UNITED NATIONS

EP

United Nations Environment Programme

Distr.
GENERAL

UNEP/OzL.Pro/ExCom/75/42
1 November 2015

ORIGINAL: ENGLISH

EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Seventy-fifth Meeting
Montreal, 16-20 November 2015

PROJECT PROPOSALS: COLOMBIA

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

Foam

- Demonstration project to validate the use of hydrofluoro-olefins for discontinuous panels in Article 5 Parties through the development of cost-effective formulations — UNDP

Phase-out

- HCFC phase-out management plan (stage II, first tranche) — UNDP/UNEP/Germany

Refrigeration and air-conditioning

- Demonstration of HC-290 (propane) as an alternative refrigerant in commercial air-conditioning manufacturing at Industrias Thermotar ltda — UNDP

PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT

COLOMBIA

PROJECT TITLE(S)	BILATERAL/IMPLEMENTING AGENCY
(a) Demonstration project to validate the use of hydrofluoro-olefins for discontinuous panels in Article 5 Parties through the development of cost-effective formulations	UNDP

NATIONAL CO-ORDINATING AGENCY	Ministry of Environment, National Ozone Unit

LATEST REPORTED CONSUMPTION DATA FOR ODS ADDRESSED IN PROJECT

A: ARTICLE-7 DATA (ODP TONNES, 2014, AS OF OCTOBER 2015)

HCFCs	156.03

B: COUNTRY PROGRAMME SECTORAL DATA (ODP TONNES, 2014, AS OF OCTOBER 2015)

HCFC-22	67.4
HCFC-123	2.1
HCFC-141b	86.3
HCFC-142b	0.3

HCFC consumption remaining eligible for funding (ODP tonnes)	146.63

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

PROJECT TITLE:	
ODS use at enterprise (ODP tonnes):	13.27
ODS to be phased out (ODP tonnes):	0.44
ODS to be phased in (ODP tonnes):	0.00
Project duration (months):	12
Initial amount requested (US $):	459,450
Final project costs (US $):	
Incremental capital cost:	226,800
Contingency (10 %):	25,680
Incremental operating cost:	
Project monitoring and reporting	30,000
Total project cost:	282,480
Local ownership (%):	100%
Export component (%):	0%
Requested grant (US $):	282,480
Cost-effectiveness (US $/kg):	n/a
Implementing agency support cost (US $):	19,774
Total cost of project to Multilateral Fund (US $):	302,254
Status of counterpart funding (Y/N):	Y
Project monitoring milestones included (Y/N):	Y

SECRETARIAT'S RECOMMENDATION	For individual consideration

PROJECT DESCRIPTION

1. On behalf of the Government of Colombia, UNDP as the designated implementing agency, has submitted to the 75th meeting a request for funding a demonstration project to validate the use of hydrofluoro-olefins (HFO) for discontinuous panels in Article 5 Parties through the development of cost-effective formulations, at the amount of US $282,480, plus agency support costs of US $19,774. This project is prepared in a response to decision 72/40[1].

2. At the 74th meeting, the Executive Committee considered the requests for preparation of projects to demonstrate low-global warming potential (GWP) technologies and feasibility studies on district cooling pursuant to decision 72/40. The proposal for Colombia was one of the two fully-developed proposals submitted at that meeting; the Executive Committee, in decisions 74/21 and 74/38, recommended that the proposal may be resubmitted to the 75th meeting. The revised project proposal is contained in Annex I to the present document.

Project description

3. Several Article 5 countries have converted their largest foam enterprises typically found in the domestic refrigeration and continuous panels sectors to hydrocarbons during stage I of the HCFC phase-out management plan (HPMP). During stage II, these countries must address the remaining foam sectors (discontinuous panels, spray foam, integral skin), characterised by a multitude of micro-, small- and medium-sized enterprises (SMEs) that do not have technical and financial resources to handle flammable substances in a safe manner. This factor along with the lack of economies of scale prevents the adoption of flammable blowing agents. The recently developed HFOs have shown better thermal performance in rigid polyurethane (PU) foam applications than the high-GWP-saturated HFCs in rigid PU. The main barriers for the introduction of these substances, however, are their high unitary cost and the limited experience available as this technology has not been used in Article 5 countries.

4. The PU foam sector in Colombia manufactures flexible foam (flex-slab and moulded and integral skin) and rigid foam and microcellular elastomers (shoe soles). Discontinuous panels account for 15 per cent (98 metric tonnes (mt)) of the total HCFC-141b consumption in Colombia.

Project objective

5. The project objectives are to: validate HFOs as PU formulations with reduced HFO for discontinuous panels; optimise the cost/performance balance to achieve a similar foam thermal performance to HCFC-141b-based formulations; and make a cost analysis of the different HFO/water formulations versus HCFC-141b-based systems. The results of this project may be replicable in other foam applications in Colombia and other Article 5 countries.

Methodology

6. The project will analyse two molecules, HFO-1233ze(E) and HFO-1336maam(z). The participating enterprise is Espumlatex[2], a systems house equipped with 18 blending tanks with capacities

[1] The Executive Committee decided *inter alia* to consider at its 75th and 76th meetings proposals for demonstration projects for low-global warming potential (GWP) alternatives to HCFCs within the framework established, and provided criteria for such projects.

[2] During the transition from CFC-11 to HCFCs, two projects were carried out with at Espumlatex: "Retroactive funding for the conversion from CFC-11 to water-based technology in the manufacture of flexible moulded and integral skin foam at Espumlatex-Promicolda" (COL/FOA/32/INV/49) and "Conversion from CFC-11 to HCFC-141b and water-based technology in the manufacture of various PU foam applications at 25 small enterprises centred around systems house at Espumlatex" (COL/FOA/32/INV/48). Espumlatex also served in 2011-2013 as the

from 1,500 to 3,000 litres, with a certified quality control laboratory, where the basic properties of the PU systems (free rise density, reactivity, foam thermal conductivity, compression strength, dimensional stability and accelerated aging) are tested. The enterprise is fully committed to test new HCFC alternatives with low-GWP and has the required capability.

Project implementation

7. The following activities will be executed:

(a) Work arrangement with Espumlatex to be signed between UNDP and the beneficiary as well as the national ozone unit;

(b) Development of the experimental protocol which includes applications procedure and conditions, properties to test, testing method;

(c) Formulation development and foam sample preparation at Espumlatex using a high-pressure dispenser and a conventional mould;

(d) Procurement of a laboratory equipment to measure foam friability, which is critical given the urea content achieved with PU high-water formulations;

(e) Testing of foam critical immediate and aged properties such as thermal conductivity, compression strength, dimensional stability and friability;

(f) Field tests at ABC Poliuretanos, a local discontinuous panels manufacturer; the reduction of 4 mt of HCFC-141b associated with this test will be included in stage II of the HPMP for Colombia as the phase-out will be achieved at that time, and should be deducted from the starting point then; and

(g) Two dissemination workshops to the Colombia and Latin American industry.

8. The project duration is expected to be 12 months.

Project budget

9. The summary of the project cost is detailed in Table 1.

Table 1. Project cost by activity (US $)

Activity	Unit cost	Quantity	MLF	Espumlatex contribution	Total cost
International technical assistance	30,000	1	30,000	-	30,000
Planning	5,000	1	5,000	-	5,000
Formulation development in systems house	110,000	1	74,000	36,000	110,000
Acquisition of friability tester	10,000	1	10,000	-	10,000
Foam testing (laboratory tests)	-	-	20,000	10,000	30,000
PU material for formulation development and field testing	8,800	1	8,800	-	8,800
Foam testing - field evaluation	5,000	1	3,000	2,000	5,000
Technology dissemination workshops		2	40,000	-	40,000
Local consultants	36,000	1	36,000	-	36,000
Sub-total incremental capital cost	196,244		226,800	48,000	274,800

local systems house for the demonstration project on supercritical CO_2 technology for spray foam under a Japan-Colombia bilateral project with Achilles Corp. (COL/FOA/60/DEM/75)

Activity	Unit cost	Quantity	MLF	Espumlatex contribution	Total cost
Project monitoring and reporting	30,000	1	30,000	-	30,000
Contingencies (10%)	-	-	25,680	4,800	30,480
Total cost	-	-	282,480	52,800	335,280

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

10. At the 74th meeting, the Executive Committee noted that the Secretariat only reviewed the project compliance with the guidelines contained in decision 72/40; the technical aspects and costs of the project were not reviewed at that time. UNDP prepared the proposal without preparatory funding from the Multilateral Fund. Furthermore, it is noted that in line with decision 74/21(c) the proposal has been revised to only address discontinuous panels thereby reducing the requested grant to a value of US $282,480, instead of the original request of US $459,450 submitted to the 74th meeting for both discontinuous panels and spray foam.

11. Since both Espumlatex and ABC Poliuretanos are included in stage II of the HPMP for Colombia submitted to the 75th meeting, the Secretariat inquired what impact, if any, the demonstration project would have on those conversions. UNDP clarified that two different kinds of development work are involved for Espumlatex:

(a) For stage II, to meet the diverse and specific requirements of several customers in commercial refrigeration, spray foam, pour-in-place, integral skin and discontinuous panels; and

(b) For the demonstration project, to meet the general-type requirements for discontinuous panels.

Both developments, different in nature, are required to be carried out. Since each systems house has its own formulations based on the specific requirements of its clients, the demonstration project will serve as a general guide to the different systems houses on the performance of reduced HFO systems but would not obviate the need to optimize their own system. It would provide experimental evidence a starting point for that optimization.

12. The proposed budget includes US $100,000 for one person-year effort by a qualified engineer and a lab technician and US $71,000 for international technical assistance, planning, and for a local consultant. These costs appeared high given that staff at Espumlatex would focus on multiple aspects of the enterprise's operation rather than just the demonstration project. UNDP believes these costs are reasonable.

Conclusion

13. The Executive Committee may wish to consider approval of this project in light of the guidelines and other projects being considered under the allocated window of US $10 million for this purpose.

RECOMMENDATION

14. The Executive Committee may wish to consider:

(a) The demonstration project to validate the use of hydrofluoro-olefins for discontinuous panels in Article 5 Parties through the development of cost-effective formulations in

Colombia 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/75/27); and

(b) Approving the demonstration project to validate the use of hydrofluoro-olefins for discontinuous panels in Article 5 Parties through the development of cost-effective formulations in Colombia, in the amount of US $282,480, plus agency support costs of US $19,774 for UNDP, in line with decision 72/40.

PROJECT EVALUATION SHEET – MULTI-YEAR PROJECTS

Colombia

(I) PROJECT TITLE	AGENCY
HCFC phase-out plan (Stage II)	UNDP (lead), UNEP

(II) LATEST ARTICLE 7 DATA (Annex C Group l)	Year: 2014	156.03 (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-22	0.0	0.0		2.2	65.2				67.4
HCFC-123			2.0		0.0				2.1
HCFC-141b	0.3	73.0	6.8	0.4	5.1	0.6			86.3
HCFC-142b					0.3				0.3

(IV) CONSUMPTION DATA (ODP tonnes)			
2009 - 2010 baseline:	225.6	Starting point for sustained aggregate reductions:	225.6
CONSUMPTION ELIGIBLE FOR FUNDING (ODP tonnes)			
Already approved:	78.91	Remaining:	146.63

(V) BUSINESS PLAN		2015	2016	2017	2018	2019	2020	After 2020	Total
UNDP	ODS phase-out (ODP tonnes)	15.57	15.5	15.5	15.5	15.5	15.5	0	93.07
	Funding (US $)	658,000	658,000	658,000	1,187,000	1,187,000	1,187,000	0	5,535,000
UNEP	ODS phase-out (ODP tonnes)	0	0.7	0	0.7	0	0	2.9	4.3
	Funding (US $)	0	37,000	0	66,000	0	0	264,000	367,000
Germany	ODS phase-out (ODP tonnes)	0	3.0	3.0	3	0	0	0	9
	Funding (US $)	0	166,000	166,000	0	0	78,000	0	410,000

(VI) PROJECT DATA			2015	2016	2017	2018	2019	2020	Total
Montreal Protocol consumption limits			203.01	203.01	203.01	203.01	203.01	146.62	n/a
Maximum allowable consumption (ODP tonnes)			203.01	203.01	203.01	203.01	203.01	146.62	n/a
Project costs requested in principle (US $)	UNDP	Project costs	2,248,562	0	2,899,092	0	1,391,661	0	6,539,315
		Support costs	157,399	0	202,936	0	97,416	0	457,752
	UNEP	Project costs	60,000	0	80,000	0	61,600	0	201,600
		Support costs	7,800	0	10,400	0	8,008	0	26,208
	Germany	Project costs	308,600	0	205,000	0	82,400	0	596,000
		Support costs	39,124	0	25,990	0	10,446		75,560
Total project costs requested in principle (US $)			2,617,162	0	3,184,092	0	1,535,661	0	7,336,915
Total support costs requested in principle (US $)			204,323	0	239,326	0	115,870	0	559,520
Total funds requested in principle (US $)			2,821,485	0	3,423,418	0	1,651,531	0	7,896,435

(VII) Request for funding for the first tranche (2015)		
Agency	**Funds requested (US $)**	**Support costs (US $)**
UNDP	2,248,562	157,399
UNEP	60,000	7,800
Germany	308,600	39,124

Funding request:	Approval of funding for the first tranche (2015) as indicated above
Secretariat's recommendation:	For individual consideration

PROJECT DESCRIPTION

15. On behalf of the Government of Colombia, UNDP as the lead implementing agency, has submitted to the 75th meeting stage II of the HCFC phase-out management plan (HPMP) at a total cost of US $7,89,6435, consisting of US $6,539,315, plus agency support costs of US $457,752 for UNDP, US $201,600, plus agency support costs of US $26,208 for UNEP, and US $596,000 plus agency support costs of US $75,560 for Germany, as originally submitted. The implementation of stage II of the HPMP will phase-out 72.76 ODP tonnes of HCFCs and assist Colombia in meeting the Montreal Protocol's compliance target of the 35 per cent reduction by 2020.

16. The first tranche for stage II of the HPMP being requested at this meeting amounts to US $2,821,485, consisting of US $2,248,562 plus agency support costs of US $157,399, for UNDP, US $60,000, plus agency support costs of US $7,800 for UNEP, and US $308,600 plus agency support costs of US $39,124 for Germany, as originally submitted.

Background

HCFC consumption

17. The Government Colombia reported consumption of 156.03 ODP tonnes of HCFC in 2014. The 2010-2014 HCFC consumption is shown in Table 1.

Table 1. HCFC consumption in Colombia (2010-2014 Article 7 data)

HCFC	2010	2011	2012	2013	2014	Baseline
Metric tonnes						
HCFC-22	1,226.2	843.08	1,582.28	1,053.40	1,226.16	1,292.6
HCFC-123	114.4	88.93	117.41	104.30	103.58	110.4
HCFC-124	0.7	1.19	0.89	1.34	0.70	1.8
HCFC-141b	1,555.4	1,529.83	1,771.63	1,054.23	783.83	1,379.5
HCFC-142b	9.6	14.52	18.93	9.77	4.35	7.5
Total	**2,906.3**	**2,477.55**	**3,491.14**	**2,223.04**	**2,118.62**	**2,791.7**
ODP tonnes						
HCFC-22	67.4	46.37	87.02	57.94	67.44	71.1
HCFC-123	2.3	1.78	2.35	2.09	2.07	2.2
HCFC-124	0.0	0.03	0.02	0.03	0.02	0.0
HCFC-141b	171.1	168.28	194.88	115.97	86.22	151.7
HCFC-142b	0.6	0.94	1.23	0.64	0.28	0.5
Total (ODP tonnes)	**241.4**	**217.40**	**285.50**	**176.65**	**156.03**	**225.6**

18. The 2014 HCFC consumption (156.0 ODP tonnes) reported under Article 7 is 30 per cent lower than its baseline consumption (225.6 ODP tonnes). Consumption of HCFC-141b has been decreasing since 2012, and the current consumption (86.2 ODP tonnes) is 43 per cent lower than the baseline (151.7 ODP tonnes). This reduction is due to completion of reconversion projects with the manufacturing of domestic refrigerants during stage I of the HPMP. Consumption of HCFC-22 has fluctuated since 2010 due to fluctuations in the price of refrigerants and introduction of HFCs into the market.

