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Executive Committee of
the Multilateral Fund for the
Implementation of the Montreal Protocol

Ninth Meeting
Montreal, 8–10 March 1993

PROJECT PROPOSALS: ECUADOR

PROJECT COVER SHEET

COUNTRY:	Ecuador
PROJECT TITLE:	Conversion of Aerosol Plants to Hydrocarbon Propellants
SECTORS COVERED:	Aerosols
ODS CONSUMPTION IN SECTOR:	290 MT CFC-12 (aerosols) in 1992
PROJECT IMPACT:	Phase out 290 MT of CFC-12
PROJECT DURATION:	2 Years
TOTAL PROJECT COST:	US$ 1.8 million
PROPOSED ODS GRANT:	US$ 0.7 million
COST EFFECTIVENESS:	US$ 2.41 /kg of ODS
NATIONAL COORDINATING AGENCY:	Ministry of Industries
IMPLEMENTING AGENCIES:	World Bank/UNDP
APPRAISAL DATE:	March 1993

PROJECT SUMMARY

Conversion of Aerosol Plants to Hydrocarbon Propellants

GRANTEE: Ecuador

COST: US $1.8 million

SECTOR BACKGROUND

1. The aerosols industry in Ecuador accounted for 464 metric tons (MT) of the CFCs consumed in 1990; most aerosol products manufactured domestically contained CFC-12 as the predominant propellant. A rapid reduction in CFC consumption in aerosols has taken place since 1990. A 1992 projection indicates that approximately 290 MT will be consumed in 1992. This reduction is due to the following factors: (i) a decline in consumer demand for aerosols, (ii) enforcement of multinational corporate policies requiring domestic subsidiaries to discontinue production and distribution of CFC-based aerosols; and, (iii) introduction of carbon dioxide as replacement for CFC-12 in some aerosol products. The latter factor reflects some manufacturers' response to growing public concern regarding the deteriorating state of the ozone layer. However, carbon dioxide is not a long term replacement for CFCs because its effectiveness is limited to a small range of products.

2. While most countries in the developing world have replaced CFCs with hydrocarbon propellants (HPs) of high purity ("aerosol grade" propane, butane, and isobutane), Ecuador has not produced or imported these hydrocarbons. Importation of these materials was restricted by import regulations that reserved hydrocarbon importation rights to PETROECUADOR, the state-owned oil company.

3. The World Bank commissioned a review of the regulatory framework for hydrocarbon importation in Ecuador[1]. Article 92 of the Law of Hydrocarbons states that all importation of HPs produced in Ecuador must be channelled through PETROECUADOR. However, the Ministry of Energy and Mines, through its Hydrocarbons Directorate, is in charge of authorizing importation of HPs not produced by PETROECUADOR. The Hydrocarbon Directorate has clarified that the direct importation of aerosol grade HPs is now feasible and that such authorization had been recently granted to a firm located in Guayaquil.

[1] "Resumen del Informe del Análisis Legal sobre la Factibilidad de Importar Hidrocarburos con Grado Aerosol o Producirlos Localmente," prepared by Dr. Ricardo Crespo Plaza, May 5, 1992.

4. Ecuador's current trade policy is promoting the elimination of trade barriers; thus, it is expected that HPs will be freely imported in the future. The implementing agency for this project (the Ministry of Industries, Commerce, and Fisheries -- MICIP) is currently working with the Ministry of Energy and Mines to simplify import procedures and ensure that aerosol manufacturers have access to HPs at project effectiveness.

PROJECT BACKGROUND

5. In very simple terms, aerosol packaging involves filling a container (usually a steel can) with an active ingredient (the material that controls the product's efficacy, e.g., a liquid resin for a hair spray), sealing the container, and adding a pressurized propellant through a valve. The propellant is normally a gas at atmospheric conditions, but when pressurized in an aerosol container it coexists with its liquid phase. The liquid phase mixes with the active ingredient either by chemical affinity or by mechanical action prior to use. When the valve is depressed (opened) a sudden change in pressure takes place causing part of the liquid phase to volatilize in a mist of active ingredient droplets. When valve action ceases, the internal pressure in the container is reestablished to a new equilibrium.

6. CFCs were used as propellants for many years until their link to stratospheric ozone depletion was established in the late 1970s. A conversion from CFCs to HPs has been the main technological response in the aerosol industry worldwide because product quality is maintained and HPs are cheaper than CFCs. However, in contrast with CFCs, HPs are highly flammable. Changes in plant equipment and layout, and new operational practices are necessary to ensure that adequate safety systems are in place to mitigate fire and explosion risks.

PROJECT OBJECTIVE

7. The primary goal of the proposed project is to eliminate use of CFC-12 in aerosol manufacturing by introducing HPs. As shown in Table 1, approximately 18 plants consumed 290 MT of CFCs in 1992. The conversion to HPs would follow established industrial safety practices to mitigate fire and explosion risks.

