-ODS, low-GWP-based refrigeration systems and demonstrate energy and cost savings obtained from their operation. The alternatives selected are CO_2 systems or CO_2 and ammonia cascade systems in supermarket refrigeration. Both types of system are expected to be substantially more energy efficient (between 10 and 50 per cent) than a conventional HCFC-22 or R-404A-based system, representing savings to users.

35. On the status of penetration of HCFC alternatives in the market, UNIDO informed that all kinds of non-ODS refrigerants are imported into South Africa, depending on the customers' needs, actual cost and applications. More detailed information on alternatives will be available when a detailed survey being done with the support of CCAC (Climate and Clean Air Coalition) is completed.

<u>Conclusion</u>

36. The Secretariat notes that the Government of South Africa established a comprehensive set of regulations to control HCFCs, including the ban on imports of HCFC-141b, either pure or as a component of blended chemicals, on 1 January 2016. The HCFC consumption levels reported by South Africa in 2013, 2014 and 2015 indicate that the country is in compliance with the Montreal Protocol and the Agreement between the Government and the Executive Committee. Several of the conversions to low-GWP technologies in the PU foam manufacturing sector have already been completed (one enterprise, one systems house and six downstream users) resulting in an estimated phase-out of 80 ODP tonnes of HCFC-141b with the Multilateral Fund assistance. Customs officers have been trained and refrigerant identifiers have been distributed. Substantive activities in the refrigeration servicing sector will start during the third tranche, including demonstration of low-GWP alternatives in supermarkets in the refrigeration servicing sector.

RECOMMENDATION

37. The Fund Secretariat recommends that the Executive Committee takes note of the progress report on the implementation of the second tranche of stage I of the HCFC phase-out management plan (HPMP) for South Africa; and further recommends blanket approval of the third tranche of stage I of the HPMP for South Africa, and the corresponding 2016-2017 tranche implementation plan, at the funding level shown in the table below, on the understanding that the approved funds would not be transferred to UNIDO until the Secretariat had reviewed the verification report and confirmed that the Government of South Africa was in compliance with the Montreal Protocol and the Agreement between the Government and the Executive Committee:

	Project title	Project funding (US $)	Support cost (US $)	Implementing agency
(a)	HCFC phase-out management plan (stage I, third tranche)	1,302,335	91,164	UNIDO

Annex I

PROJECT COVER SHEET

COUNTRY: **South-Africa**

IMPLEMENTING AGENCY: UNIDO

PROJECT TITLE: Demonstration project on the technical and economic advantages of the Vacuum Assisted Injection in discontinuous panel's plant retrofitted from 141b to pentane

PROJECT IN CURRENT BUSINESS PLAN	Yes
SECTOR	Foams and commercial refrigeration
SUB-SECTOR	PU Discontinuous Sandwich Panel
ODS USE IN SECTOR (Average of 2009-10)	N/A
ODS USE AT ENTERPRISES (2015)	N/A
PROJECT IMPACT	N/A
PROJECT DURATION	16 months
TOTAL PROJECT COST:	
Incremental Capital Cost	US$ 202,000
Contingency	US$ 20,200
Incremental Operating Cost	N/A
Total Project Cost	US$ 222,200
LOCAL OWNERSHIP	100%
EXPORT COMPONENT	Nil
REQUESTED GRANT	US$ 222,200
COST-EFFECTIVENESS	N/A
IMPLEMENTING AGENCY SUPPORT COST (7%)	US$ 19,998
TOTAL COST OF PROJECT TO MULTILATERAL FUND	US$ 242,198
STATUS OF COUNTERPART FUNDING	
PROJECT MONITORING MILESTONES	Included
NATIONAL COORDINATING/ MONITORING AGENCY	Ozone Office

Project summary
Dalucon Co. agreed to host the project for conversion of the most important segment of their products, insulated trucks and other transport containers to Vacuum Assisted Injection (VAI)/Cyclopentane technology. The chosen technology is a novel method for the high quality discontinuous production of sandwich panels. These panels for refrigerated trucks, reefers, walk-in refrigerators and industrial cold stores will be manufactured using the industrially proven VAI technology. This technology will enhance Cyclopentane blowing technology, which is a definitive alternative under the Montreal Protocol and additionally has a positive impact on climate, in compliance with MOP Decision XIX/6.
Impact of project on global Montreal Protocol programms

If successfully validated, the optimized technology will contribute to availability of cost-effective options that are urgently needed to implement HCFC phase-out, particularly for applications where the size of products and high thermal insulation performance are crucial.

Prepared by: UNIDO Date: 07 September 2015
Reviewed by: Mr. Kimmo J. Sahramaa Date: 18 September 2015

Revision 24 March 2016

Changes in the document, since last submission, are yellow shaded and include:

- Paragraph on Improvement of Safety Conditions, including illustrative technical drawing
- Relevant alterations in this regard, to respective paragraphs, (Objectives, Methodology and Description of the process expectations) and
- Respective cost implications as following:
  - Savings on Plant Safety, namely ventilation and gas detection
  - Additional costs on testing of improvement of safety conditions, which include:
    - Verification of pentane concentration near the press in the conditions without and with VAI
    - Report on the findings and results, conclusions and recommendations.