19. Table 2 presents the consumption of HCFCs by sector as reported in country programme (CP) data for 2014.

Table 2. HCFC sector consumption in Colombia (2014)

HCFC	Aerosol	Foam	Fire fighting	Ref. manufact.	Ref. serving	Solvent	Total
Metric tonnes							
HCFC-22	0.64	0.8	0	39.83	1,184.89	0	1,226.16
HCFC-123	0	0	102.1	0	1.48	0	103.58
HCFC-124	0	0	0	0	0.70	0	0.70
HCFC-141b	2.94	664.09	61.62	3.69	46.40	5.48	784.22
HCFC-142b	0	0	0	0	4.35	0	4.35
Total (mt)	**3.58**	**664.89**	**163.72**	**43.52**	**1,237.82**	**5.48**	**2,119.01**
ODP tonnes							
HCFC-22	0.04	0.04	0.00	2.19	65.17	0	67.44
HCFC-123	0	0	2.04	0	0.03	0	2.07
HCFC-124	0	0	0.00	0	0.02	0	0.02
HCFC-141b	0.32	73.05	6.78	0.41	5.10	0.60	86.26
HCFC-142b	0	0	0	0	0.28	0	0.28
Total (ODP tonnes)	**0.36**	**73.10**	**8.82**	**2.60**	**70.60**	**0.60**	**156.08**

20. In 2014, the total HCFC consumption was 2,119.01 mt (156.08 ODP tonnes), with HCFC-22 and HCFC-141b accounting for 98 per cent of the total consumption measured in ODP tonnes. The vast majority (85 per cent) of HCFC-141b was used as a blowing agent for polyurethane (PU) insulating foam for the production of rigid and integral skin foam used in continuous and discontinuous panels, as well as minor uses in spray and integral skin. There was still some use of HCFC-141b in the aerosol, manufacturing, servicing and solvent sectors but those uses have been phased out under stage I. HCFC-141b was also used in the fire protection sector, representing 8 per cent of the total HCFC-141b consumption.

21. The high rate of consumption of HCFC-22 in the servicing sector (97 per cent of the total HCFC-22 consumption) is due to the large number of HCFC-based equipment in supermarkets, hotels, hospitals and residential air-conditioners, and the variable technical knowledge among technicians and servicing enterprises. At present, commercially available HCFC-22 alternatives have high-global warming potential (GWP); natural refrigerants have been used in a few refrigeration and air-conditioning (RAC) applications. In contrast, consumption of HCFC-22 in the manufacturing sector comprises three per cent of the total HCFC-22 consumption in 2014, and it has been decreasing due to the conversion of manufacturing enterprises with their own resources to high-GWP refrigerants (i.e., R-410A).

Progress report on the implementation of stage I of the HPMP

22. Stage I of the HPMP for Colombia was approved by the Executive Committee at its 62nd meeting to meet the 10 per cent reduction of the HCFC baseline of 225.6 ODP tonnes by 1 January 2015. Colombia complied with the freeze in consumption in 2013; based on the consumption reported for 2014 (156.03 ODP tonnes) it appears it would also comply with the control target for 2015. Stage I includes the reduction of HCFCs in the foam, manufacturing, refrigeration servicing sector, solvent, and aerosol sectors.

Regulatory action

23. The ODS import and export licensing and quota system has been fully operation since 2012 and extended to include HCFCs in 2013. Further, in 2013, a ban on manufacturing and import of HCFC-based refrigerators, freezers and refrigerator freezes was established. In 2014, measures to control the export of ODS were established. Preparations to ban the use of HCFCs for emissive uses are underway.

Activities in the foam sector

24. Four national enterprises in the production of PU rigid insulation foam in the domestic refrigeration subsector converted to hydrocarbons (HC) and phased out 61.33 ODP tonnes of HCFC-22 and HCFC-141b.

Activities in the refrigeration servicing sector

25. The recovery, recycle and reclamation network of refrigerants was consolidated through workshops, guides and information dissemination. Eighteen collection centres were selected and equipped, and are currently in the process of attaining their corresponding environmental license for operation.

26. Thirty-eight workshops of good service practices were provided and 1,850 refrigeration technicians were certified, and five train-the-trainer seminars for Servicio Nacional de Aprendizaje (SENA) instructors were also provided. Also, 27 workshops on the use of flushing and cleaning were held resulting in 521 technicians trained. One hundred and sixty-five nitrogen flushing kits were delivered to 128 technicians and SENA centres. Guidelines on good practices were produced and 1,500 documents delivered to technicians and SENA centres

27. Two national and 35 regional seminars to promote low-GWP technologies and energy efficiency for end-users were held during stage I of the HPMP. International standards for the safe management of HC were reviewed; a proposal for the inclusion of the safe and efficient use of HC in the Norma Técnica Colombiana was sent to the Colombia Institute of Standards, and three courses on HC management were held for 43 participants.

28. The Unidad Técnica de Ozono (UTO) led awareness raising activities on technological substitution alternatives for 1,050 end-users. In addition, UTO visited end-users, such as supermarkets and flower producers, to promote ODS-free pilot demonstration projects.

Activities in the aerosol, fire protection and solvent sectors

29. Preliminary evaluations of low-climate impact alternatives to HCFC-141b as a solvent for the production of hypodermic needles was completed; an initial Collaboration Agreement with Rymco Laboratories S.A to eliminate the use of HCFC-141b as a solvent in making hypodermic needles was drafted. A strategy for replacing HCFC as propellants, solvents, fire suppressants and cleansing agents was finalized and a technical report on alternatives for these uses was published. A database on HCFC consumption in emissive uses was upgraded and a workshop for end-users on alternatives was held.

Disbursement

30. As of August 2015, of the US $6,821,483 approved for stage I, US $6,756,799 (99 per cent) had been disbursed. The balance of the funds will be disbursed in 2016.

HCFC phase-out strategy and proposed activities in stage II

31. The overarching strategy proposes a 35 per cent reduction in HCFC consumption from the baseline by promoting the use of non-ODP, low-GWP and high energy efficient alternatives in the foam, commercial air-conditioning manufacturing, and fire protection sectors. Those activities will be complemented by activities in the servicing sector and technical assistance to support the HCFC phase-out. Colombia would commit to the following activities to be implemented in stage II of the HPMP:

(a) Adopting and enforcing national policies, legal requirements and voluntary initiatives to reduce refrigerant emissions;

(b) A ban on the use of HCFC-141b for the foam and fire protection sectors by 2020;

(c) A ban on the manufacture and import of HCFC-22 package- and condensed-unit AC equipment with a cooling capacity equal to or greater than 1 tonnes of refrigeration by 2020;

(d) Improving skills, handling of tools and equipment for the safe and efficient use of HCFCs and new low-GWP alternative technologies and substances;

(e) Avoiding growth in demand of HCFC-22 for the servicing sector;

(f) Promoting the introduction of low-GWP RAC equipment (CO_2, NH_3 and HC) in order to limit the current growth of high-GWP HFC based equipment; and

(g) Enable environmentally sound end-of-life procedures for ODS-based equipment.

32. Through stage II of the HPMP, the Government of Colombia would address the additional 25 per cent reduction in order to comply with the 35 per cent reduction target by 2020, and would be willing to consider an extended commitment in 2021 or 2022.

Technical assistance for regulatory activities

33. Technical assistance for the following regulatory activities will be implemented in stage II of the HPMP:

(a) Strengthening of the regulatory and legal frameworks (UNDP, US $243,360);

(b) Strengthening of the trade control of HCFCs and HCFC-based equipment (UNDP, US $251,600); and

(c) Disseminating information, holding awareness raising activities and environmental education on the phase out of HCFCs and HCFC-free products (UNDP, US $275,200).

Activities in the foam sector

34. One enterprise that manufactures discontinuous panels, Rojas Hermanos S.A., and four systems houses (Espumlatex, GMP, Olaflex, and QIC), serving more than 791 downstream customers, would be converted under stage II. All the enterprises are second conversions, as are numerous downstream users. Rojas Hermanos S.A. was established in 1968 and is 100 per cent locally owned and would convert to cyclopentane. The conversion would include the installation of equipment for hydrocarbon storage and blending, retrofit of foaming equipment, installation of a safety control system and gas monitoring, trials and training, and a safety audit.

35. The downstream users of the systems houses are SMEs that produce various applications of rigid foam (e.g., discontinuous panels; insulation foam for refrigerated trucks, pipes and tanks; and fibreglass boats). Less than 3 per cent of their total consumption is for flexible foam, integral skin and reaction injection moulding for the auto industry. The enterprises would convert to HFO-reduced formulations. The system houses will conduct the verification of the number and consumption of enterprises, collect letters of participation from recipients, provide technology assistance and conduct trials at the recipients, collect individual statements of completion and assist in project completion procedures. The recipients would be required to sign letters of participation and commitment to permanently phase-out the use of

HCFC-141b. UNDP confirmed that if during implementation any enterprise is determined to be non-eligible, the funding associated with that enterprise would be returned to the Fund.

36. In addition, two of the systems houses, Espumlatex and Olaflex, manufacture PU rigid foam sheets for insulation. Espumlatex would phase-out 7.6 mt of HCFC-141b by converting to water blown technology. The incremental capitals costs are limited to formulation development, trials and testing. Olaflex would phase-out 42.3 mt of HCFC-141b by converting to cyclopentane and would follow a similar conversion process as Rojas Hermanos S.A.

37. Completion of conversions would result in the phase-out of 26.78 ODP tonnes (Table 3).

Table 3. Conversion projects of enterprises in the foam sector (HCFC-141b)

Enterprise	mt	ODP tonnes	Alternative technology	ICC (US $)	IOC (US $)	Total cost (US $)	Fund request (US$)	CE (US$/kg)
Rojas Hermanos	23.57	2.59	Cyclopentane	508,750	8,542	517,292	230,662	9.79
Espumlatex, systems house	99.91	10.99	HFO- reduced	1,053,460	962,531	2,015,991	1,095,213	10.96
Espumlatex, rigid sheets	7.60	0.84	Water-blown	38,500	30,828	69,328	83,357*	10.96*
GMP, systems house	41.41	4.55	HFO- reduced	475,750	398,897	874,647	453,902	10.96
Olaflex, systems house	13.23	1.45	HFO- reduced /cyclopentane	226,250	127,418	353,668	145,001	10.96
Olaflex, rigid sheets	42.27	4.65	HFO- reduced /cyclopentane	410,300	38,790	449,090	413,721	9.79
QIC, systems house	15.47	1.70	HFO- reduced	289,260	149,081	438,341	169,638	10.96
Total foam	**243.46**	**26.78**				**4,718,357**	**2,591,494**	

*As requested

Activities in the RAC sector

38. Stage II included a project to demonstrate the use of HC-290 in the manufacture of commercial air-conditioning equipment at a total cost of US $769,160. Industrias Thermotar-Ltda, established in 1978, is the manufacturer of the largest volume of HCFC-22-based condensing units in the country and would phase-out 1 ODP tonne of HCFC-22. On average, the enterprise produces 4,100 units per year, with cooling capacity ranging from 1 to 5 tonnes. Conversion would require product design (controllers, electrical components, refrigerant circuit, and prototype) and development; installation of a leak-proof system; installation of a safety system; training and certification of staff in the safe handling of HC refrigerants; and safety audits. The duration of the project was estimated at 24 months. Implementation of the project would result in the complete phase-out of HCFC-22 in this subsector and the Government of Colombia would ban the manufacture and import of type packaged and condensed AC equipment that use HCFC-22 with a cooling capacity greater than 1 tonne of refrigeration by 2020. The cost-effectiveness of the proposed project was US $42.26/kg.

Activities in the refrigeration servicing sector

39. The following activities in the refrigeration servicing sector will be implemented in stage II of the HPMP:

(a) Training and enforcement of technical standards; development of an online log book for RAC servicing enterprises and end-users for better containment of existing HCFC stocks; training on the safe use of natural and other low-GWP refrigerants; and establish technical standards for the use and application of refrigerants in the RAC sector (Germany, US $946,000);

(b) Develop and implement new labour competence standards for the certification of 200 technicians and 1,800 workers on best service practices in safe and efficient use of natural refrigerants; accreditation of institutions other than SENA to perform certification; and procure tools for the installation and maintenance of hydrocarbon-based RAC equipment (UNDP, US $840,500);

(c) Strengthen the recovery, recycling and reclaim programme by providing 360 recovery units and 720 storage cylinders to technicians at the best practices training certification. A feasibility assessment of the assembly of refrigerants recovery machines will be undertaken. Storage capacity of recovered and reclaimed refrigerants will also be undertaken (UNDP, US $815,601); and

(d) Awareness on the use of low-GWP alternatives for refrigeration and commercial air-conditioning systems through the development and implementation of five pilot experiences for the adoption of low environmental impact alternatives in refrigeration systems in a strategic alliance between end-users (supermarkets, air-conditioning systems in public and private buildings, hospitals and hotels) and assembly enterprises (UNDP, US $950,000).

Activities in the fire protection sector

40. Stage II includes technical assistance for the phase-out of HCFC-141b consumption in the fire protection sector. In 2003, the use of halon-1211 was phased out for portable fire-extinguishing units. Initially the industry converted to HCFC-123; however, due to the limited supply and high price of HCFC-123, the use of blended HCFC-123 and HCFC-141b was adopted. The Government of Colombia became aware of the use of HCFC-141b in the fire protection sector in 2011 and has issued warnings to importers against this use. However, this has not been sufficient to curb the use. Therefore, technical assistance has been requested to ban the use of HCFC-141b as a fire extinguishing agent. In addition, halon recovery and recycling activities will be undertaken. Codes of practice for halon recovery, recycling and reclamation, and improvement of halon recycling facilities will be developed; and storage cylinders, halon identifier and recycling system will be procured to improve halon recycling facilities (UNDP, US $458,000).

Programme for implementation and monitoring activities

41. Funds for activities for the implementation, monitoring, verification and follow-up were also requested (UNDP, US $786,000).

Total cost of stage II of the HPMP

42. The total cost of the activities proposed in stage II of the HPMP amounts to US $7,336,915 to phase-out of 72.76 ODP tonnes of HCFCs at a cost-effectiveness of US $7.09/kg, as shown in Table 4.