PROJECT DESCRIPTION

8. The World Bank commissioned a pre-feasibility study to identify plants that could substitute CFCs with HPs and to assess indicative costs of plant conversion. The company profiles in Annex A represent companies that could substitute CFCs with HPs. Out of a total of 18 existing plants, four plants were visited and assessed in detail (Laboratorios Windsor, Pro Quim, Jabonería Nacional, Camposa). The remaining plants are considered likely beneficiaries and have been included in the project cost estimate.

Table 1: Incremental Costs for Ecuador's Aerosol Plants

Company	1992 CFC Use (MT)	PV of Operating Savings[1]	Investment Cost	Incremental Costs
Laboratorios Windsor	60	($238,000)	$289,000	51,000
Pro Quim	6	($24,000)	73,000	49,000
Jabonería Nacional	50	($198,000)	151,000	0[2]
Camposa	5	($20,000)	73,000	53,000
Other companies (about 14)	169	($670,000)	1,214,000[3]	544,000
Total	290		$1,800,000	$697,000

[1] Assumes that each kg of HP saves $1.25 per kg of CFC replaced. Operating savings are discounted over a four year period using an economic rate of return of 10%.
[2] Due to the relatively large consumption of CFC-12, this firm's net operating benefits appear to be higher than investment costs; thus, lifting of HP import restrictions would encourage this firm to undertake the conversion.
[3] It is estimated that two out of the 14 plants would have investments of about $151,000 and the remaining 12 firms of about $76,000.

9. The project consists of a US$0.7 million line of grant to support conversion of aerosol manufacturing plants from CFCs to HPs. Each subproject would consist of two components: (i) a plant conversion component and (ii) a training component. These components are described below in general terms and then they are applied to an illustrative case (Laboratorios Windsor).

Plant Conversion Component

10. Three sections of each aerosol manufacturing plant would be modified as a result of this project: (i) propellant delivery and storage, (ii) filling system (i.e., room and equipment that injects the pressurized propellant), and (iii) final product warehouse.

11. Two alternatives would be considered for the storage and delivery of Hps to the aerosols manufacturing plant: (a) purchase stationary storage tanks, so that delivery is made by a tank truck, and (b) adapt facilities to accept delivery of movable containers. The selection depends on volume requirements, and for stationary storage tanks over 7,600 liters in capacity, on available distance to separate tanks from walls and buildings as set in international standards (e.g., 15 meters according to the U.S. National Fire Protection Association).

12. In each plant, the filling station would be adapted to minimize the risk of fire during propellant injection. In industrialized countries with extreme weather conditions, gassing rooms are usually indoors and require expensive gas detection and fire protection systems.

When temperate weather and natural ventilation is present, and open system allows the wind to carry away any settlement of HP that may occur due to leaks during the filling process. This is a concept known as "open-air filling room" (OAFR). Compared to closed gassing rooms, OAFR offers various advantages such as low cost, reducing the risk of human error, and relatively less extensive training.

13. Warehouses would also be modified to store materials packaged with HPs. The risk of fire would be reduced by completely opening windows at floor level to assure natural ventilation. In addition, the installation of a simple sprinkler system would be necessary to meet the requirements set by international standards for fire prevention.

Training Component

14. In addition to plant equipment changes, operating practices would be adapted to meet safety guidelines for mitigation of flammability risks. A fire fighting system would be established to respond to potential fire or explosion. Each plant would undergo a four-part training program. The first training session would provide the plant manager or owner a non-technical explanation of the characteristics of HPs, and the restrictions on plant expansion, installment of new equipment, and storage of materials. In the second session, department heads would be given an overview of the changes in product characteristics, safety requirements in the production area, and plant safety. The third session would address all aspects of plant safety, and would involve plant and production managers, maintenance managers, and production supervisors. In the fourth training session supervisors and workers would be trained on the production line, with the understanding that supervisors would be responsible for the training of new workers as they join the company. Training manuals would be modified to emphasize the special details that affect safety in that particular plant.

PROJECT COSTS

15. Adapting an aerosols manufacturing plant to HPs involves two types of costs: investment and operating costs. Investment costs include capital costs and other non-recurring costs (training, engineering, etc.) associated with adapting the manufacturing facility and operating practices to the safe use of HPs. The primary change in operating costs is a reduction in raw material costs.

16. To illustrate the approach used to arrive at the cost estimates summarized in Table 1, a representative firm (Laboratorios Windsor) is examined in detail. Tables 2, 3, 4, and 5 summarize investment cost estimates for the other three companies listed in Table 1. Direct taxes (import, excise, etc.) applicable to the equipment have been excluded from the cost estimates as it is expected that these projects, as other UN/Bank project, will be exempt from such taxes.