1 BACKGROUND AND JUSTIFICATION

In 2007, the Parties to the Montreal Protocol agreed to accelerate the phase-out of the hydrochlorofluorocarbons (HCFCs) as the main ozone depleting substances largely because of the substantive climate benefits of the phase-out. In the following years, Parties operating under the Montreal Protocol's Article 5 (mostly developing countries) have formulated their HCFC Phase-out Management Plans (HPMPs) for implementation under financial assistance from the Multilateral Fund for the implementation of the Montreal Protocol (MLF).

The Executive Committee in decision 72/40 agreed to consider proposals for demonstration projects for low-GWP alternatives and invited bilateral and implementing agencies to submit demonstration project proposals for the conversion of HCFCs to low-global warming potential (GWP) technologies in order to identify all the steps required and to assess their associated costs.

In particular, Par (b)(i)a. of the Decision 72/40 indicates that project proposals should propose options to increase significantly in current know-how in terms of a low-GWP alternative technology, concept or approach or its application and practice in an Article 5 country, representing a significant technological step forward.

The use of the vacuum assisted technology for the application of alternatives to HCFCs fully fits the actual ExCom decision on Demonstration project proposals as defined in ExCom Decision 72/40.

The Executive Committee of Multilateral Fund for the Implementation of the Montreal Protocol approved at its 74th meeting held in Montreal, Canada in May 2015, the preparation of the demonstration project for foam and refrigeration sectors. The project was approved for UNIDO implementation in the republic of South Africa.

2 OBJECTIVE

- Demonstrate benefits from the application of the vacuum assisted injection in replacement of HCFC-141b with pentane in term of insulation properties in the panel's sector
- Demonstrate the easy applicability of the technology and, consequently, the replicability of the results
- Demonstrate that lower cost structure can be obtained by means of shorter foaming time, lower foam density, lower thermal conductivity
- Demonstrate the advantages in terms of safety against explosion and environmental and health sustainability for the operators
- Objectively analyze, if the incremental capital cost could be reduced overall in similar future projects by means of using Vacuum Assistance applied in the foaming process automatically used also for suction of flammable and harmful gaseous substances. Thus, providing means of reducing the cost of exhaust ventilation system in the hydrocarbon based plant conversions.

3 METHODOLOGY

Intention of this demonstration project is to provide means for the evaluation of sandwich panels manufactured with new technology in comparison and in regards to;

- Thermal transmittance
    - Measurement of lambda values (thermal conductivity W/mK)

    - Ageing of lambda value
- Mechanical resistance of the panels and its core material
    - Shear strength and shear modulus
    - Compressive strength
    - Cross panel tensile strength
    - Bending moment and wrinkling stress
- Foam density distribution through the foam matrix in various positions of the panels
- Reclassification of the dangerous area from zone 1 to zone 2 i.e. less critical, according to ATEX regulation
    - Measurement of the presence of pentane vapors in the area near the press

All tests above will be conducted according to EN 14509 (Self-supporting double skin metal faced insulating panels - Factory made products – Specifications)

3.1 Description of process expectations

Quality of PU panel relies, in most of the application, on the insulation property. Considering the PU physical properties, insulation of final products can be influenced by the: a) thermal conductivity of the blowing agent b) thermal conductivity polymer matrix and c) overall foam structure, its uniformity and homogeneity. These factors of thermal conductivity then determine the thickness of the foam insulation.

Therefore, one of the critical points in the retrofitting from 141b to blowing agents with higher thermal conductivity value , is the losses in insulation properties.

Aim of this demonstration project is to evaluate the advantages of Vacuum Assisted Injection (VAI) in discontinuous panel production process, when using Cyclopentane as foam blowing agent instead of HCFC-141b and to demonstrate higher safety of foaming operations through downgrading of one area (around the press) according to ATEX regulations..

The Vacuum injection technology will give advantages to a standard pentane converted plant in term of:

- Decreased lambda value
- Better overall foam structure/ foam distribution
- Decreased demolding time of 30%
- Increased safety. Reclassification/downgrade of safety zone, from zone 1 to zone 2 (according to ATEX)

The above is expected to generate substantial technical improvements in the final products as well as reduction of operation costs (reduction of time for manufacturing as well as reduction of raw materials inputs).

The project results will be extremely relevant for those sectors where insulation property of final products is crucial and thickness of panels cannot be increased (e.g. panels for refrigerated trucks, refrigerated containers, etc.)

3.2 Detailed description of Methodology

In the selection of the most suitable partner for the application of the vacuum assisted technology, priority was given a company, which is eligible and willing for the pentane conversion.