Table 4. Overall cost of stage II of the HPMP for Colombia

Description of projects	HCFC-22 (mt)	HCFC-141b (mt)	Total (mt)	ICC (US $)	IOC (US $)	Total cost (US $)	Co-financing (US $)	Grant request (US $)	CE (US $/kg)
PU foam sector conversion									
Enterprises (UNDP)									
Espumlatex, rigid sheets	0.00	7.60	7.60	38,500	30,828	69,328	-	83,357*	10.97*
Olaflex, rigid sheets	0.00	42.27	42.27	410,300	38,790	449,090	35,369	413,721	9.79
Rojas Hermanos, discontinuous panels	0.00	23.57	23.57	508,750	8,542	517,292	286,630	230,662	9.79
Sub-total foam enterprises	0.00	73.44	73.44	957,550	78,160	1,035,710	321,999	727,740	9.91*

Description of projects	HCFC-22 (mt)	HCFC-141b (mt)	Total (mt)	ICC (US $)	IOC (US $)	Total cost (US $)	Co-financing (US $)	Grant request (US $)	CE (US $/kg)
System houses (UNDP)									
Espumlatex, systems house	0.00	99.91	99.91	1,053,460	962,531	2,015,991	920,778	1,095,213	10.96
GMP,systems house	0.00	41.41	41.41	475,750	398,897	874,647	420,745	453,902	10.96
Olaflex, systems house	0.00	13.23	13.23	226,250	127,418	353,668	208,667	145,001	10.96
QIC	0.00	15.47	15.47	289,260	149,081	438,341	268,703	169,638	10.96
Sub-total foam system house	0.00	170.02	170.02	2,044,720	1,637,927	3,682,647	1,818,893	1,863,754	10.96
Subtotal foam sector	0.00	243.46	243.46	3,002,270	1,716,087	4,718,357	2,140,892	2,591,494	10.64
Commercial AC manufacturing sector (UNDP)									
Conversion of Industrias Thermotar	18.20	0.00	18.20	654,500	114,660	769,160	0	769,160	42.26
Sub-total commercial AC manufacturing sector	18.20	0.00	18.20	654,500	114,660	769,160	0	769,160	
RAC servicing sector									
Training, technical standards and online log book (GIZ)	124.17	0.00	124.17	0	0	946,000	350,000	596,000	4.80
Technician certification and provision of tools (UNDP)	104.27	0.00	104.27	0	0	840,500	340,000	500,500	4.80
Refrigerant recovery, recycling and reclamation (UNDP)	153.25	0.00	153.25	0	0	815,601	80,000	735,601	4.80
Education and information on low environmental impact alternatives for end-users (UNDP)	102.08	0.00	102.08	0	0	950,000	460,000	490,000	4.80
Sub-total RAC servicing sector	483.77	0.00	483.77	0	0	3,552,101	1,230,000	2,322,101	
Fire protection sector (UNDP)									
Technical assistance	0.00	61.60	61.60	0	0	458,000	150,000	308,000	5.00
Sub-total fire protection sector	0.00	61.60	61.60	0	0	458,000	150,000	308,000	
Regulatory activities									
Regulatory and legal framework (UNEP)	0.00	38.20	38.20	0	0	243,360	60,000	183,360	4.80
Strengthening the trade control (UNDP)	0.00	42.00	42.00	0	0	251,600	50,000	201,600	4.80
Awareness raising (UNDP)	0.00	36.50	36.50	0	0	275,200	100,000	175,200	4.80
Sub-total of regulatory activities	0.00	116.70	116.70	0	0	770,160	210,000	560,160	4.80
Total	**501.97**	**421.76**	**923.73**	**3,656,770**	**1,830,747**	**10,267,778**	**3,730,892**	**6,550,915**	**7.09**
Project management and implementation									
Project management and implementation						846,000	60,000	786,000	

*As requested

SECRETARIAT'S COMMENTS AND RECCOMENDATIONS

COMMENTS

43. The Secretariat reviewed stage II of the HPMP for Colombia in light of stage I, the policies and the guidelines of the Multilateral Fund, including the criteria for funding HCFC phase-out in the consumption sector for stage II of HPMPs (decision 74/50), and the 2015-2017 business plan of the Multilateral Fund.

Overarching strategy

44. The Secretariat noted the comprehensive strategy proposed by the Government of Colombia. The strategy addresses the foam and air-conditioning sectors, and the servicing sector through a series of targeted activities. The strategy only includes conversions to low-GWP alternatives and would promote the uptake of low-GWP alternatives, including natural refrigerants.

45. Colombia's baseline is 225.60 ODP tonnes and stage I phased out a total of 78.92 ODP tonnes. As submitted, stage II would phase-out 72.76 ODP tonnes. Combined with the additional 12.30 ODP tonnes of HCFC-141b exported in pre-blended polyols that will be deducted from Colombia's starting point for aggregate reduction in accordance with decision 68/42(b), the total reductions would be 163.98 ODP tonnes, representing 73 per cent of Colombia's baseline. Colombia's remaining eligible consumption after stage II would be 61.62 ODP tonnes, as submitted. However, the Government proposed to commit to a 35 per cent reduction from its baseline by 2020, while also noting a willingness to consider an extended commitment. Colombia's 2014 consumption was already 31 per cent below its baseline.

Proposed activities in stage II

Activities in the foam sector

46. The Secretariat noted that one of Rojas Hermanos's chemical supplier of its polyol is Espumlatex, one of the enterprises that is proposed to be converted under stage II and enquired whether, rather than convert to cyclopentane, the enterprise could instead purchase the pre-blended HFO-polyol from Espumlatex or from the other systems houses that are being converted in stage II. UNDP indicated that while technically possible, the enterprise preferred to convert to cyclopentane in light of financial and technological implications. Given this choice of technology, the Secretariat discussed costs associated with the additional mixing head, the pentane premixing unit, polyol/pentane buffer tank, retrofit of moulds, and safety and fire protection systems, where costs were found to be higher than those in other similar projects already approved. Following discussions, the incremental costs were agreed at US $403,909 (US $403,150 capital costs and US $759 operating costs).

47. Two of the systems houses, Espumlatex and Olaflex, produce rigid PU sheets in addition to the pre-blended polyol systems they provide to their downstream customers. Taking into account the small size of the operation at Espumlatex (6.60 mt in 2014), the enterprise chose all-water blown technology, limiting the proposed incremental capitals to technical assistance, trials and testing. Noting that Espumlatex had received funding to convert to water-blown systems under previously approved projects (see COL/FOA/32/INV/49 and COL/FOA/32/INV/48), it was agreed to deduct the requested US $20,000 for technical assistance. IOCs were agreed at US $22,607. Rigid sheet production at Olaflex would convert to cyclopentane. The Secretariat discussed costs associated with retrofitting the high-pressure dispenser, the pentane premixing unit, and safety and fire protection systems, where costs were found to be higher than those in other similar projects already approved. Following discussions, the incremental costs were agreed at US $377,747 (US $376,200 capital costs and US $1,547 operating costs).

48. With regard to the four systems houses, the following changes were agreed related to the incremental capital costs: equipment related to the use of flammable alternatives (US $58,000) was not incremental given that the selected technology, reduced HFO formulations, are not flammable; the cost of laboratory equipment (US $26,250) would be provided to the systems houses except for Espumlatex since it had already received such equipment under the demonstration project on supercritical CO_2 technology.

49. The Secretariat noted that that the consumption of the downstream customers of some systems houses was calculated on the basis of the average of the last three years, while for others it was calculated based on the last year, and that some downstream customers appeared on the list of multiple systems

houses. In order to avoid double-counting those customers, which might change the systems house from which they purchase systems in different years, the Government of Colombia elected to use 2014 as the basis for calculating consumption and to associate the full consumption of each downstream customer to a single systems house. Combined with three small enterprises that were established after the cut-off date and inadvertently included, this resulted in a small change in consumption from 193.59 mt to 185.01 mt of HCFC-141b. In light of the more than 800 small- and medium-sized enterprises in Colombia, and in accordance with past practice, UNDP and the Government of Colombia will verify the eligibility of all enterprises during implementation and return any funds associated with enterprises found to be ineligible.

50. UNDP estimated the IOCs costs related to the conversion to reduced-HFO formulations at US $9.63/kg based on a cost of US $17.00/kg for the HFO-1233zd(E) and HFO-1336mzzm(Z), a 50 per cent reduction of the HFOs relative to HCFC-141b given their superior behaviour in terms of foam properties, and a ratio of blowing agent and polyol to polymeric methylene diphenyl diisocyanate (MDI) of 1:1. After a detailed review, the Secretariat has determined that the IOCs are uncertain at this time. The primary drivers of this uncertainty is the unknown quantity of additional water that would be co-blown with the HFO[3]; how the formulation of the polyol would be changed given the additional water (e.g., changes in surfactants, catalysts, and constituent polyols themselves); the quantity of polymeric MDI that would be needed for the formulation; and the ratio of blowing agent plus polyol to MDI. The testing, trials and training that would be provided for each downstream would help the enterprise to use reduced-HFO formulations that may require a different ratio of polyol plus blowing agent to MDI.

51. Given that all other costs were agreed and the cost-effectiveness threshold of US $10.96/kg calculated in line with decision 74/50(c)(iii),[4] the IOC would have be lower than US $2.13/kg for the eligible funding from the Multilateral Fund to be reduced. It was therefore agreed that UNDP would report the IOCs to the Executive Committee upon implementation and that if those costs were below US $2.13/kg, the additional funds would be returned to the Multilateral Fund.

52. Regarding the eligibility of the second conversions, the enterprises are converting to low-GWP alternatives and are therefore eligible in accordance with decision 74/50(b)(i) and (c). In accordance with decision 74/20, the Government has contacted the suppliers of the HFOs and confirmed the availability of samples for Colombia in 2015 and commercial product for Colombia in 2017, which is the proposed start for the implementation of the projects in the foam sector. The Government of Colombia confirmed that all the SMEs customers in the umbrella projects are 100 per cent locally owned and do not export to non-A5 parties. Finally, the Government agreed to deduct 433.92 mt (47.73 ODP tonnes) of HCFC-141b associated with non-eligible projects from Colombia's remaining eligible consumption of HCFC-141b. This quantity includes the 111.82 mt (12.3 ODP tonnes) of HCFC-141b in exported pre-blended polyols to be deducted from Colombia's remaining eligible consumption in accordance with decision 68/42(b).

Table 5: Agreed costs for the foam sector in Colombia

Description	HCFC-141b (mt)	Cost (US $)			CE ($/kg)
		Capital	Operating	Total requested	
Enterprises					
Espumlatex, rigid sheets	6.60	16,500	22,607	39,107	5.93
Olaflex, rigid sheets	42.27	376,200	1,547	377,747	8.94
Rojas Hermanos, discontinuous panels	23.49	403,150	759	229,928	9.79

[3] The Government of Colombia and UNDP have submitted a demonstration project to validate reduced-HFOs to produce polyurethane foam, including by analyzing and optimizing different HFO/water formulations. The Government of Saudi Arabia and UNDP have submitted a demonstration project for the phase-out of HCFCs by using HFO as a foam blowing agent in spray foam applications in high ambient temperatures, including by analyzing and optimizing different HFO/water formulations (UNEP/OzL.ProExCom/75/27).

[4] "…small and medium-sized enterprises (SMEs) in the foam sector with consumption of less than 20 mt, the maximum would be up to 40 per cent above the cost-effectiveness threshold of US $7.83."

Description	HCFC-141b (mt)	Cost (US $)			CE ($/kg)
		Capital	Operating	Total requested	
Sub-total foam enterprises	72.36	795,850	24,913	646,782	8.94
System houses					
Espumlatex, systems house	95.34	951,160	*	1,044,915	10.96
GMP, systems house	39.92	352,825	*	437,545	10.96
Olaflex, systems house	13.23	152,825	*	144,957	10.96
QIC, systems house	13.04	215,835	*	142,929	10.96
Sub-total foam system house	161.53	1,672,645	*	1,770,346	10.96
Non-eligible projects	433.92				
Total foam sector	**667.81**	**2,468,495**	*****	**2,417,128**	**3.62**

(*) Uncertain.

Activities in the RAC sector

53. The Secretariat discussed the viability of the conversion at Industrias Thermo-Tar with a cost effectiveness of $42.26/kg as proposed. It was noted that the consumption at the enterprise has been decreasing (with the 2014 consumption less than half of that in 2012), and that consumption of HCFC-22 in RAC manufacturing has dropped substantially from 121 mt in 2009 to 40 mt in 2014. The Secretariat suggested that this conversion may be more appropriately considered as a demonstration project in accordance with of decision 74/21(d) since, to the Secretariat's knowledge, commercial HC-290 AC equipment in the 3.5-17.5 kW range is not in production.

54. In light of these considerations, the Government decided to remove this project from stage II and instead submit it as a demonstration project to the 75th meeting, while noting that the conversion would be an important component of its HCFC strategy since it would permit the country to institute a ban on the manufacture and import of certain AC equipment using HCFC-22 and, without such a ban, enterprises will continue to manufacture AC equipment with high-GWP refrigerants, currently HCFC-22 or HFC-410A.

Activities in the fire protection sector

55. It is proposed to phase-out HCFC-141b consumption by means of a prohibition through national regulations. The Secretariat noted that the proposed activities would not address the use of HCFC-123 in portable extinguishers at this time and that the phase-out of HCFC-141b for this sector is likely to result in an increased consumption of HCFC-123 (an additional 1.24 ODP tonnes if replaced on a 1:1 basis). It was noted that if Colombia's consumption of HCFC-123 were to increase above its starting point for sustained aggregate reductions, the Government would address that additional consumption without assistance from the Multilateral Fund.

56. The Secretariat suggested that the Government of Colombia consider to start implementation of the project as early as possible and to ban the use of HCFC-141b for handheld fire extinguishers as soon as possible rather than in 2020. The Secretariat also inquired whether an immediate ban on HCFC-141b in small cylinders may complement the proposed ban. UNDP explained that HCFC-141b for handheld fire extinguishers is supplied in 13.6 kg cylinders and 250 kg drums, so a ban on small cylinders is unlikely to be a useful complement to the proposed prohibition. The schedule of the activities for the fire protection sector was modified in order to start as soon as the stage II is approved, and the ban will be put in place by 31 December 2017.

57. The Secretariat also discussed possible overlapping activities proposed as technical assistance for strengthening the regulatory and legal framework, and the costs of the needed activities. On the basis of those discussions, the agreed activities and cost were agreed at US $75,900.

58. The Secretariat noted that the proposed activities to strengthen halon recovery, recycling and reclamation were not eligible for compensation as part of Colombia's HPMP since those substances are not HCFCs. Moreover, the Multilateral Fund had provided assistance to Colombia for activities under the national programme of halon management. The Government of Colombia agreed to remove the proposed project for halon management, while noting that the activities to help ensure the safe supply of halon to civil aviation industry have been encouraged in decision XXVI/7 and the country does not have the resources to undertake these activities in the short- or medium-term.

Activities in the refrigeration servicing sector

59. Reductions achieved through the proposed servicing sector activities would account for 11.7 per cent of Colombia's baseline. Given other activities proposed under stage II and the reductions already achieved under stage I, the activities were adjusted resulting in agreed cost of US $1,685,576 (Table 6).

Table 6. Agreed activities and costs for the servicing sector

Project	Initial request (US $)	As agreed (US $)	Changes
Training, technical standards and online log book	596,000	543,000	Rationalization of activities
Certification and provision of tools for technicians	500,500	382,800	Cost of consultancies to prepare labour standards; the number of certification workshops; number of set of tools for the use of hydrocarbons (from 200 to 150).
Articulate refrigerant gas recovery, recycling and reclaim	735,601	503,776	Reduction in recovery units (from 360 to 250); cylinders (from 720 to 500); cylinders for collection centres (from 1200 to 690)
Change in end-users consumption habits of refrigeration and commercial AC systems	490,000	256,000	Reduction on the number of workshops and pilot projects (from 5 to 2).
Total cost	**2,322,101**	**1,685,576**	**Phase out of 19.31 ODP tonnes of HCFC-22**

Technical assistance to support the HCFC phase-out

60. The Secretariat noted that starting in 2015 the only consumption of HCFC-141b in the country would be in foam manufacturing and the fire protection sector. As such, the proposed activities in the programme for technical assistance in the formulation and implementation of policies to support the HCFC phase-out do not have a direct nexus with Colombia's consumption of HCFC-141b and are therefore not incremental costs. Because the activities would strengthen the ability of the country to address its consumption of HCFC-22, it was agreed to associate reductions in HCFC-22 with the funding requested under this activity.

61. The Secretariat discussed options to rationalize the activities and costs. The total cost of the activities was agreed at US $454,560, as shown in Table 7.

Table 7. Agreed activities and costs for the technical assistance activities

Project	Initial request (US $)	Adjusted request (US $)	Changes
Strengthen the regulatory and legal framework	183,360	129,360	Reduction in the number of consultation meetings and in the scope of studies related to economic impact of adopted measures.
Strengthen trade control of HCFCs and HCFC-based equipment	201,600	175,000	Reduction in the number of workshops, travel and promotional material.
Environmental education, dissemination and awareness raising	175,200	150,200	Reduction in printed material and the number of awareness activities.
Total cost	**560,160**	**454,560**	**Phase out of 5.21 ODP tonnes of HCFC-22**

Programme for implementation, monitoring, and follow-up

62. Under stage I, Colombia proposed and the Executive Committee agreed to associate a reduction of HCFC-22 consumption with the project monitoring unit. The Secretariat proposed that a similar approach for this programme be used as under stage I. The Government of Colombia indicated that it did not wish to associate a reduction with this activity. In light of changes in the activities to be undertaken under stage II, the costs of the programme for implementation, monitoring, and follow-up was adjusted to US $463,316.

Revised overall phase-out and cost of the HPMP stage II

63. As submitted, stage II would phase-out HCFC-141b in the foam and fire protection sectors, and the Government would ban the use of HCFC-141b for those sectors by 2020. Noting that starting in 2015, the only consumption of HCFC-141b would be in those sectors, the Secretariat proposed that the Government of Colombia ban all uses and import of HCFC-141b by 2020, allowing the remaining 17.55 ODP tonnes of remaining eligible HCFC-141b to be deducted. The Government agreed to ban all uses and imports of HCFC-141b by 2020. However, the Government wishes to discuss with the Executive Committee whether to deduct the remaining eligible consumption of HCFC-141b in light of the agreed ban.

64. In light of the additional reductions to be achieved under the foam sector programme associated with the non-eligible projects, and the revised activities agreed to under stage II, the Government would phase-out a total of 104.75 ODP tonnes. Combined with the reductions funded under stage I, this represents a reduction of 183.66 ODP tonnes from Colombia's starting point for sustained aggregate reductions. Colombia's remaining eligible consumption after stage II would be 18.5 per cent of its baseline. In light of these reductions, the Government of Colombia proposed to commit to a reduction of 60 per cent below its baseline by 2020 and 65 per cent below its baseline by 2022. Noting that the Colombia's remaining eligible consumption after stage II would only be 18.5 per cent, the Secretariat invited the Government of Colombia to consider a more ambitious commitment by 2022.

65. Under stage II, the Government would ban HCFC-141b for all uses by 2020. In addition, the Government would ban the use of HCFC-141b in the fire protection sector by 31 December 2017. Finally, the Government agreed to ban the manufacture and import of HCFC-22 split-system air-conditioning equipment by 31 December 2022. Detailed activities and costs are shown in the table below. The Secretariat notes that, in light of the 2020 ban on all uses and imports of HCFC-141b, an additional 17.55 ODP tonnes of HCFC-141b could be deducted from Colombia's remaining HCFC-141b eligible consumption. Doing so would bring the cost effectiveness of Colombia's stage II HPMP to US $3.47/kg.

Table 8. Overall agreed phase-out and cost of stage II of the HPMP for Colombia

Description	HCFC-22 (mt)	HCFC-141b (mt)	Total cost (US $)	CE (US $/kg)
PU foam enterprises				
Sub-total foam enterprises		72.36	646,782	8.94
System houses				
Subtotal foam system house		161.53	1,770,346	10.96
Non-eligible projects		433.92	0	0.00
Subtotal foam sector		667.81	2,417,128	3.62
RAC servicing sector				
Subtotal	351.16	0.00	1,685,576	4.80
Fire protection sector				
Subtotal		61.60	75,900	1.23
Regulatory activities				
Sub-total	94.70	0.00	454,560	4.80

Description	HCFC-22 (mt)	HCFC-141b (mt)	Total cost (US $)	CE (US $/kg)
Total	**445.86**	**729.41**	**4,633,164**	**3.94**
Project management			463,316	
Total cost of stage II			**5,096,481**	

Impact on the climate

66. The conversion of the remaining PU foam manufacturing enterprises in Colombia would avoid the emission into the atmosphere of some 167 thousand tonnes of CO_2 equivalent per year, as shown in Table 9. The technology to which the non-eligible enterprises will convert is unknown and was therefore not included.

Table 9. Impact on the climate PU foam projects

Substance	GWP	Tonnes/year	CO_2-eq (tonnes/year)
Before conversion			
HCFC-141b	725	233.9	169,567
Total before conversion			**169,567**
After conversion			
Cyclopentane, HFO, water	~20	132.3	2,645
Impact			**(166,922)**

67. The 61.6 mt of HCFC-141b (44.6 thousand tonnes of CO_2 equivalent) to be phased out in the fire protection sector are expected to be replaced by an equivalent quantity of HCFC-123 (7.4 thousand tonnes of CO_2 equivalent), resulting in a net climate benefit or around 37 thousand tonnes of CO_2 equivalent per year. In addition, the proposed technical assistance activities and activities in the servicing sector, which include training and assistance to reduce leakage rates and to facilitate the adoption of low-GWP alternatives in Colombia, would reduce the amount of HCFC-22 used for refrigeration servicing. Each kilogram of HCFC-22 not emitted due to better refrigeration practices results in the savings of approximately 1.8 CO_2 equivalent tonnes.

2015-2017 business plan of the Multilateral Fund

68. UNDP, UNEP and Germany are requesting US $5,096,481, plus agency support costs, for the implementation of stage II of the HPMP (2015-2020). The total funding requested for stage II in the business plans for UNDP, UNEP and Germany is US $6,312,000.

Draft Agreement

69. At the time of finalizing this document, the draft Agreement between the Government and Colombia and the Executive Committee was being finalized through discussions with UNDP, on behalf of the Government of Colombia. The outcome of those discussions will be communicated via an addendum to this document prior to the 75th meeting.

RECOMMENDATION

70. The Executive Committee may wish to consider:

(a) Noting:

(i) The progress report on the implementation of the third and final tranche of stage I of the HCFC phase-out management plan (HPMP) for Colombia;

(ii) That the Government of Colombia has committed to reduce HCFC consumption by 60 per cent in 2020 and 65 per cent in 2022;

(iii) That the Government of Colombia would ban the use of HCFC-141b in the fire protection sector by 31 December 2017;

(iv) That the Government of Colombia would ban the manufacture and import of HCFC-22 split-system air-conditioning equipment by 31 December 2022;

(b) Deducting 104.75 ODP tonnes of HCFCs from the remaining eligible consumption, including 12.3 ODP tonnes of HCFC-141b contained in exported pre-blended polyols in accordance with decision 68/42(b);

(c) [Deducting a further 17.55 ODP tonnes of HCFC-141b from Colombia's remaining eligible consumption]; and

(d) Approving in principle, stage II of the HCFC phase-out management plan (HPMP) for Colombia with the levels of funding as reflected in the Agreement, which is forthcoming and will be communicated with the Executive Committee prior to the 75th meeting.

PROJECT EVALUATION SHEET – NON-MULTI-YEAR PROJECT

COLOMBIA

PROJECT TITLE(S)	BILATERAL/IMPLEMENTING AGENCY
(a) Demonstration of HC-290 (propane) as an alternative refrigerant in commercial air-conditioning manufacturing at Industrias Thermotar ltda	UNDP

NATIONAL CO-ORDINATING AGENCY	National Ozone Unit

LATEST REPORTED CONSUMPTION DATA FOR ODS ADDRESSED IN PROJECT

A: ARTICLE-7 DATA (ODP TONNES, 2014, AS OF OCTOBER 2015)

HCFCs	156.03

B: COUNTRY PROGRAMME SECTORAL DATA (ODP TONNES, 2014, AS OF OCTOBER 2015)

HCFC-22	67.4
HCFC-123	2.1
HCFC-141b	86.3
HCFC-142b	0.3

HCFC consumption remaining eligible for funding (ODP tonnes)	146.63

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

PROJECT TITLE:	
ODS use at enterprise (ODP tonnes):	0.73
ODS to be phased out (ODP tonnes):	0.73
ODS to be phased in (ODP tonnes):	n/a
Project duration (months):	18
Initial amount requested (US $):	500,000
Final project costs (US $):	
Incremental capital cost:	681,000
Contingency (10 %):	68,100
Incremental operating cost:	114,660
Total project cost:	863,760
Local ownership (%):	n/a
Export component (%):	n/a
Requested grant (US $):	500,000
Cost-effectiveness (US $/kg):	n/a
Implementing agency support cost (US $):	35,000
Total cost of project to Multilateral Fund (US $):	535,000
Status of counterpart funding (Y/N):	Y
Project monitoring milestones included (Y/N):	Y

SECRETARIAT'S RECOMMENDATION	For individual consideration

PROJECT DESCRIPTION

71. On behalf of the Government of Colombia, UNDP as the designated implementing agency has submitted to the 75th meeting a request for funding a demonstration project of HC-290 (propane) as an alternative refrigerant in commercial air-conditioning manufacturing at Industrias Thermotar ltda in the amount of US $500,000, plus agency support costs of US $35,000.

72. At the 74th meeting, the Executive Committee considered the requests for preparation of projects to demonstrate low global warming potential (GWP) technologies and feasibility studies on district cooling pursuant to decision 72/40. At the same meeting, the Executive Committee agreed to allow the submission of additional projects for the air-conditioning manufacturing sector. This project is submitted in line with decision 72/40[5] and decision 74/21(d)[6]. The proposal is contained in Annex II to the present document.

Project description

73. Consumption of HCFC-22 in Colombia for manufacturing of commercial air-conditioning equipment is equivalent to approximately 3 per cent of the total HCFC-22 consumption in the country.

Objectives

74. The project objectives are to:

(a) Demonstrate the safe use of HC-290 (propane) as a low-GWP refrigerant in the commercial air-conditioning manufacturing sector with ranges between 3.5 kW (one tonne of refrigeration) and 17.5 kW (five tonnes of refrigeration);

(b) Explore and facilitate the possibility of manufacturing HC-based air-conditioner equipment with good performance and minimum incremental operating cost; and

(c) Demonstrate the safe handling and proper risk management for the introduction of flammable refrigerants in the commercial air-conditioning sector in Colombia, to encourage possible adoption in other Article 5 countries.

Methodology

75. The demonstration project will be implemented with Industrias Thermotar ltda (Thermotar), the largest manufacturer of HCFC-22-based condensing units for air-conditioning systems and packaged type air-conditioning equipment in the country, and will include the following activities:

(a) Modifying the product design, safety testing, risk analysis, risk assessment and third party approvals where relevant;

(b) Constructing a prototype taking into account the controllers, and electrical components, refrigerant circuit design, prototype development and testing;

(c) Converting the production line through acquisition and installation of a leak proof system (leak testing equipment); a storage station and feeding line for HC charging, a charging

[5] The Executive Committee decided *inter alia* to consider at its 75th and 76th meetings proposals for demonstration projects for low-GWP alternatives to HCFCs within the framework established, and provided criteria for such projects.

[6] The Executive Committee decided, *inter alia*, to allow the submission of additional requests for the preparation of projects to demonstrate low-GWP technologies in the air-conditioning manufacturing sector.

station for HC and a leak testing system for HC-charged equipment, including safety equipment necessary for the manufacturing process, and a safety audit will; and

(d) Training and qualification of service staff to ensure the safe handling and management of HC refrigerant.

76. A technical report will be prepared to describe the activities undertaken, lessons learned, and approaches to replicate the technology in other enterprises in the country and the region. It is expected that the results will allow for replication in other Article 5 countries. Two workshops to promote the replicability of this technology in other enterprises will be held; one at a local level with the participation of the other refrigeration and air-conditioning (RAC) manufacturing enterprises and interested end-users, and the second at a regional level, where RAC manufacturers will be invited.

77. The demonstration project is expected to result in the phase-out of 0.73 ODP tonnes (13.27 mt) of HCFC-22 at Thermotar, thereby contributing to the overall phase-out of HCFCs in the country under stage II of the HCFC phase-out management plan (HPMP) that has been submitted to the 75th meeting.

Project budget

78. The estimate cost of the project as proposed is US $863,760. The enterprise would provide counter-part funding of US $363,760 bringing the cost to the Multilateral Fund of the project to US $500,000.

Table 1. Proposed project costs

Description	Cost (US $)
International expert (controllers and electrical components, refrigerant circuit design)	50,000
Product design modifications, safety testing, risk analysis, risk assessment and third party approvals	35,000
Construction and testing of a prototype	30,000
HC charging unit station, valve box, drop box, vacuum re-process (production line), a leak proof testing system for equipment to be charged with HC, a storage station and feeding line, and a leak testing system for already HC charged equipment	330,000
Safety systems for production lines	50,000
Training and start-up equipment already in production line	13,000
Training for installation and service technicians for end-users	22,000
National consultant for monitoring of project development	50,000
International expert	35,000
Safety audit	30,000
Two workshops for dissemination of results	36,000
Contingencies (10 %)	68,100
Sub-total	749,100
Operating costs	114,660
Total	**863,760**

SECRETARIAT'S COMMENTS AND RECOMMENDATION

COMMENTS

79. The conversion at Thermotar was originally submitted as a component stage II of the HPMP for Colombia. In light of other activities in stage II, the cost-effectiveness of the project, and that commercial HC-290 air-conditioning equipment in the 3.5-17.5 kW range is not in production and that thus this conversion may be more appropriately considered a demonstration project, the Government of Colombia

decided to remove it from stage II and submit it for the Committee's consideration in accordance with decision 74/21(d).

80. Successful implementation of this project would be an advance in technology and would enable the introduction of a low-GWP alternative to a sector that is otherwise converting to HFC-410A. Stage II of Colombia's HPMP includes activities for the development and the establishment of regulations and standards for flammable refrigerants and online log book in the air-conditioning servicing sector that would complement this conversion by allowing for the use and servicing of HC-290 equipment.

81. The majority of the equipment manufactured by the enterprise has a cooling capacity below 5 tonnes of refrigeration. The refrigerant charge used for such equipment ranges from 1 to 5 kg of HCFC-22. It is expected that these units would have an HC-290 charge between 0.5-2.0 kg. A very small number of units with a charge size between 2-2.8 kg of HC-290 might also be manufactured.

82. The Secretariat noted that all units would require some re-design given the conversion to HC-290 and that units with a charge size greater than 2 kg would require major re-design, and inquired whether energy efficiency would be addressed under that re-design. UNDP indicated that Thermotar has considered further optimizing the design in order to improve energy efficiency with its own funding.

83. Two dissemination workshops are planned, one focused on stakeholders in Colombia and the other for the region. Information generated on the design and engineering would be made available, which could benefit other manufacturers in the region. The Secretariat recalls that a similar demonstration project in the Philippines with likely broader replicability was submitted but then subsequently withdrawn from the 74th meeting.

Conclusion

84. The Executive Committee may wish to consider approval of this project in light of the guidelines and other projects being considered under the allocated window of US $10 million for this purpose.

RECOMMENDATION

85. The Executive Committee may wish to consider:

(a) The demonstration project of HC-290 (propane) as an alternative refrigerant in commercial air-conditioning manufacturing at Industrias Thermotar ltda in the context of its discussion on proposals for demonstration projects for low-global warming potential (GWP) alternatives to HCFCs as described in the document on the overview of issues identified during project review (UNEP/OzL.Pro/ExCom/75/27);

(b) Approving the demonstration project of HC-290 (propane) as an alternative refrigerant in commercial air-conditioning manufacturing at Industrias Thermotar ltda in the amount of at the amount of US $500,000, plus agency support costs of US $35,000 UNDP; and

(c) Deducting 0.73 ODP tonnes (13.27 mt) of HCFC-22 from Colombia's remaining eligible consumption.

Annex I

COUNTRY: Colombia **IMPLEMENTING AGENCY:** UNDP

PROJECT TITLE: Demonstration project to validate the use of Hydrofluoro Olefins (HFO) for discontinuous panels in Article 5 parties through the development of cost effective formulations

PROJECT IN CURRENT BUSINESS PLAN	
SECTOR	Foam
SUB-SECTOR	Rigid PU (discontinuous panels)
ODS USE IN SECTOR (2014)	668 metric tons (HCFC-141b)
ODS USE AT ENTERPRISE (2014)	120.6 MT of HCFC-141b
PROJECT DURATION	12 months
TOTAL PROJECT COST:	
Incremental Capital Cost	US $ 304,800
Contingency	US $ 30,480
Total Project Cost	US $ 335,280
LOCAL OWNERSHIP	100%
EXPORT COMPONENT	0 % to non-A5
REQUESTED GRANT	US $ 282,480
COST-EFFECTIVENESS	Non applicable
IMPLEMENTING AGENCY SUPPORT COST	US $ 19,774
TOTAL COST OF PROJECT TO MULTILATERAL FUND	US $ 302,254
STATUS OF COUNTERPARTS FUNDING	Received letter of commitment Included
NATIONAL COORDINATING AGENCY	Ministry of Environment - National Ozone Unit

Project summary

This project undertakes the validation of the Hydrofluoro Olefins (HFOs), a low GWP and non-flammable option, for discontinuous panels in the scenario of the Article 5 parties through the development of polyurethane (PU) foam formulations with reduced HFO contents that have CO_2, derived from the water-isocyanate reaction, as co-blowing agent. The aim is to optimise the cost/performance balance while achieving a similar foam thermal performance to that of HCFC-141b based formulations.