Dalucon is willing and eligible beneficiary which was selected and the project will include the implementation of:

1- Pentane conversion of the plant
2- Retrofitting kit to vacuum injection technology of the existing presses

The pentane conversion will include: Provision of Cyclopentane preblended polyol, Dosing unit (retrofit or substitute the existing one), Safeties for the use of flammable blowing agent (safety control panel, gas sensors, ventilators…), engineering services for the pentane conversion, safety report and White book and certification (TUV or similar).

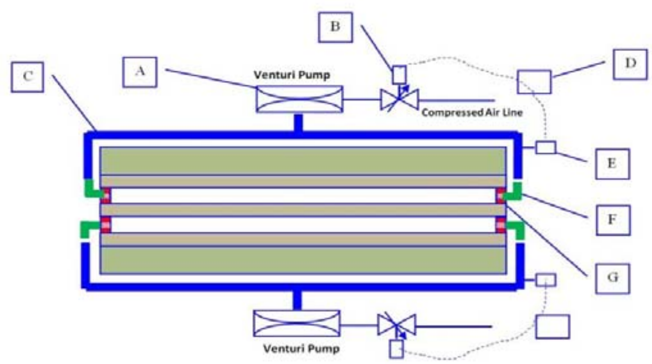
1- Retrofitting kit to vacuum injection technology

The retrofitting kit to vacuum injection technology will include three main components: vacuum unit, vacuum plant and vacuum molds, (as explained below).

VACUUM UNIT

System where the vacuum is generated and controlled.

This includes vacuum pumps, control valves, sensors, control hardware and software. The unit can control the level of vacuum in the cavity, the duration of the process and can store different recipes according to different kind of panel models, with optimized parameters.



VACUUM PLANT

This part is to connect the vacuum up to the cavities where PU foam is injected. Objective is to keep the normal movement of the press and the press platens and reduce costs of retrofitting.

VACUUM MOULDS (SIDE MOULDS OR PROFILES)

Molds are to define the shape of the panel, especially its external shape and dimensions. The scope of supply considers a complete additional set of molds designed to create the vacuum inside the press cavity.

Each side mold will be equipped with connections for connecting the cavity to the vacuum plant, vacuum distribution in the whole cavity and a dedicated injection holes able to maintain the vacuum level even at the insertion of the injection head.

4 COMPANY BACKGROUND

Dalucon Refrigeration Products (DRP) is a family owned business, originally founded by Aldo Martinelli in 1991 with combined company knowledge between its members of over 50 years. Their core focus is on quality and delivery time and therefore DRP has set a benchmark for all of its products that competitors find hard to match. DRP remains a successful business employing over 110 staff members and are situated in Centurion, with over 10,000 m² of manufacturing space available; 800m² office space; 3000 m² storage, assembly and stock area. DRP is situated in Highway Business Park, Centurion, Gauteng – a gateway between Johannesburg and Pretoria, which forms a natural extension to the rest of South Africa.

Address:

P.O. Box 7827
Centurion
0046
Tel: 012 661 8480/1/2
Fax: 012 661 0354
Website: www.dalucon.co.za
Members: A. Martinelli, M. Martinelli, S. Martinelli
Reg No: 2006-089100-23
Vat No: 444 0126 730

4.1 PRODUCTION PROCESS

The raw materials, including polyol blend with HCFC-141b as a pre-blend from the local system house, and isocyanate is being procured in 1,000 liter IBC containers. The polyol-blend, once received, is shifted to the polyol tank of 1,000 liters through pneumatic pump. This tank is kept in the temperature-controlled storage room. The blend of poly and HCFC-141b is taken to the day tank of the foaming machine. Iso is taken in similar process from the tank of 1,000 liter to the Iso day tank of the foaming machine. The plant has 3 foaming lines and 3 units 2 +2 Manni presses. The chemical is poured discontinuously in the panel in the desired quantity to achieve the required foam parameters. The production process is to a large extent automated.

The production cycle is as follows:

- Warehouse and storage for metal coils
- Cutting and profiling to length of the metal sheets
- Assembly of the panels
- Movement to the foaming tables of the press
- Foaming
- Extraction and transport to the warehouse for shipment

The chemical composition of various chemical uses in the manufacturing PU sandwich panels is provided in the table below:

Description	**HCFC 141b**	**Polyol**	**Isocyanate**
%age mixing ratio	11.90%	36.71%	51.39%

The higher than normal content of HCFC-141b is found and proven to provide the optimum thermal transmittance for the panels and enhanced PU mixture flowability, which is required, in particular in the transport vehicle use of insulated sandwich panels.

The description of the foaming machine, press and storage tanks are provided below.