Impact of project on Country's Montreal Protocol Obligations

The project aims to contribute to the country obligation to reduce the HCFC consumption as per the Montreal Protocol obligation by converting the current HCFC-141b foam blowing technology to the HFO based formulations. The Colombian discontinuous panels subsector used 98.5 tonnes of HCFC-141b in 2014. With the results of this project, a significant portion of this HCFC-141b consumption would be replaced by this technology during the second stage of the HPMP. A direct impact of this project is the conversion of ABC Poliuretanos, 5.2 tonnes of HCFC-141b, in the mentioned second stage.
The results of this project would be applicable not only for the discontinuous panels subsector but the principles would also apply to other foam applications in Colombia and other developing countries.

Prepared by: Mr Miguel W. Quintero Date: September 11, 2015

1. BACKGROUND

1.1. PROJECT BACKGROUND

This project has been prepared as response to the Executive Committee Decision 72/40. It is part of a set of projects with the objective to validate chemical systems for use with non-HCFC blowing agents in the context of Decision XIX/6.
The developing countries will address in the short term the second phase of the HPMP (2015-2020) in the foam sector. One of the most critical subsectors that still uses HCFC-141b and accounts for a significant market portion is the manufacture of **discontinuous panels** for the construction and the commercial and industrial refrigeration industries. It is characterized by a great number of small and medium enterprises without the sufficient knowledge and discipline to handle flammable substances. This factor along with the lack of economies of scale prevents the adoption of hydrocarbons and the introduction of high GWP alternatives such as HFCs would result in a negative climate impact.
This projects undertakes the validation of the Hydrofluoro Olefins (HFOs), a low GWP and non-flammable option, for discontinuous panels in the scenario of the Article 5 parties through the development of polyurethane (PU) formulations with reduced HFO contents that have CO_2, derived from the water-isocyanate reaction, as co-blowing agent. The aim is to optimise the cost/performance balance while achieving a similar foam thermal performance to HCFC-141b based formulations.
Further, the project aims to contribute to the country obligation to reduce the HCFC consumption as per the Montreal Protocol obligation by converting the current HCFC-141b foam blowing technology to the HFO based formulations. The Colombian discontinuous panels subsector used in 2014 98.5 tonnes of HCFC-141b. With the results of this project, a significant portion of this HCFC-141b consumption would be replaced by this technology during the second stage of the HPMP.

It is important to note that the results of this project would be applicable not only for the discontinuous panels subsector but the principles would also apply to other foam applications in Colombia and other developing countries. Therefore, the results should be seen in a broader perspective.

1.2. SECTOR BACKGROUND IN COLOMBIA

Colombia became a party to the Vienna Convention and Montreal Protocol on October 16, 1990 and on March 6, 1994 respectively. Colombia also ratified the London, Copenhagen, Montreal and Beijing Amendments. The country is fully committed to the phase-out of HCFCs and willing to take the lead in assessing new HCFC phase-out technologies, particularly in the foam sector.

The Colombian PU market can be spread out in three different industrial sectors: flexible foam (flex-slab and moulded and integral skin), rigid foam and microcellular elastomers (shoe soles). HCFCs are used in rigid foam for thermal insulation and, in marginal quantities, in integral skin.

In PU rigid foam three different segments can be differentiated: domestic refrigeration (refrigerators and freezers), commercial refrigeration (mainly bottle and commercial displays) and industrial thermal insulation for the refrigeration and construction sectors (continuous and discontinuous panels, transportation and spray). While the domestic refrigeration and most of the commercial refrigeration have been converted to hydrocarbons the remaining market players still use HCFC-141b. The main suppliers are local “system houses” (Espumlatex, GMP, Olaflex,

Química Industrial y Comercial) that sell two-component systems: a fully formulated polyol, which includes the blowing agent (HCFC-141b), and an isocyanate (Polymeric MDI).
A recent market survey showed that in 2014 out of a total of 784.25 tonnes of imported HCFC-141b, 668 were used in foam manufacture. Table 1 shows the distribution by application. Discontinuous panels account for 15% of the total HCFC-141b consumption.

TABLE 1. 2014 USE OF HCFC-141b IN THE COLOMBIAN FOAM MARKET		
Foam Application	HCFC-141b, kg	%
Commercial Refrigeration	66,390	9.94%
Continuous Panels	80,920	12.12%
Industrial Refrigeration & Construction (Discontinuous Panels)	98,589	14.76%
Spray	51,958	7.78%
Integral Skin	3,428	0.51%
Polyol formulation	366,495	54.89%
TOTAL	667,780	100.0%

Source: Imports Declarations, Database of the Ministry of Commerce, Industry and Tourism. Personal interviews with key market players (system houses and end users)

2. PROJECT DESCRIPTION

2.1. PROJECT OBJECTIVES

The objectives of this project are:

1. To validate the use as foam blowing agents of the recently developed HFOs in blends with CO_2 for the production of discontinuous panels in the context of an Article 5 party. The aim is to optimise the HFO/CO_2 ratio in the cell gas to get a similar thermal performance to HCFC-141b at a minimum incremental operating cost. The results of this project would be applicable not only for the discontinuous panels subsector but the principles would also apply to other foam applications in Colombia and other developing countries.
2. To make a cost analysis of the different HFO/CO_2 formulations versus the currently used HCFC-141b based system.

2.2. JUSTIFICATION

The Article 5 parties are in the process of preparing the second stage of the HPMPs to be implemented in the 2016-2020 period. Taking into account the priorities defined in Decision XIX/6, particularly those referred to ODP and climate change impact, the developing countries opted for converting in the first phase (2011-2015) the largest foam enterprises typically found in the domestic refrigeration and continuous panels sectors. Hydrocarbons, basically pentanes, were the substances of choice based on their favourable cost/performance balance at large size operations.
Situation is different at the second stage where the countries have to address the remaining foam sectors still using HCFCs. These sectors (discontinuous panels, spray, integral skin) are characterised by a multitude of micro, small and medium size enterprises that do not have the

adequate knowledge and operating discipline to handle flammable substances in a safe manner. This factor along with the lack of economies of scale prevents the adoption of flammable blowing agents, while the introduction of high GWP alternatives such as HFCs results in high climate impact within processes which are typically less well engineered.

The recent developed unsaturated HFCs and HCFCs (commonly called HFOs), 1233zd(E) and 1336maam(z), marketed under the trademarks Forane (Arkema), Formacel (DuPont) and Solstice (Honeywell), have shown in rigid PU foam applications such as domestic refrigeration and spray a better thermal performance that the high GWP-saturated HFCs currently used in the developed countries. Their general properties are shown in table 2. They offer a unique opportunity for introducing safe non-flammable technologies that while enhancing energy efficiency will have a positive effect on climate change in terms of greenhouse emissions. Based on the physical properties of these substances (non flammability and relatively high boiling points) it is anticipated that their application does not require the retrofit of the foaming equipment currently in use. This is particularly true and important at the level of small and medium enterprises. Commercial availability has already been established for HFO-1233zd(E). Pilot scale production of HFO-1336mzzm(Z) commenced in late 2014, with full commercialisation expected in 2016. Although for these options availability is likely to be targeted mostly in markets within non-Article 5 Parties where the requirement for improved thermal efficiency is best identified, the demand to leapfrog high GWP alternatives to HCFCs could accelerate distribution to Article 5 regions. There are not legal or commercial barriers for the introduction of these products.

TABLE 2. HFO PROPERTIES

	Formacel® 1100	***Solstice® Liquid BA***	***Forane® 1233zd***
Common name	1336mzz(Z)	1233zd(E)	1233zd(E)
Chemical Formula	Cis-CF_3-CH=CH-CF_3	Trans-ClCH=CH-CF_3	Trans-ClCH=CH-CF_3
Molecular weight	164	130.5	130.5
Boiling Point (°C)	33	19	19
GWP (100 years	2	1	<7

From the three market sectors mentioned above, the discontinuous panels application was chosen for the development of this project taking into consideration the high volume involved. According to the last FTOC assessment report (2010), in 2008 around 7,300 tonnes of CFCs and HCFCs were used in the discontinuous panels subsector in the developing countries.

Two are the main barriers for the introduction of these substances:

1. Their high unitary cost that is reflected in the final cost of the PU formulation.
2. The minimum experience with these products in developing country conditions. This technology has not been demonstrated in conditions prevailing in Article 5 parties.

The main objective of this project is precisely to remove or attenuate the mentioned obstacles. The formulation science associated to the PU technology and the excellent foam thermal characteristics provided by HFOs open the door for the development of PU formulations with reduced HFO contents that have CO_2, derived from the water-isocyanate reaction, as co-blowing agent. The aim is to optimise the cost/performance balance of these substances, achieving a similar foam thermal behaviour to HCFC-141b at the lowest possible cost, and, simultaneously, to carry out a comprehensive assessment of the HFO performance at developing countries conditions. The project will be conducted at Espumlatex, a recognised local system house equipped with the required injection and testing laboratory facilities, and a field test with selected formulations will be done at ABC Poliuretanos, a typical small manufacturer of discontinuous panels.

2.3. METHODOLOGY

With the aim of analysing the two HFO molecules, 1233zd(E) from Honeywell or Arkema and 1336maam(z) from Chemours, in comparison with HCFC-141b, six steps are contemplated for the project development:

1. PLANNING. A statistical experimental design (DOE) will be designed having as factors (or independent variables) the type of molecule and the composition of the cell gas (mole fraction of the physical blowing agent). The responses (or dependent variables) will be the foam properties critical for this application (Lambda value, compression strength, dimensional stability, friability). A commercial HCFC-141b based formulation will be used as control.
2. FORMULATION DEVELOPMENT. The resulting formulations will be prepared at laboratory scale and injected with a conventional high-pressure dispenser. Catalysis and overall blowing agent amounts will be adjusted to have among formulations a similar reactivity and free-rise density. A typical Brett or Lance mould with temperature control will be used to manufacture the panels to test the foam properties. Samples for testing will be done by duplicate.
3. TESTING. The critical immediate and aged foam properties for this application (Lambda value, compression strength, dimensional stability, friability) will be tested following ASTM or ISO standard procedures.
4. ANALYSIS OF RESULTS: foam performance and formulation cost. A detailed analysis of the resulting foam properties at different HFO levels and the associated formulation cost will be carried out. A typical HCFC-141b formulation will be used as standard.
5. FIELD TEST. A field test with selected formulations will be done at ABC Poliuretanos, a small manufacturer of discontinuous panels with typical market characteristics.
6. TECHNOLOGY REPLICATION/DISSEMINATION OF RESULTS. One of the critical outcomes of a demonstration project is the definition of the possibility to replicate the technology in other enterprises, in other regions and in other applications. In the case of HFOs, having in mind that the main barrier for their introduction is the associated formulation cost, it is anticipated that if results are positive and an adequate cost/performance balance is achieved, there is a great potential for the technology to be replicated in other system houses in the country, in Latin America and other regions, and even in other applications such as commercial refrigeration and spray. To assure this, it is planned to conduct two workshops, a first one at local level with the participation of the other Colombian system houses (GMP, Olaflex, Química Industrial y Comercial) and interested end users, and a second one at regional level, where regional system houses, importers and end users will be invited. It is important to note that all the Colombian and several Latin American system houses have shown interest in these products. In addition to the seminars, a detailed technical report will be written with the results of the project. Information on the performance of the HFOs at different mole fractions in the cell gas along with the associated formulation cost (incremental operation cost compared to HCFC-141b) will be delivered. It will serve as starting point for the other system houses to design/develop appropriate HFO based formulations.

2.4. INFORMATION ON PARTICIPATING COMPANIES

Espumlatex

Espumlatex was established in 1959 to serve the automotive industry in Colombia as the main supplier of PU based materials: RIM and sound insulation parts and flex moulded foam for car seats. Throughout all these years it became the leader of PU suppliers in the Andean countries

with annual sales of 52 million dollars in 2008. It is certified QS9000/ISO9000, EAQF level Q1 status, ISO14000.

At the end of the eighties Espumlatex expanded its activities to formulate PU systems for the manufacture of thermal insulating and integral skin foams. Its current capacity is estimated in 500 MT per month with an annual current production of 4,000 MT of PU systems, from which 2,000 MT are dedicated to rigid foam materials. 15 % of their PU systems production is exported to Ecuador, Peru and Venezuela. Additional to PU systems they manufacture PU rigid foam sheets for insulation purpose in a process that involves the production of large foam blocks and their subsequent cutting.

The system house production facilities are equipped with 18 blending tanks with capacities that go from 1,500 to 3,000 l. They have mechanical agitation, recirculation and a direct feeding system from the raw materials drums as well as a closed pumping system for raw materials loading. The basic properties of the PU systems (free rise density, reactivity, foam thermal conductivity, compression strength, dimensional stability and accelerated aging) are tested in a certified quality control laboratory.

The consumption of chemicals for the PU systems sold for the manufacture of discontinuous panels during the last 5 years was:

Table 3. Consumption of PU chemicals for Discontinuous Panels at Espumlatex, tonnes

Substance	**2009**	**2010**	**2011**	**2012**	**2013**
Polyol	327	381	425	423	462
HCFC-141b	82	96	107	106	115
Polymeric MDI	445	518	578	575	628
TOTAL	854	995	1,110	1,104	1,205

During the transition from CFC-11 to HCFCs the following two projects were carried out with Espumlatex:

- The project COL/FOA/32/INV/49, "Retroactive funding for the conversion from CFC-11 to water-based technology in the manufacture of flexible molded and integral skin foam at Espumlatex-Promicolda", retroactively funded one of the Espumlatex´ divisions, Promicolda, for the conversion from CFC-11 to water and HCFC-141b based technologies in the manufacture of flexible molded and integral skin foam respectively. Promicolda is the Expumlatex´ division that manufactures the car seats and several parts based on integral skin foam for the automotive industry in the Andean Countries. The grant received by Promicolda was US$ 82,020.00.
- The project COL/FOA/32/INV/48, "Conversion from CFC-11 to HCFC-141b and water based technology in the manufacture of various polyurethane foam applications at 25 small enterprises centred around their systems house Espumlatex", was an umbrella project where 25 SMEs -centred around Espumlatex as the system house- were successfully converted from CFC-11 to HCFC-141b and water based technologies. Total cost of the project was US$ 332,768.00. Espumlatex received funds for the project administrative expenses and a laboratory equipment (one K factor indicator not suitable to measure lambda values at different temperatures).

Espumlatex also served in 2011-2013 as the local system house host for the demonstration project on Supercritical CO_2 technology for spray foam undertaken under a Japan-Colombia bilateral with Achilles Corp.

The company is fully committed to test new HCFC alternatives of low GWP and has the required capability (laboratory facilities, technical knowledge and human resource). Its contribution to the project has been quantified in US$ 52,800 (see table 5).

3. PROJECT IMPLEMENTATION MODALITY

Project will be implemented by UNDP as an executing agency. Relevant activity such as equipment procurement, recruitment of experts, foam testing will be arranged under the UNDP Financial Rule and Regulation.