Baseline Equipment

Sr. #	Type of Equipment	Model	No.	Design Capacity	Manufacturer Type	Commissioning Year
Foaming Line 1						
1	Polyol Preblend Storage Tank	Dalucon Stainless Steel	2	1000 liter	Dalucon	2006
2	Isocyanate Storage Tank	Dalucon Stainless Steel	2	1000 liter	Dalucon	2006
1	Polyol Day Tank	Cannon, Italy	1	200 liter	Cannon, Italy	2006
2	Isocyanate Day Tank	Cannon, Italy	1	200 liter	Cannon, Italy	2006
3	PU Foaming Machine with mixing heads	Cannon A-100 Basic, Italy	1	100 kg/min	Cannon, Italy	2006
4	Manni 2+2 Press	Manni/Cannon, Italy	1	9.5x1.45 meter	Cannon, Italy	2006
Foaming Line 1 (mainly for the refrigerated truck panels) is subject for the conversion and demo project						
Foaming Line 2 for longer panels						
1	Polyol Day Tank	Cannon, Italy	1	350 liter	Cannon, Italy	2012
2	Isocyanate Day Tank	Cannon, Italy	1	350 liter	Cannon, Italy	2012
3	PU Foaming Machine with mixing heads	Cannon A-200 CMPT, Italy	1	200 kg/min	Cannon, Italy	2012
4	Manni 2+2 Press	Manni/Cannon, Italy	1	13.5x1.45 meter	Cannon, Italy	2012
Foaming line 3						
1	Polyol Day Tank	Cannon, Italy	1	350 liter	Cannon, Italy	2015
2	Isocyanate Day Tank	Cannon, Italy	1	350 liter	Cannon, Italy	2015
3	PU Foaming Machine with L-14 mixing head	Cannon A-100 Basic, Italy	1	100 kg/min	Cannon, Italy	2012
4	Manni 2+2 Press	Manni/Cannon, Italy	1	13.5x1.45 meter	Cannon, Italy	2015

The Cannon A-100 will be converted to cyclopentane. Further, the electrical system of the hydraulic control of the presses needs to be adapted to ATEX requirement.

Few photographs taken at the plant is provided below:

4.2 ANNUAL PRODUCTION PROFILE IN 2014

Panel thickness mm	Capacity m2 / 8 hrs	Share of production %	PU m3	PU kgs	PU total kg/a	HCFC-141b kg	HCFC-141b Total / a
40	500	10,0	2,0	83,2	20800,0	9,9	2475
50	500	5,0	1,3	52,0	13000,0	6,2	1547
60	450	30,0	8,1	337,0	84240,0	40,1	10025
80	400	30,0	9,6	399,4	99840,0	47,5	11881
100	380	20,0	7,6	316,2	79040,0	37,6	9406
125	350	5,0	2,2	91,0	22750,0	10,8	2707
		100,0	30,7	1278,7	319670,0	152,2	38041

5 TECHNOLOGY OPTION FOR VACUUM ASSISTED INJECTION TECHNOLOGY (VAI)

5.1 Overview of alternatives to HCFC-141b for PU foam application

HCFC-141b has mainly been used as a blowing agent in various formulations in the manufacturing of PU foam for the production of PU sandwich panels for various sizes and thickness in South-Africa.

Factors that influence the technology selection include consideration of the following major features for PU foam.

- Mechanical properties
- Density
- Insulation properties
- Costs

5.2 Alternate Technologies Considered

In accordance with the 2014 report of the rigid and flexible foams technical options committee, there are a number of alternatives that are available to replace the use of HCFC 141b in rigid polyurethane foam. Several foaming technologies including the following are used as alternate technology.

- Cyclopentane
- HFC-245fa
- HFC-365mfc/227ea
- HFC-134a
- Methyl formate
- CO_2 (Water)
- u-HFC
- Liquid unsaturated HFC/HCFC (HFOs) as emerging technology

The below table provides an overview of the blowing agents that has been used in various sub-sectors of foam sector.

Sector	*HCFCs*	*HFCs*	*HCs*	*HCOs*	*HFOs*	*CO2-based*
PU Appliances	HCFC-141b HCFC-22	HFC-245fa HFC-365mfc/227ea	cyclo-pentane cyclo/iso-pentane	Methyl Formate	HFO-1233zd(E) HFO-1336mzzm(Z)	CO2 (water)*
PU Board	HCFC-141b	HFC-365mfc/227ea	n-pentane cyclo/iso pentane		HFO-1233zd(E) HFO-1336mzzm(Z)	
PU Panel	HCFC-141b	HFC-245fa HFC-365mfc/227ea	n-pentane /iso pentane		HFO-1233zd(E) HFO-1336mzzm(Z)	CO2 (water)*
PU Spray	HCFC-141b	HFC-245fa HFC-365mfc/227ea			HFO-1233zd(E) HFO-1336mzzm(Z)	CO2 (water)* Super-critical CO2

Sector	***HCFCs***	***HFCs***	***HCs***	***HCOs***	***HFOs***	***CO2-based***
PU In-situ / Block	HCFC-141b	HFC-245fa HFC-365mfc/227ea	n-pentane cyclo/iso pentane		HFO-1233zd(E) HFO-1336mzzm(Z)	CO2 (water)*
PU Integral Skin	HCFC-141b HCFC-22	HFC-245fa HFC-134a		Methyl Formate Methylal		CO2 (water)*
XPS Board	HCFC-142b HCFC-22	HFC-134a HFC-152a		DME	HFO-1234ze(E)	CO2 CO2/ethanol
Phenolic	HCFC-141b	HFC-245fa HFC-365mfc/227ea	n-pentane cyclo/iso pentane		HFO-1233zd(E) HFO-1336mzzm(Z)	

*CO_2 (water) blown foams rely on the generation of CO_2 from reaction of isocyanate with water in the PU system itself.

The pros & cons for commercially available options as well as emerging options as highlighted in the UNEP 2014 report of the rigid and flexible foams technical options committee for the manufacturing of PU foam are provided in the below tables:

Commercially Available Options

Option	**Pros**	**Cons**	**Comments**
Cyclopentane & n-Pentane	Low GWP Low operating costs Good foam properties	High flammable	High incremental capital cost, may be uneconomic for SMEs
HFC-245fa, HFC-365mfc/227ea, HFC-134a	Non-flammable	High GWP	Low incremental Capital Cost
	Good foam properties	High Operating Cost	Improved insulation (cf. HC)
CO2 (water)	Low GWP Non-flammable	Moderate foam properties -high thermal conductivity-	Low incremental Capital Cost
Methyl Formate/Methylal	Low GWP Flammable although blends with polyols may not be flammable	Moderate foam properties -high thermal conductivity-	Moderate incremental capital cost (corrosion protection recommended)

Emerging Options

Option	**Pros**	**Cons**	**Comments**
Liquid Unsaturated HFC/HCFC (HFOs)	Low GWP	High operating costs	First expected commercialization in 2013
	Non-flammable	Moderate operating costs	Trials in progress
			Low incremental capital cost

The Indicative assessment of criteria for commercially available options as well as emerging alternatives in PU foam is provided in the table below:

Assessment of criteria for commercially available options

	c-pentane	**i-pentane n-pentane**	**HFC-245fa**	**HFC365mfc/ 227ea**	**CO_2 (water)**	**Methyl Formate**
Proof of performance	+	++	++	++	++	+
Flammability	---	---	++	+(+)	+++	--
Other Health & Safety	0	0	+	+	-	0
Global Warming	+++	+++	--	---	++	++
Other Environmental	-	-	0	0	++	-
Cost Effectiveness (C)	--	---	++	++	++	0
Cost Effectiveness (O)	++	+++	--	--	+	+
Process Versatility	++	++	+	++	+	+

Assessment of criteria for Emerging Technology options

	HFO-1234ze(E)	**HFO-1336mzzm(Z)**	**HFO-1233zd(E)**
	Gaseous	liquid	Liquid
Proof of performance	0	+	+
Flammability	++	+++	+++
Other Health & Safety	+	+	+
Global Warming	+++	+++	+++
Other Environmental	+	+	+
Cost Effectiveness (C)	++	++	++
Cost Effectiveness (O)	--	--	--
Process Versatility	+	+	+

IOC comparison between major alternatives

IOC	HCFC-141b			HFO-1233zd			c-pentane / vacuum			Water-blown / Formic Acid		
	Formula	%	Cost/kg	Formula	%	Cost/kg	Formula	%	Cost/kg	Formula	%	Cost/kg
Polyol	100	36,71%	2,70	100	38,17%	2,70	100	37,88%	2,70	100	37,95%	2,70
B.A	32,42	11,90%	2,70	22	8,40%	13,00	9	3,41%	2,68	3,5	1,33%	2,70
MDI	140	51,39%	2,50	140	53,44%	2,50	155	58,71%	2,50	160	60,72%	2,50
Total	**272,42**	**100,00%**	**2,60**	**262**	**100,00%**	**3,46**	**264**	**100,00%**	**2,58**	**263,5**	**100,00%**	**2,58**
Thermal conductivity mW/mK			**23**			**21**			**23**			**31**
Foam density			42			42			37,8			
Equivalent cost USD			**2,60**			**3,16**			**2,32**			**3,48**
Total PU consumption 2015	319670	38,04	830253	319670		1009300	287703		742819	319670		1110996
IOC / year USD						**179047**			**-87434**			**280744**

5.3 Selection of alternative technology for the VAI

The technology chosen has been Cyclopentane due to the following:

- Experience has been gained and training, technology options costs are lower
- Cyclopentane is a well-established technology with zero ODP and is a low GWP

- The existing (VAI) foam formulations in the manufacture of domestic refrigerators and sandwich panels are based on the utilization of c-pentane as core foaming agent

6 Activities required for conversion

6.1 Modification of production process

The following modification and replacements in the existing process is assumed to implement the conversion.

- Retrofit of existing foam dispenser where applicable
- Replacement of pre-mixing unit,
- Modification of Press
- Hydrocarbon tank and accessories (piping and pumps, ventilation).
- Buffer tank for polyol, however, at Dalucon, it will not be required, since the storage tank of polyol blend will act as buffer tank
- Nitrogen supply system

- The following features need to be introduced

  - Ventilation system
  - Safety system controls
  - Adaptation of foaming equipment controls (software) and electrical equipment in order to comply with ATEX or equivalent safety regulations
  - Suitability of pressure equipment to comply with the regulations
  - Control of emissions of the equipment used which includes magnetic joints on electrical motors and EX parts for all equipment in contact with the liquid
  - Safety verification by the supplier or independent entity like TUV.