The following activities will be executed:

- Work arrangement with local System House to be signed between UNDP and the beneficiary as well as the National Ozone Unit (NOU).
- Development of the experimental protocol which includes application procedure and conditions, properties to test, testing methods etc.
- Formulation development and foam sample preparation to be done at Espumlatex laboratory facilities using a high-pressure dispenser and a conventional Brett mould. Procurement of a laboratory equipment to measure foam friability. This foam property is considered critical having in mind the high urea content typical of PU high water formulations.
- Testing of foam critical immediate and aged properties such as thermal conductivity, compression strength, dimensional stability and friability.
- Conduction of a field test at ABC Poliuretanos, a local discontinuous panels manufacturer.
- Delivery of two dissemination workshops to the Colombian and Latin American industry.

Project implementation time schedule

Table 4. Project Implementation Time Schedule

ACTIVITY	2015	2016			
	Q4	Q1	Q2	Q3	Q4
Approval	*				
Grant transfer to UNDP		*			
Work Arrangement between UNDP and beneficiary		*			
Detailed project planning. Development of experimental protocol		*			
Import of HFO samples		*			
Procurement & delivery of equipment to measure friability		*	*		
Formulation Development		*	*	*	
Foam testing		*	*	*	
Analysis of results: performance versus cost				*	
Field testing at a local discontinuous panels manufacturer					*
Dissemination workshops					*
Reporting & Final review					*

4. PROJECT BUDGET

The summary of the project cost is as follows:

Table 5. Project cost by activity						
Activity	**Specification or detail**	**Unit cost, US$**	**Quantity**	**Total Cost US$**	**Espumlatex contribution US$**	**MLF US$**
International technical assistance		30,000	1	30,000		30,000
Planning	Participation of Espumlatex, National Ozone Unit (NOU) and international consultant	5,000	1	5,000		5,000
Formulation Development	Estimated that one man year effort of a qualified engineer and lab technician are required	110,000	1	110,000	36,000	74,000
Acquisition of Friability tester		10,000	1	10,000		10,000
Foam Testing	It is anticipated that around 120 foam samples (5x3x4x2) x2 will be tested for lambda, value, compression strength, dimensional stability and friability			30,000	10,000	20,000
PU material for formulation development	Estimated that 60 kg of PU system (US$ 4/kg) are required for each trial	240	20	4,800		4,800
PU material for field testing	Estimated that 1000 kg (4 drums) are required	4	1,000	4,000		4,000
Foam testing - Field evaluation	Resulting foam will be tested for lambda, value, compression strength, dimensional stability and friability	5,000	1	5,000	2,000	3,000
Technology Dissemination Workshops	For Colombian industry and Latin American countries		2	40,000		40,000
Local Consultant	Technical support to project implementation.	36,000	1	36,000		36,000
Project monitoring & reporting		30,000	1	30,000		30,000
Sub-total Incremental Capital Cost				304,800	48,000	256,800
Contingencies (10%)				30,480	4,800	25,680
Total Cost				335,280	52,800	282,480

Notes:

Formulation Development: The formulations will be prepared at Espumlatex laboratory facilities by company personnel.

Provision of equipment: The project plans to acquire a laboratory equipment to measure foam friability according to ASTM test.

Foam testing: All the foam properties will be determined at Espumlatex laboratory facilities by company technicians.

Dissemination workshop: Cost to organize the dissemination workshops is included. Two workshops will be organized, both in Colombia, a first one for the local industry and a second one for Latin America.

Annex II

COUNTRY: Colombia **IMPLEMENTING AGENCY:** UNDP

PROJECT TITLE: Industrias Thermotar Ltda. – Demonstration project for the use of R-290 (propane) as an alternative refrigerant in the commercial air conditioning manufacturing with ranges between 3.5 kW (1 ton of refrigeration) and 17.5 kW (5 tons of refrigeration), contributing to the elimination of HCFC-22 use in this RAC subsector.

PROJECT IN CURRENT BUSINESS PLAN	
SECTOR	Air conditioning and refrigeration manufacture
SUB-SECTOR	Commercial air conditioning manufacture
ODS USE IN SECTOR (2014)	40 metric tonnes (HCFC-22)
ODS USE AT ENTERPRISE (2014)	13.27 metric tonnes of HCFC- 22
PROJECT DURATION	18 months
Incremental Capital Cost	US $ 681,000
Contingency	US $ 68,100
Incremental Operating Cost	US $ 114,660
Total Project Cost	US $ 863,760
COST-EFFECTIVENESS	Non applicable
GRANT REQUESTED	US$ 500,000
IMPLEMENTING AGENCY SUPPORT COST	US $ 35,000
TOTAL COST OF PROJECT TO MULTILATERAL FUND	US $ 535,000
STATUS OF COUNTERPARTS FUNDING	Received letter of commitment Included
NATIONAL COORDINATING AGENCY	Ministry of Environment - National Ozone Unit

Project summary

This project seeks to demonstrate the safe use of HC as low GWP option for the manufacturing of commercial air-conditioning equipment that will be used in tropical areas of the Article 5 parties. It will be carefully considered modifications in different production operations such refrigerant storage stations, HC feed lines, vacuum stations, HC charging station and the design modifications that will be undertaken as well as unit testing. Moreover, training for operators and technical assistance to end users will be introduced to improve the complete framework of risk management.
A technical report will be submitted to the Executive Committee at the end of the demonstration project, and the results will be disseminated in a workshop organized by the NOU.

Impact of project on Country's Montreal Protocol Obligations

The project aims to contribute to the country obligation to reduce the HCFCs consumption as per the Montreal Protocol obligation by converting the current HCFC-22 to the hydrocarbons in commercial air conditioning sector. The condensing units and package type equipment, represent the major share of the market in the commercial air conditioning sector in Colombia. If the results are positive, a significant portion of the market that has migrated towards different types of

transition refrigerants such as R-410A which have increased the operational costs of production will be have an economic option. A direct impact of this project is the conversion of Industrias Thermotar Ltda. and the phase out of 0.73 ODP tonn (13.27 tons) of HCFC 22. In agreement with Decision XIX/6 this project applies proven non-ODS, low GWP technology 0.73 tons of HCFC 22 would eventually be phased-out and deducted from the starting point in Colombia.

Prepared by: **National Ozone Unit (UTO)** Date: **October 01, 2015**

TABLE OF CONTENT

Content **Page**

1. BACKGROUND

1.1. PROJECT BACKGROUND

Consumption of HCFC-22 in Colombia for manufacturing of commercial air conditioning equipment is equivalent to 3% of the total HCFC-22 consumption in the country (See annex 1). This corresponds to an average of 5,600 units manufactured per year. Designs of the currently manufactured equipment are developed for vertical and horizontal condensing units for air conditioning. The same happens for package type air conditioning equipment.

Considering that consumption of refrigerant HCFC-22 in Colombia for the manufacturing of commercial air conditioning equipment is significant for the development of stage II of HPMP, this demonstrative project seeks to demonstrate the use of R-290 (propane) as an alternative refrigerant in commercial air conditioning equipment, contributing to the elimination of HCFC-22 use in this RAC subsector.

The government of Colombia will address the main barriers associated with the use of hydrocarbon refrigerants, through of appropriate actions, involving training and certification of technicians, and the establishment of technical standards for the use of hydrocarbons as refrigerants under the Stage II HPMP (if approved as proposed).

This conversion will be carried out with Industrias Thermotar ltda. a factory that manufactures the largest proportion of the total volume of HCFC-22-based condensing units for air conditioning systems and packaged type air conditioning equipment in Colombia. The company also produces heat exchangers, metal-mechanics, electrical installations, furthermore, they execute assembly and installation of the condensing units.

This demonstrative project will reduce 0.73 ODP tonnes of HCFC (13.27 tonnes of HCFC-22 in 2014) used for the manufacturing of commercial air conditioning equipment in 2014. Each kilogram of HCFC-22 not emitted due to use of propane as new refrigerant results in the savings of approximately 1.8 CO_2-equivalent tons. A preliminary estimation of the impact on the climate indicates that about 23,867 CO_2-equivalent tonnes would not be emitted into the atmosphere per year.

1.2. SECTOR BACKGROUND IN COLOMBIA

The commercial air conditioning equipment manufacturing sector consumes in average 40 metric tonnes of HCFC-22. Currently designs are developed for the manufacturing of vertical and horizontal condensing units for air conditioning systems and for packaged type air conditioning equipment.

In regards to the market, the condensing units and package type equipment, represent the major share of the market in the commercial air conditioning sector in Colombia. Likewise, one segment has migrated towards different types of transition refrigerants such as R-410A which have increased the operational costs of production and the final cost of the equipment; therefore some manufacturing companies have maintained HCFC-22 as the refrigerant for manufacturing their air conditioning equipment. Manufacturing costs differ in 10.8% between the two equipment mentioned above, being more expensive R-410A units than the units with HCFC-22. (See annex 2)

Industrias Thermotar Ltda. is the factory that manufactures the largest proportion of the total volume of HCFC-22-based condensing units for air conditioning systems and packaged type air conditioning equipment, and their principal users are trade outlets and retails located in tropical areas.

The nominal cooling capacity of models are in ranges between 3.5 kW (1 ton of refrigeration) to 17.5 kW (5 tons refrigeration). The refrigerant charge used for such equipment ranges from 1 to 5 kg of HCFC-22.

Table 1 shows the total estimated amount of manufactured factory-charged condensing units and air conditioning equipment and the HCFC-22 consumption by Industrias Thermotar Ltda. during the last three years:

Table. 1 Manufactured equipment at Industrias Thermotar.

Year	Manufactured Equipment (Units)	HCFC-22 charged- (Kg.)
2014	2,415	13,267
2013	3,980	16,644
2012	5,905	24,694

The average output is 4,100 units per year, equivalent to an approximately 20 units per day. For the manufacturing line reconversion, capital investment would be required for unit testing, leak detection equipment, refrigerant storage stations, HC feed lines, vacuum stations, HC charging station, and training of operators, technical assistance for project implementation, and the safety audit. Likewise, there is an increase in operational costs due to the increase of fixed and variable costs in production plant, as they are related to power consumption and increases in raw materials.

It is worth highlighting that part of the national production is exported to Central and South American countries. Hence, developing a demonstration project could have environmental effect not only in Colombia, but also in the region through the wider use and consumption of environmentally friendly alternative refrigerants in commercial air conditioning equipment.

2. PROJECT DESCRIPTION

2.1. PROJECT OBJECTIVE

The objectives of this project are:

1. To demonstrate the safe use of R-290 (propane) as a low GWP refrigerant in the commercial air conditioning manufacturing with ranges between 3.5 kW (1 ton of refrigeration) and 17.5 kW (5 tons of refrigeration), contributing to the phase out of HCFC-22 use in RAC manufacturing sector in the context of an Article 5 Party. The aim is to develop HC based AC equipment with good performance with a minimum incremental operating cost.

2. To assure safe handling and good risk management for the introduction of flammable refrigerants in the commercial air conditioning sector in the context of an article 5 Party.

2.2. JUSTIFICATION

The Article 5 parties are in the process of preparing the second stage of the HPMPs to be implemented in the 2016-2020 period, considering the priorities defined in Decision XIX/6, which means that countries should work on eliminating the consumption of HCFC-22 in all consumer sectors, especially RAC, prioritizing its replacement by alternative low GWP.

The main current commercially available technology options for HCFC-22 replacement in air conditioners are limited to R-410A, HFC-32 and HC-290 (propane). Below, these refrigerants are briefly discussed regarding their main aspects:

R410A: R-410A is a refrigerant blend constituted by HFC-125 and HFC-32 (50%/50%), and has a GWP of 2100. Due to its better properties and performance than R-407C (initially adopted by [1]many companies for HCFC-22 replacement), R-410A has been considered in the last years as the main alternative to HCFC-22 by the air conditioning, chiller and heat pump industry. Regarding the safety, R-410A is categorized as an A1 refrigerant (lower toxicity, non-flammable).

Normally the efficiency is equivalent to R-22 or better, especially at lower temperatures. One problem presented by R-410A is the use at higher ambient temperatures. R-410A equipment has capacity and efficiency deterioration more rapidly than with HCFC-22. R-410A cost is approximately two to three times greater than HCFC-22 (UNEP, 2010).

The design of the R-410A equipment components is different because of the higher operating pressure.

HFC-32: R-32 is a single component refrigerant, originally used as a component of R-410A, R-407C, R-425A, R-439A and other refrigerant blends. It has a GWP of 675. Saturation pressure and capacity are around 1.5 times higher than HCFC-22 and similar to R-410A. It is classified as A2L (low toxicity, lower flammability). HFC-32 production capacity is already available, though commercial availability of cylinders is not yet common. (UNEP, 2014)

The efficiency of HFC-32 systems is similar to R-410A and the theoretical COP is a slightly better than R-410A. The capacity is a little higher (approximately~5%). Discharge temperatures are significantly higher than R-410A. Higher polarity of refrigerant makes necessary the use of new lubricant oils.

The direct cost of this refrigerant is lower than R-410A. The new lubricant oils and mitigation devices for high discharge temperature may add some cost. Although HFC-32 has low flammability, the required charge of such units is unlikely in the event of a leak into the room to reach concentration that can be ignited (UNEP, 2010[1]).

[1]UNEP, 2010 "2010 Report Of The Refrigeration, Air Conditioning And Heat Pumps Technical Options Committee"
[2]UNEP, 2014 Decision Xxv/5 Task Force Report Additional Information To Alternatives On ODS (Draft Report)

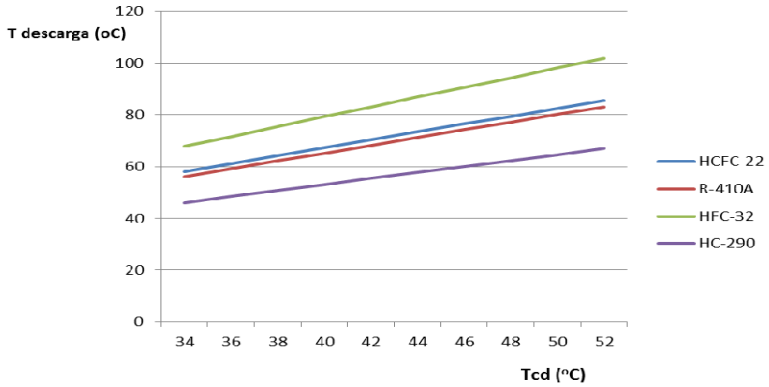
HC-290 (propane): Hydrocarbons, HC, refrigerants constituted by pure substances have been used commercially for decades. One of the hydrocarbon refrigerants that is expanding its use is HC-290 (propane). Having very good thermo-physical and transport properties, HC-290 provides good equipment efficiency (roughly the same COP than HCFC-22) and low discharge temperatures. HC-290 has GWP<3 and safety classification A3 (lower toxicity, higher flammability).

Hydrocarbon refrigerant can be cheaper than other refrigerants. Due to the flammability issue, additional costs are necessary for handling this characteristic in the design of the equipment. The magnitude of these costs is dependent upon the type of equipment and standards to be considered.

HC-290 has been used in portable air conditioners for many years and several companies are producing them. Several manufacturers are now newly developing other types of air conditioners with HC-290 (UNEP, 2014[2]).

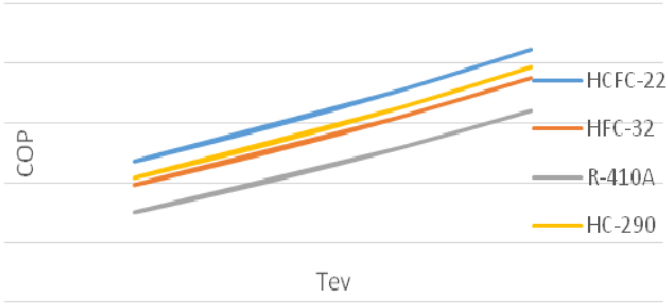
Figures 1 and 2 below present a comparison of the compressor discharge temperature and cycle COP for HCFC-22, R-410A, HFC-32 and HC-290.

Figure 1. Compressor discharge temperature



Vapor compression cycle with Tev = 5 °C, superheating = 5°C and isentropic efficiency = 0, 80

Figure 2. Theoretical cycle COP for HCFC-22, HFC-32, R-410A and HC-290.