6.2 Improvement of safety conditions

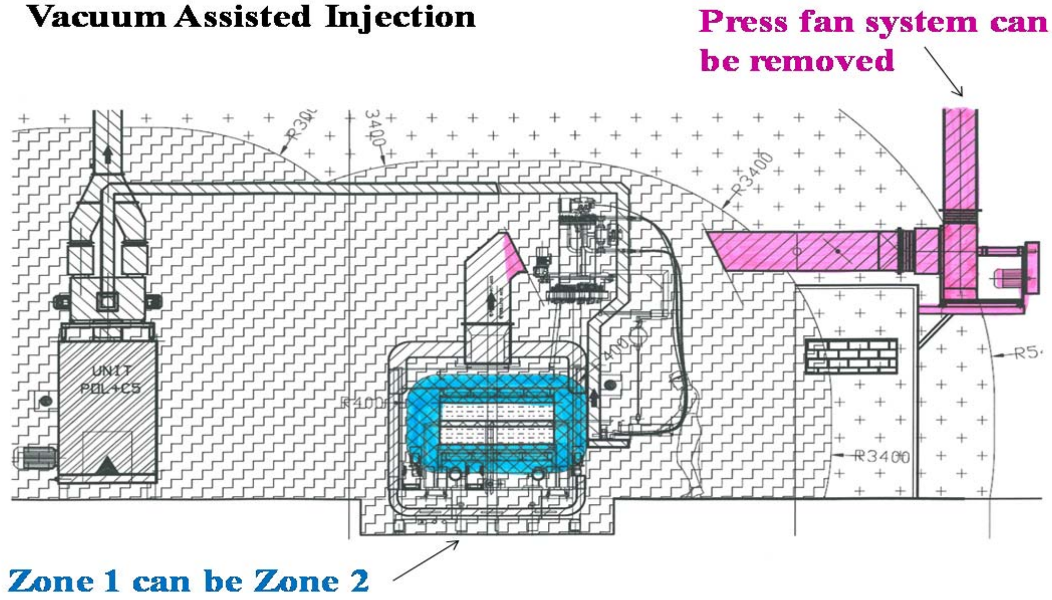
Another important aim of the project is to demonstrate that using the Vacuum Assisted Technology, all the vapours (pentane as well as isocyanate) are extracted directly from the source at their origin, while frothing, by the vacuum itself and, therefore vapours and fumes, they could not be released into the atmosphere around the press with the following consequences:

- Avoid the presence in the atmosphere around the press, of the blowing agent (hydrocarbon) and isocyanate vapors thus also, consequently, allow safe and healthy working conditions for the operators

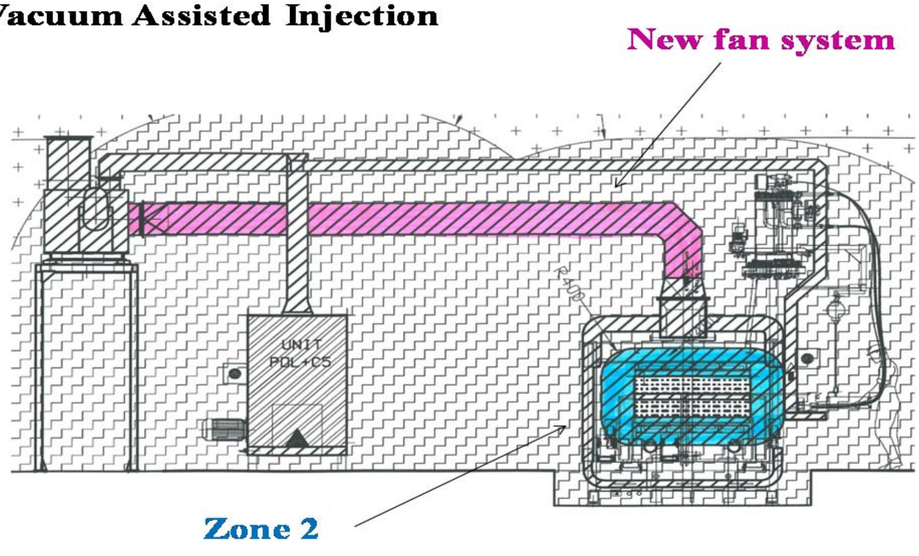
- Downgrading of the area from zone 1 to zone 2 and, consequently, reduction of the ventilation needed, as shown in the following layouts. The new function of fan system is dual as mentioned above, for health and safety. However safety aspect now becomes as secondary as safety reclassification results in no permanent presence of blowing agent.

Savings in the safety costs are solely related to VAI.

Vacuum Assisted Injection



Vacuum Assisted Injection



The training of the beneficiary staff for the adaptation of new technology is covered in this project. Further, the trials and testing of the product is also covered. Once the plant is put in commercial operation, the safety verification by the safety certifier shall be carried out and is being covered in the cost of the project.

After the successful completion of testing and commercial production, the removed equipment will be destroyed.

7 PROJECT COST

7.1 Project Cost as per MP Guideline decision 55/47

The conversion plan and costs are following the guidelines of decision 55/47 to the extent possible.

7.2 Incremental capital cost

The foaming line 1 shall be converted to the use of Cyclopentane from HCFC-141b with VAI technology. Funds are requested to cover the modification, provision of the VAI Kit and retrofit of existing A-100 foaming machine and the provision of necessary equipment, accessories as well as technology transfer, training, trials and commissioning. The ICC calculation is based on Appendix-I of the above referenced guidelines. These guidelines are based on 2008 market costs.
While calculating the incremental capital cost for each plant, the cost provided for 2008 basis has to be adjusted according to the inflation rate as a matter of acceptance of principles of market economy, as also manufacturers of equipment adjust to inflation.
The ICC of this project is calculated using only the base cost figures as provided in the guideline 55/47.

All cost in US$

	Guidelines Decision 55/47 US$	**Counterpart cost sharing**	**Project cost US$**
Retrofit of High pressure foaming machine (Cannon A-100 Basic; Ref. note in the Baseline Equipment table; p.5 above)	100 000	80 000	
Modification of press for VAI (cost break down detailed below)*	80 000	-	80 000
Set of side profiles (60 and 80 mm)	20 000	-	20 000
Premixing unit	84 000	84 000	
Hydrocarbon tank and accessories including polyol-pentane drum pump	55 000	20 000	
Buffer tank for pentane-polyol tank 1,000 liters	100 000		
Nitrogen supply system	15 000	2 000	
Plant Safety			
Ventilation and exhaust system (fans, piping, ductworks, grounding, electrical boards/connection) complete	115 000	90 000	0

Gas sensors, alarm, monitoring system for entire plant	57 000	50 000	0
Fire protection/control system for the plant	10 000		0
Lightning protection and grounding	15 000		0
Antistatic floor	5 000		0
Safety Audit / Safety Inspection and certification	20 000	18 000	2 000
Stand by electric generator	15 000	15 000	0
Civil work / Plant modifications	25 000	25 000	0
Technology transfer / training	25 000		25 000
Installation, commissioning, start up and trials **	75 000		75 000
Total	816 000	326 000	202 000
Contingency	81 600		20 200
Grand Total	**897 600**	**326 000**	**222 200**
IOC			N.a.
Total project cost US$			**222 200**

*Cost break down for Modification of press for VAI, which is described as three component retrofitting kit (Chapter 3.2 ; p. 3 above).

VACUUM UNIT	35,000
VACUUM PLANT	24,000
VACUUM MOULDS (SIDE MOULDS OR PROFILES)	21,000
Total	80,000

****Trials and commissioning include testing mentioned in the methodological chapter (3):**

- Positioning and installation of equipment U$ 25,000
- Commissioning U$ 20,000
- Start up of equipment an U$ 10,000
- Testing of physical properties of panels U$ 5000
  Thermal transmittance
  - Measurement of lambda values (thermal conductivity W/mK)
  - Ageing of lambda value

  Mechanical resistance of the panels and its core material
  - Shear strength and shear modulus
  - Compressive strength
  - Cross panel tensile strength
  - Bending moment and wrinkling stress
- Foam density distribution through the foam matrix in various positions of the panels
- Improvement of safety conditions
  Verification of pentane concentration near the press in the conditions without and with VAI
  U$ 10,000

Report on the findings and results, conclusions and recommendations. U$ 5,000

7.3 Incremental operating cost

IOC is not included in this project budget, since this demo cannot contribute to the HCFC 141b phase out in the Country. However it is calculated below as an example to illustrate important financial advantage of this Vacuum Assisted Injection (VAI) technology.

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

- The use of Cyclo-Pentane is only about 28.6% of the use of HCFC 141b.
- The conversion of technology to VAI / Cyclo-pentane system shall reduce the density of the foam to 90% of present HCFC-141b based formulations.

Incremental operating cost related to the conversion of the foaming technology was calculated based on the formulations as applicable at Dalucon. Current prices are as follows:

- HCFC-141b: US$ 2.70/kg
- Polyol: US$ 2.70/ kg
- Isocyanate: US$ 2.50/ kg
- Cyclo-Pentane: US$ 2,68/kg

Chemicals	**R-141b system**			**VAI/Cyclo-pentane system**		
	Amount Kg	**Price US$/kg**	**Cost US$**	**Amount Kg**	**Price US$/kg**	**Cost US$**
Polyol	0.367	2.70	0.99	0.379	2.70	1.02
Isocyanate	0.514	2.50	1.28	0.587	2.50	1.47
Blowing agent	0.119	2.70	0.32	0.034	2.68	0.09
Total	**1.000**		**2.60**			**2.58**
				Difference per kg		**-0.02**

The IOC is calculated based on 1 year as provided in the table below

	Before conversion	**Year I**
Foam production [kg]	319,670	287,703
Total annual cost of chemicals used	830,253	742,819
Cost difference per annum - Total IOC, US$		-87,434

7.4 Valuation of costing

- Plant safety costs in this demonstration project are solely related to VAI and they are necessary to:

  a) validate the difference between atmospheric pentane blowing and VAI and also

  b) facilitate plant safety certification.
- Additional savings at both, ICC and IOC are very likely, on the account of increased safety and higher quality of the end products as in comparison with HCFC 141b blowing as well as cyclopentane

atmospheric (non-vacuum) blowing.