Vapor compression cycle with Tcd = 48 °C, saturated vapor at compressor inlet, and isentropic efficiency = 0,80

According to the last data; the R-410A is an established technology and it is a class A1 refrigerant (lower toxicity, non-flammable), which means that there are no significant safety implications concerning its use. On the other hand, due to its higher GWP it has a higher negative direct climate impact, and it is starting to be regulated in some regions and countries.

HFC-32 is a possible alternative, it is starting to be used by some companies, mainly Japanese. It has a lower flammability and a medium GWP that may cause some restrictions in the future.

HC-290 is an attractive refrigerant offering good efficiency and cost implications. Due to its higher flammability, in order to be dealt with safely, there is a need to train technicians in good practices for handling flammable refrigerants.

Considering that direct impact (GWP) is not the only criterion to be used, it is also considered of upmost importance that the alternatives considered provide good energy efficiency, in order to minimize the indirect climate impact caused by systems energy (electricity) consumption.

In the process of phasing out HCFCs, the government of Colombia is committed to promote the introduction of low GWP alternatives, for the project development and the choice of technology it is fundamental that the company where the demonstration project will be implemented is alligned with this strategy. Based on former evaluations performed by the company, and the discussions regarding the options available, with experts involved in the project preparation, the company has chosen the use of the hydrocarbon refrigerant HC-290 for replacing the use of HCFC-22 in its models of air conditioners in this demonstration project. A proven and commercial available technology will be applied in the manufacturing of commercial air conditioning equipment with ranges between 3.5 kW (1 ton of refrigeration) and 17.5 kW (5 tons of refrigeration).

The main barriers associated with the use of HCs arise from its flammability. To deal with this aspect in an appropriate way, it is necessary considering other actions like training and certification of technicians, and the establishment of technical standards for the use of alternative refrigerants.

This demonstrative project will support two of the most important strategies for the reduction of the demand for HCFC in the manufacturing sector via industrial reconversion projects to introduce cero ODP and low GWP alternatives and to promote the introduction of low GWP RAC equipment, in order to limit the current growth of high GWP HFC based AC equipment.

The project will phase out 13.27 tons of HCFC-22 generating a positive impact to both the ozone layer protection and climate change. This environmental impact was calculated from the ozone depletion and global warming potentials of the different substances (ODP and GWP) (See annex 3).

2.3. METHODOLOGY

With the aim of implementing the demonstration project, for this conversion will be taken into account the technical considerations and the activities required for types of air conditioners manufactured.

A manufacturing line that currently use HCFC-22 will be converted in order to manufacture commercial air conditioning equipment with R-290 (propane).

The technical considerations and activities required for the demonstration project are described below.

For conversion of the manufacturing line of commercial air conditioning equipment using HCFC–22 to HC refrigerant, the following activities would be required:

- Design: Determination of product design modifications, safety testing, risk analysis, risk assessment and third party approvals where relevant.
- Testing: Construction of a prototype taking into account the controllers, and electrical components, refrigerant circuit design, prototype development and testing.
- Conversion of production line: Acquisition and installation of a leak proof system (leak testing equipment), a storage station and feeding line for HC charging, a charging station for HC and a leak testing system for HC-charged equipment. Acquisition and installation of a safety system for the refrigerant storage, charging, sealing and leak testing areas for HCs. This would include use of gas sensors, alarms, ventilation systems and appropriate controllers, warnings and markings.
- Training: Training and qualification of staff in safe handling and management of hydrocarbon refrigerant for the personnel involved in the activities of services to end users.
- Safety audit: Will be conducted by a certified third party entity.
- Dissemination workshops: The main objective of this project is the definition of the possibility to replicate the technology in other enterprises in Colombia, Latin America and other A5 countries globally. In the case of commercial air conditioning subsector, having in mind that the main barrier for their introduction of a low GWP option is the associated capital and operational cost, it is anticipated that if results are positive and an adequate cost/performance balance is achieved, there is a great potential for the technology to be replicated in other air conditioning manufacturer in the country, in Latin America and other regions, and even in other applications of commercial air conditioning. Because of this, it is planned to conduct two workshops, a first one at local level with the participation of the other RAC Colombian manufacturing and interested end users, and a second one at regional level, where regional RAC manufacturers will be invited.
- Scheme for risk reduction for end users: to complete the framework of risk management is necessary to develop tools for accompanying to end users in operational cycle with adequate manuals, training and a schedule of preventive maintenance.
- Technical report: At the end of the demonstration project, a technical report will describe the outcome of the demonstration project. This includes performance review of the new AC equipment.

It would be worth mentioning that the above activities are associated with the development and establishment of regulations and/or technical standards for the safe use and application of HC refrigerants in the RAC sector. This activity is included in the project for training, technical standards and online log book in the RAC servicing sector that will be developed in the Colombian HPMP II stage (if approved as submitted).

Activities of monitoring shall be carried out by UTO consultants and officers from regional environmental competent authorities and/or entities.

Monitoring on the strategies proposed herein shall be based on commitments established and fulfilled within the cooperation agreement that shall be entered into beforehand the start and

development of this project. The mentioned agreement shall have the details of activities to be developed and goals to comply. They are mainly related to the HCFC-22 total elimination in consumption when manufacturing commercial air conditioning equipment.

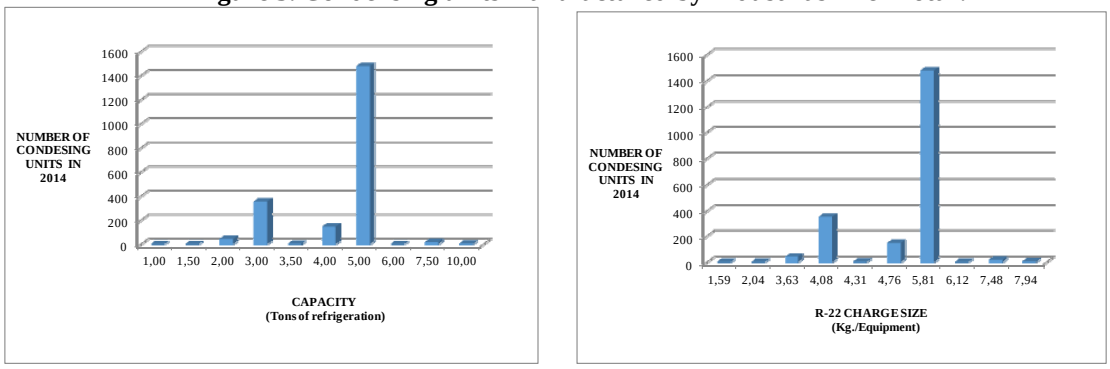
The activities related to product design modifications, safety testing, risk analysis and risk assessment will be carried out in conjunction with national experts so that the expertise can be repeated with other national projects.

2.3.1 TECHNICAL CONSIDERATIONS

Some technical considerations are described below, which are necessary to define the activities required for the conversion:

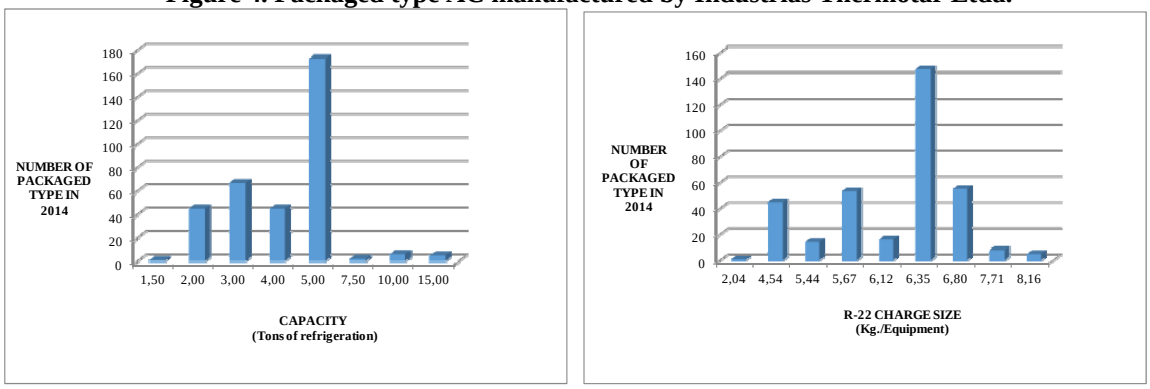
✓ The condensing units and package type air conditioning devices that are factory-charged for Industrias Thermotar Ltda are shown below:

Figure 3. Condensing units manufactured by Industrias Thermotar.



According to the above graphs, 92.37% of the condensing units are manufactured with a lower or equal to 60,000 BTU (5 tons of refrigeration) capacity, and the load of refrigerant R-22 is between 1.0 kg and 5.8 kg. It should be noted that equipment manufactured above a capacity of 5 tons of refrigeration, are being manufactured with an independent number of 5 ton of refrigeration circuits (See annex 4).

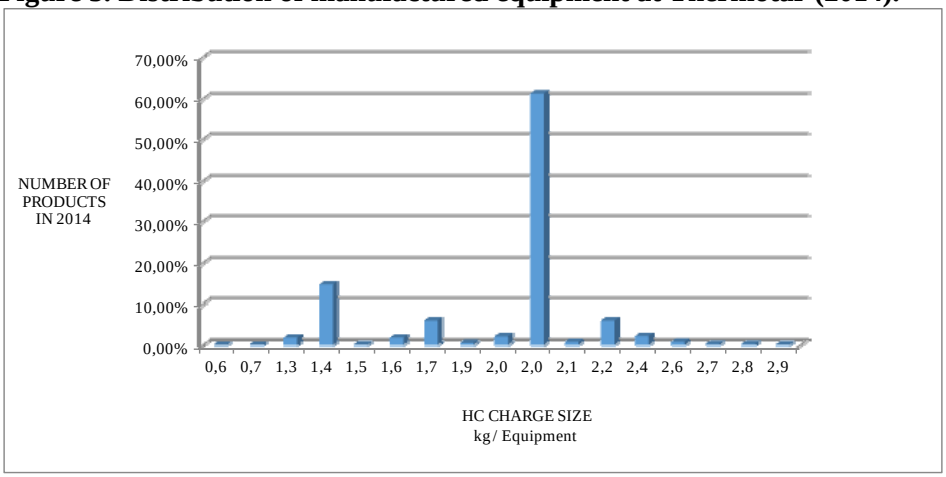
Figure 4. Packaged type AC manufactured by Industrias Thermotar Ltda.



According to the above graphs, 96.22% of the packaged type equipment are manufactured with a lower or equal to 60,000 BTU (5 tons of refrigeration) capacity, and the load of refrigerant R-22 is between 2.0 kg and 6.8 kg. It should be noted that the equipment manufactured above a capacity of 5 tons of refrigeration, are being manufactured with an independent number of 5 ton of refrigeration circuits (See annex 4).

✓ Based on the data the HCFC–22 consumption for the equipment manufactured, and according the distribution of the systems and refrigerant charges. The following figure shows the equivalent HC charge (HCFC-22 charge adjusted downwards to 35% or HCFC-22 charge equivalent to 35%) and the corresponding number of units (as a percentage of the total). The majority of the units would have an HC charge of 0.5 kg to 2 kg. There are a very small number between 2 – 2.8 kg.

Figure 5. Distribution of manufactured equipment at Thermotar (2014).



✓ An initial assessment made with the enterprise showed that for the systems with less than or equal to 1 kg, it won't be required a major redesign, but for those equipment from 1 to 2 kg, they will need to redesign these units. Primarily this includes use of additional shut-off valve(s), possibly the use of a gas detector and/or a controller based on temperature and/or pressure measurement in the evaporator (also for leak detection). They estimated work to do of charge reduction too, which primarily involves redesign of the condenser (smaller tube diameter,

different circuitry), also they estimated that possibly for the evaporator and the packaged units, it may also be appropriate to add a damper to the duct outlet.

2.3.2 INFORMATION ON PARTICIPATING COMPANY

INDUSTRIAS THERMOTAR LTDA was established in March 1978; with address at Calle 58 No 66B-23 (Barranquilla, Colombia), in order to manufacture, market and provide the service of installation and maintenance of air conditioning units. In the same year, the factory began importing equipment, in order to increase the number of customers and be more competitive.

Thermotar achieved recognition in the air conditioning market and its demand increase; in the course of the time, the factory was manufacturing some equipment parts in order to offer an integral product and service.

In the eighties, Thermotar started manufacturing and marketing of air distribution parts, like grilles and diffusers. For the success of these products, in 1982, Aluminaire was established (an independent division), since that moment, the new division would become the trademark for grilles and air diffusers.

In 1985, the factory purchased the appropriate machinery to manufacture coils, an important part for air conditioners equipment. With the acquisition of this modern machinery, besides start coils production, new markets emerged in the refrigeration area. This year, Thermotar also started implement refrigerant R-22.

Year after year, production increased and in 1995 a cutting machine Strippit was acquired, the second in South America in that moment, in order further to improve in manufacturing activities. In 1998, CNC machines were included in the production plant for different activities and improve productivity.

In 2000 the serial production of air conditioners equipment is implemented, which meant an important achievement in employment generation, productivity and manufacturing time.

At the present in Colombia, Industrias Thermotar Ltd. is a factory that manufactures the largest proportion of the total volume of HCFC-22-based condensing units for air conditioning systems and packaged type air conditioning equipment.

3. PROJECT IMPLEMENTATION MODALITY

The project will be implemented using UNDP's National Execution Modality. Time line is as follows:

QUARTER	1	2	3	5	6	7	8	9	9	10	11	12	13	14	15	16	17	18
Define and contract an expert consultant for project development.		X	X															
Project design: controllers and electrical components. Design of the refrigerant circuit, construction and prototype testing.			X	X	X													

QUARTER	1	2	3	5	6	7	8	9	9	10	11	12	13	14	15	16	17	18
Collaboration Agreements			X	X	X													
Selection of the stationary equipment supplier.						X	X	X										
Installation and implementation of equipment as required.									X	X	X							
Training in production line operation and maintenance.											X	X						
Assessment and review of installed equipment.												X	X	X	X			
Training for servicing in installation during guarantee, post-sales services.														X	X	X	X	
Safety Audit															X			
Monitoring /tracking						X	X	X	X	X	X	X	X	X	X			
Dissemination activities									X						X	X	X	
Report to ExCom.																		X

4. PROJECT BUDGET

The total incremental costs (ICC + IOC) are **US$ 863,760**, including 10% for contingencies. The incremental operating costs (IOC) are **US$ 144,660** for one-year operation (See annex 2). The following table shows associated costs to the implementation of this project:

Description **Incremental Capital Costs**	Amount	Costs / Unit (USD)	Total cost (USD)
International expert (Controllers and electrical components, refrigerant circuit design).	1	50,000	50,000
Product design modifications, safety testing, risk analysis, risk assessment and third party approvals.	1	35,000	35,000
Construction and testing of a prototype.	1	30,000	30,000
HC charging unit station, valve box, drop box, vacuum re-process (production line), with a leak proof testing system for equipment to be charged with HC, a storage station and feeding line, and a leak testing system for already HC charged equipment.	1	330,000	330,000
Safety systems for production lines.	1	50,000	50,000
, Training and start-up equipment already in production line (Training for line operation and maintenance).	1	13,000	13,000

Description	Amount	Costs / Unit (USD)	Total cost (USD)
Incremental Capital Costs			
Training for installation and service technicians for end users.	1	22,000	22,000
National consultant for monitoring of project development	1	50,000	50,000
International Expert	1	35,000	35,000
Safety Audit	1	30,000	30,000
(2) Workshops for dissemination of results	1	36,000	36,000
Contingencies (10 %)	-	-	68,100
Sub –total			**749,100**
Expected increase of operational costs			114,660
Total			**863,760**

Requested Grant to the MLF: 500,000 US$

ANNEX 1.