- For example saving on extraction fan will result also in IOC saving for electricity.
- Downgrade of around press safety zone will result in additional IOC saving for electricity since importance and capacity of reaming fan(s) is reduced due to non-permanent presence of cyclopentane.
- Reduced number of equipment (ventilation and detection) will result in reduced IOC for maintenance cost.
- Also reduction in IOC for insurance should be considered.
- Potential higher price of end products due to increased quality yet lower weight should add to overall savings/ revenue.
- Also modification of the process for the case of the use of pre-blended polyol will be associated with obvious savings.
- These additional cost benefits could be quantified only after implementation of this demo project.

8 GLOBAL WARMING IMPACT ON THE ENVIRONMENT

8.1 Project Impact on the Environment

The project impact on the environment was studied for both the chemicals i.e. HCFC 141b and Cyclopentane. The CO_2 emission before conversion (using HCFC 141-b as blowing agent with Global Warming Potential of 713) is expected as 27,123 metric ton per year whereas after conversion to Cyclopentane with GWP 25, it is estimated 245 metric ton per year. The net impact on the environment is positive. The CO_2 emission is expected to be reduced by 26,878 MT after implementing the new technology. The net effect is provided in the table below:

Name of Industry	Substance	GWP	Phase out amount MT/ year	Total equivalent warming impact CO2 eq. MT/ year
Before Conversion				
Total CO_2 emission in M tonnes	HCFC 141b	713	38.04	27,123
After Conversion				
Total CO_2 emission in M tonnes	Cyclopentane	25	9.81	245
Net Impact				-26,878

9 PROJECT IMPLEMENTATION MODALITIES

9.1 Implementation structure

The National Ozone Unit reporting to the Department of Environmental Affairs, Government of South-Africa is responsible for the overall project, coordination, assessment and monitoring. The National Ozone Unit (NOU) cleared the Letter of Commitments with Dalucon DRP. NOU will clear Agreement on Implementation Procedures with the counterpart and other partners of this project (if any), to ensure that project objectives are met. Terms of Reference (TOR) for the implementation of this demonstration project will be prepared by

UNIDO in close collaboration with his technology originator and provider(s) of equipment and Dalucon (recipient company). Main objective of this Plan is to ensure project successful implementation and provision of process replication to other companies in South-Africa and other Article 5 countries.

UNIDO as the implementing agency is responsible for the financial management of the respective grant. UNIDO will also assist the Dalucon in equipment procurement, technical information update, monitoring the progress of implementation, and reporting to the ExCom. The counterpart/enterprise is responsible to achieve the project objective by providing financial and personnel resources required for smooth project implementation. Financial management will be administered by UNIDO following UNIDO's Financial Rules and Regulation.

9.2 Working arrangement for implementation

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

9.3 Modification of production process

Procurement of equipment required for the production line modification will be done through a single source purchase, however according to respective regulation stipulated by UNIDO's Financial Rules and Regulations. Smaller equipment and parts may be procured locally, if local procurement is found to be more economical. Local procurement will also be done based on UNIDO's Financial Rules and Regulations. This applies also for contracting with contractors for provision of technical services. Terms of references and technical specifications for the procurement of contracts and equipment will be prepared by UNIDO in consultation and agreement with the enterprise and the NOU.

9.4 Project monitoring

Project monitoring is done by the executing and implementing agencies through regular missions to the project site and continuous communications through e-mails and telephone/skype discussion. Occasional visits and communication by the NOU are also to be done to ensure adequate project implementation.

9.5 Project completion

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

9.6 Timetable for implementation

Milestone	**2016**				**2017**				**2018**			
	Q1	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Approval												
Working arrangement												
Preparation of TORs												
Bidding & contract award												
Equipment Delivery												
Modification of line												
Staff training												
Safety certificate												
Project completion												

In conformity with the Montreal Protocol Executive Committee's decision 23/7 on standard components on monitoring and evaluation, milestones for project monitoring are proposed as follows:

Sr. #	Milestone	Months
1	Project approval	-
2	Start of implementation	1
4	TOR prepared	3
5	Bids prepared and requested	5
6	Contracts awarded	8
7	Equipment delivered	13
8	Commissioning and trial runs	16
9	De-commissioning/destruction of redundant baseline equipment	18
10	Submission of project completion report	18-24