HCFC CONSUMPTION IN 2009-2014 AND ITS SECTOR DISTRIBUTION

Substance	Application	Sector	2009		2010		2011		2012		2013		2014	
			MT	ODP	MT	ODP	MT	ODP	MT	ODP	MT	ODP	MT	ODP
HCFC-141b	Blowing agent	Manufacture of domestic refrigeration	420.00	46.20	531.10	58.42	684.57	75.30	783.64	86.20	-	-	-	-
	Blowing agent	Manufacture of commercial refrigeration	67.70	7.45	83.90	9.23	109.05	12.00	123.70	13.61	148.60	16.35	66.42	7.31
	Blowing agent	Manufacture of continuous panels	119.00	13.09	150.50	16.56	193.20	21.25	221.90	24.41	253.18	27.85	81.52	8.97
	Blowing agent	Manufacture of industrial and construction refrigeration	216.00	23.76	274.27	30.17	351.70	38.69	402.70	44.30	474.60	52.21	98.52	10.84
	Blowing agent	Manufacture of spray foam	20.00	2.20	25.30	2.78	32.60	3.59	37.30	4.10	44.40	4.88	51.90	5.71
	Blowing agent	Manufacture of Integral skin foam	18.00	1.98	22.70	2.50	29.20	3.21	33.43	3.68	40.20	4.42	3.42	0.38
	Blowing agent	Polyol formulation	276.74	30.44	369.22	40.61	28.22	3.10	-	-	8.27	0.91	366.03	40.26
	Maintenance of refrigeration equipment	Flushing	59.79	6.58	51.29	5.64	72.06	7.93	83.62	9.20	31.35	3.45	46.40	5.10
	Extinguisher agent	Fire control	-	-	37.66	4.14	47.75	5.25	77.85	8.56	49.61	5.46	61.62	6.78
	Solvent	Manufacture of hypodermic needles	5.75	0.63	5.00	0.55	10.50	1.16	7.60	0.84	1.48	0.16	5.48	0.60
	Aerosol	Industrial cleaning solvent	0.75	0.08	5.61	0.62	-	-	-	-	2.53	0.28	2.94	0.32
Total HCFC-141b			**1,203.73**	**132.41**	**1,556.55**	**171.22**	**1,558.85**	**171.47**	**1,771.74**	**194.89**	**1,054.22**	**115.96**	**784.25**	**86.27**
HCFC-22	Refrigerant gas	Manufacture of commercial refrigeration and Air Conditioning (RAC)	261.40	14.38	208.45	11.46	233.71	12.85	151.30	8.32	59.91	3.30	40.63	2.23
	Refrigerant gas	Refrigeration and Air Conditioning (RAC) systems maintena	1,096.99	60.33	1,025.53	56.40	658.50	36.22	1,439.62	79.18	986.39	54.25	1,184.89	65.17

Substance	Application	Sector	2009		2010		2011		2012		2013		2014	
			MT	ODP	MT	ODP	MT	ODP	MT	ODP	MT	ODP	MT	ODP
		nce												
	Aerosol	Propellant in commercial aerosol	0.60	0.03	4.21	0.23	1.92	0.11	3.64	0.20	7.10	0.39	0.64	0.04
Total HCFC-22			**1,358.99**	**74.74**	**1,238.19**	**68.10**	**894.13**	**49.18**	**1,594.56**	**87.70**	**1,053.40**	**57.94**	**1,226.16**	**67.44**
HCFC-123	Extinguisher agent	Fire control	106.39	2.13	113.22	2.26	87.49	1.75	108.09	2.16	101.99	2.04	102.10	2.04
	Refrigerant gas	RAC systems maintenance	-	-	1.18	0.02	1.44	0.03	9.33	0.19	2.31	0.05	1.48	0.03
Total HCFC-123			**106.39**	**2.13**	**114.40**	**2.29**	**88.93**	**1.78**	**117.42**	**2.35**	**104.30**	**2.09**	**103.58**	**2.07**
HCFC-142b	Maintenance of refrigeration equipment	RAC systems maintenance	5.39	0.32	9.61	0.58	14.52	0.87	18.93	1.14	9.77	0.59	4.35	0.26
Total HCFC-142b			**5.39**	**0.32**	**9.61**	**0.58**	**14.52**	**0.87**	**18.93**	**1.14**	**9.77**	**0.59**	**4.35**	**0.26**
HCFC-124	Maintenance of refrigeration equipment	RAC systems maintenance	2.88	0.06	0.68	0.01	1.19	0.02	0.89	0.02	1.34	0.03	0.70	0.01
Total HCFC-124			**2.88**	**0.058**	**0.68**	**0.01**	**1.19**	**0.02**	**0.89**	**0.02**	**1.34**	**0.03**	**0.70**	**0.01**

TOTAL HCFCs CONSUMPTION			**2,677.38**	**209.66**	**2,919.43**	**242.20**	**2,557.76**	**223.32**	**3,503.54**	**286.09**	**2,223.03**	**176.60**	**2,119.04**	**156.05**

ANNEX 2.

MANUFACTURING COSTS

Incremental costs of the project herein were calculated keeping into account the considerations as follows:

- ✓ As a reference for calculations, condensing units and package – type equipment were taken with a capacity of 5 refrigeration tons (17.5 Kw). This is due to the fact that they are the air conditioning devices manufactured the most in this plant facility.
- ✓ Average manufactured equipment during last 3 years were 4,100 units.
- ✓ Manufacture costs for R–290 were estimated keeping in mind current manufacturing costs of an equipment working with R–22 (Annex 4)
- ✓ Cost increases were calculated comparing manufacture costs related to R–22 equipment.

Incremental Cost		
Refrigerant Class	*** Manufacturing Costs / Unit (USD $)**	**Cost Increase (%)**
R-22	$ 594,89	-
R-290	$ 650,89	8.6%
R-410A	$ 666,56	10.8%

*Conversion Equivalent rate equal to COP $ 2623/ USD $

- ✓ The difference between manufacture cost of an R–22 unit minus the cost of manufacturing a R–290 Unit is equivalent to the incremental cost of a manufactured unit. When multiplying such amount times the average of units produced during the last three (3) years, the incremental cost value would correspond to USD **229,600.**

Air Conditioning	***Manufacture Costs / R–22 Unit (USD)**	***Manufacture costs of an R–290 Unit (USD)**	**Difference between manufacture costs (USD)**
5 ton refrigeration equipment (17.5 KW)	$ 594,89	$ 650,89	$ 56
Increases of cost per year - $ US (4,100 units made average last 3 years)			**$ 229,600**
Incremental operation costs according to decision 74/50 ($ US 6.3/Kg ODS)			**$ 114,660**

ANNEX 3.

ENVIRONMENTAL IMPACT ASSESSMENT

The environmental impact was calculated from the ozone depletion and global warming potentials of the different substances (ODP and GWP).

The average annual production is equivalent to 4,100 units, with each unit containing 4.44 Kg. HCFC-22. Calculations are detailed in the table below. In the long run the conversion will represent an annual reduction in emissions of 0.73 ODP tons and 23,866.7 of equiv. CO_2 tons. So the chosen technology complies with MOP Decision XIX/6 on minimizing negative environmental side effects, particularly, to climate change.

Calculations of Environmental Impact:	**HCFC-22**	**R-290**	
Refrigerant substances by unit (kg)	4.44	1.55	
Annual production of units	4,100	4,100	
Gas emissions of all units produced in one year during life time (kg/year)	13,267	6,355	
Tones of ODP emitted per Thermotar´s annual production	0.73	0	**-0.73**
Kg of equiv. CO2 emitted per Thermotar's annual production.	23,880,600	13,894	**-23,866,706**

ANNEX 4.

MANUFACTURED EQUUIPMENTS IN 2014

EQUIPOS FABRICADOS	UNIDADES CONDENSADORAS

ÍTEM	MODELO	CAPACIDAD (BTU)	DESCRIPCIÓN	CANT	LB/EQUIPO	KILOGRAMO /EQUIPO	CONSUMO TOTAL (KILOGRAMO)	PORCENTAJE (%)
1	CH012-	12000	Condensadoras horizontales de 1TR; 1PH y 3PH	3	3,500	1,588	4,763	0,14%
2	CV018-	18000	Condensadoras verticales de 1.5TR; 1PH y 3PH	3	4,500	2,041	6,123	0,14%
3	CV024-	24000	Condensadoras vertical de 2TR; 1PH y 3PH	37	8,000	3,629	134,263	1,79%
4	CH024-	24000	Condensadoras horizontal de 2TR; 1PH y 3PH	8	8,000	3,629	29,030	0,39%
5	CV036-	36000	Condensadoras vertical de 3TR; 1PH, 3PH Y 3PH 440V	284	9,000	4,082	1159,382	13,71%
6	CH036-	36000	Condensadoras horizontal de 3TR; 1PH y 3PH	72	9,000	4,082	293,928	3,48%
7	CV042-	42000	Condensadoras vertical de 3.5TR; 1PH, 3PH	3	9,5	4,309	12,927	0,14%
8	CH042-	42000	Condensadoras horizontal de 3.5TR; 1PH y 3PH	2	9,5	4,309	8,618	0,10%
9	CV048-	48000	Condensadoras vertical de 4TR; 1PH, 3PH	145	10,5	4,763	690,594	7,00%
10	CH048-	48000	Condensadoras horizontal de 4TR; 1PH y 3PH	3	10,5	4,763	14,288	0,14%
11	CV060-	60000	Condensadoras vertical de 5TR; 1PH, 3PH Y 3PH 440V	1353	12,8	5,806	7855,494	65,33%
12	CH060-	60000	Condensadoras horizontal de 5TR; 1PH, 3PH Y 3PH 440V	126	12,8	5,806	731,554	6,08%
13	CV072-	72000	Condensadoras vertical de 6TR; 1PH Y 3PH	1	13,5	6,123	6,123	0,05%
14	CV072-2C	72000	Condensadoras vertical de 6TR; 1PH Y 3PH; 2 Circuito	1	13,5	6,123	6,123	0,05%
15	CH072-2C	72000	Condensadoras horizontal de 6TR; 1PH Y 3PH; 2 Circuito	1	13,5	6,123	6,123	0,05%
16	CV096-	96000	Condensadoras vertical de 7.5TR; 1PH Y 3PH	11	16,5	7,484	82,327	0,53%
17	CV096-2C	96000	Condensadoras vertical de 7.5TR; 1PH Y 3PH; 2 Circuito	8	16,5	7,484	59,874	0,39%
18	CH096-	96000	Condensadoras horizontal de 7.5TR; 1PH Y 3PH	1	16,5	7,484	7,484	0,05%
19	CV120-	120000	Condensadoras vertical de 10TR; 1PH Y 3PH	5	17,5	7,938	39,689	0,24%
20	CV120-2C	120000	Condensadoras vertical de 10TR; 1PH Y 3PH; 2 Circuito	2	17,5	7,938	15,876	0,10%
21	CDW060-3	60000	Condesador vertical condensado por agua de 5TR; 1PH Y 3PH	2	12,800	5,806	11,612	0,10%

TOTAL DE EQUIPOS FABRICADOS	2071	-	-	11176,198	-

EQUIPOS FABRICADOS	UNIDADES EQUIPOS PAQUETES

ÍTEM	MODELO	CAPACIDAD (BTU)	DESCRIPCIÓN	CANT	LB/EQUIPO	KILOGRAMO /EQUIPO	CONSUMO TOTAL (KILOGRAMO)	PORCENTAJE (%)
4	EPHWC-018-	18000	Equipo paquete horizontal condensador por agua de 1.5TR	1	4,5	2,041	2,041	0,29%
5	EPAC-024-	24000	Equipo paquete vertical condensador por aire de 2TR	4	10	4,536	18,144	1,16%
7	EPWC-024-	24000	Equipo paquete vertical condensador por agua de 2TR	7	10	4,536	31,751	2,03%
8	EPHWC-024-	24000	Equipo paquete horizontal condensador por agua de 2TR	34	10	4,536	154,221	9,88%
9	EPAC-036-	36000	Equipo paquete vertical condensador por aire de 3TR	14	12	5,443	76,204	4,07%
11	EPWC-036-	36000	Equipo paquete vertical condensador por agua de 3TR	16	12,5	5,670	90,718	4,65%
12	EPHWC-036-	36000	Equipo paquete horizontal condensador por agua de 3TR; 1PH ; 3PH	37	12,5	5,670	209,786	10,76%
13	EPAC-048-	48000	Equipo paquete vertical condensador por aire de 4TR	3	13,5	6,123	18,370	0,87%
15	EPWC-048-	48000	Equipo paquete vertical condensador por agua de 4TR	13	13,5	6,123	79,605	3,78%
16	EPHWC-048-	48000	Equipo paquete horizontal condensador por agua de 4TR; 1PH ; 3PH	29	14	6,350	184,159	8,43%
17	EPAC-060-	60000	Equipo paquete vertical condensador por aire de 5TR	118	14	6,350	749,335	34,30%
19	EPWC-060-	60000	Equipo paquete vertical condensador por agua de 5TR	25	15	6,804	170,097	7,27%
20	EPHWC-060-	60000	Equipo paquete horizontal condensador por agua de 5TR; 1PH ; 3PH	30	15	6,804	204,117	8,72%
21	EPAC-096TD-2C-	96000	Equipo paquete condensado por aire de 7.5TR; 3PH; 2 Circuito	2	17	7,711	15,422	0,58%
22	EPAC-120TP-2C-	120000	Equipo paquete condensado por aire de 10TR; 3PH; 2 Circuito	6	17	7,711	46,266	1,74%
23	EPAC-180TP-3C-	180000	Equipo paquete condensado por aire de 15TR; 3PH; 3 Circuito	2	18	8,165	16,329	0,58%
24	EPAC-180TP-2C-	180000	Equipo paquete condensado por aire de 15TR; 3PH; 2 Circuito	3	18	8,165	24,494	0,87%

TOTAL DE EQUIPOS FABRICADOS	344	-	-	2091,061	-

ANNEX 5.

Manufacturing costs presented hereon are shown in Colombian pesos (COP $).

ÍTEM	ETAPA DEL PROCESO DE FABRICACIÓN	VALOR TOTAL POR ETAPA CONDENSADOR DE 5 TON PARA R-22	VALOR TOTAL POR ETAPA CONDENSADOR DE 5 TON PARA R-290	VALOR TOTAL POR ETAPA CONDENSADOR DE 5 TON PARA R-410a
1	ETAPA DE CORTE	$ 30.539,44	$ 65.711,92	$ 65.711,92
2	ÁREA DE LATONERÍA Y ENSAMBLADO	$ 1.224.291,55	$ 376.312,16	$ 1.352.622,61
3	ESTACIÓN DE VACÍO	$ 1.021,57	$ 1.021,57	$ 1.021,57
4	ESTACIÓN DE CARGA	$ 44.487,82	$ 7.950,00	$ 37.633,21
5	SUB-TOTAL I	$ 1.300.340,38	$ 449.974,08	$ 1.456.989,31
	DETALLES			
6	MANO DE OBRA	$ 195.051,06	$ 67.496,11	$ 218.548,40
7	MATERIALES FUNGIBLES	$ 65.017,02	$ 3.374,81	$ 72.849,47
8	SUB-TOTAL I I	$ 260.068,08	$ 70.870,92	$ 291.397,86
	COMPONENTES DISTINTIVOS			
1	COMPRESOR	$ 0,00	$ 759.099,34	$ 0,00
2	SERPENTÍN CONDENSADOR	$ 0,00	$ 268.568,00	$ 0,00
3	DETECTOR DE FUGA	$ 0,00	$ 87.500,00	$ 0,00
4	PRESOSTATO DE ALTA	$ 0,00	$ 35.586,00	$ 0,00
5	PRESOSTATO DE BAJA	$ 0,00	$ 35.694,00	$ 0,00
6	SUB-TOTAL I I I	$ 0,00	$ 1.186.447,34	$ 0,00
	COSTO TOTAL DE FABRICACIÓN	**$ 1.560.408,46**	**$ 1.707.292,34**	**$ 1.748.387,17**