Investment Costs

17. Laboratorios Windsor is one of the two largest consumers of CFCs for the aerosols sector in Ecuador. In 1992, Windsor is projected to consume about 60 MT of CFC for filling 2,000,000 units, mainly consisting of personal deodorants, hair spray, shave cream, insecticides, and room deodorants. The Laboratorios Windsor plant lot is approximately 7500 square meters, situated on a hill, with a 10 meter drop from the plant to the farthest lot corner. Located in the Laurels colony of the Inca section of Quito, a mixed area of private and industrial buildings, it has private dwellings as immediate neighbors. Its hillside location guarantees continuous, and usually quite strong winds, ideal for the use of an OAFR. The current use of pneumatic filling machines at Laboratorios Windsor satisfies the requirement for explosion proof equipment.

18. Storage and Delivery of Hydrocarbons (US$19,000 to US$22,000). Windsor's lot appears to barely meet the 15 meter standard distance between the HP storage area and surrounding buildings. An official lot survey should be conducted to determine whether stationary tanks of more than 7,600 liters could be installed. If the distance constraint can not be met, it may be necessary to extend the driveway to allow delivery of HPs by smaller, movable containers. Both cases were considered for the cost estimates presented in Table 2.

19. Equipment (US$121,000). Following the tank installation, the gassing cylinders on all stations would be replaced to avoid leakage of HPs. Two conveyers leading to the water bath have open motors which may generate sparks, and their length is insufficient for transporting cans to and from an OAFR to the plant. Thus, two new conveyers would be required to transport the cans to the gassing area, and to bring them back into the plant. The motors for the conveyers would remain in the plant and away from the OAFR where HPs are being used.

20. In addition, Laboratorios Windsor can also replace CFCs in certain product lines representing about 300,000 units per year by switching to plastic pumps. Laboratorios Windsor would produce the bottles in-house, import the remaining parts for the pumps, and assemble them in the plant. The major cost component is US$60,000 for bottle molds needed to produce the pump containers.

21. Open Air Filling Room (US$18,000). The next step is to build the OAFR. The construction of the OAFR, behind the present filling area, could follow a standard procedure developed in Mexico. For the rotary machines, concentrates would be pumped from the present filling room to the OAFR, and empty cans would be transported on a conveyer to the OAFR. For the manual filling machines, the cans would be filled with concentrate and shaped in the present filling area, and sent to OAFR only for gassing. The valves would be hand carried. It is important not to obstruct the natural ventilation of the room with packaging materials.

22. Warehouse and Fire Fighting (US$ 40,000). Windsor's warehouse occupies the entire ground floor South portion of the building. Completely enclosed, the warehouse must modified to store aerosols packaged with HPs. Six windows would be opened at floor level, two on the South side and four on the West side, to promote natural ventilation. The installation of a simple sprinkler system, connected to the water storage and the pump system used for general plant safety is recommended to comply with the international safety standards.

23. For a plant such as Laboratorios Windsor, a fire fighting system should consist of a 50,000-liter underground water reserve, connected to a pump with three outlets: one at the entrance to warehouse, another within the plant in the concentrate/filling room area, and the last one equidistant from the tank area and the OAFR with sufficient hose to reach all areas of each. The pump must be connected to a special locked switch, and directly supplied with electricity (because it is typical to shut down the plant's electrical system in case of fire or an explosion).

24. Industrial Safety and Environmental Review (US$ 31,000). Engineering work to design and supervise construction of the OAFR and other plant changes and the training program mentioned in para. 14 are necessary to ensure that industrial safety standards are being met. In addition, resources for an environmental review are included to verify that the changes did not cause any violations of environmental regulations and standards.

Operating Costs

25. Information concerning the delivered price of aerosol grade HPs in Ecuador is not available because they have not been imported in the past. According to expert sources, the price for HPs in the United States West Coast ($1.00/gallon) plus a 50% to 70% increase for shipping and handling provides an approximate estimate of the likely price. With a density of 0.54 kg/l, this means that HP prices would be about one third the price of CFC-12 (US$2.50/kg). However, usually less HP is used by weight than the CFC that it replaces due to density and pressure differences. Thus, for a given container size more active ingredients may needed to compensate for the loss in weight associated with the replacement of CFCs. Active ingredients are generally more expensive than propellants; therefore, this compensation may in turn increase the overall product cost. As a conservative estimate, the overall replacement of CFCs with HPs is calculated to save $1.25 per kg of CFC replaced effectively reducing raw material costs by 50%.

26. The consumption of Laboratorios Windsor of 60 tons of CFC per year, or US$150,000 per year for CFC propellants. A switch from CFCs to HPs could represent annual savings of US$75,000. Similarly, Pro Quim (6,000 kg of CFCs), Jaboneria Nacional (50,000 kg of CFCs), and Camposa (5,000 kg of CFC) could have annual savings of US$7,500, US$62,500, and US$6,250, respectively.

Incremental Costs

27. Incremental costs are defined as the net present value of incremental economic costs. For these subproject incremental economic costs are calculated by taking the difference between investment costs (already in present value terms) and the discounted stream of operating savings over 4 years using a 10% discount rate in real terms (constant prices). These two elements (investment costs and present value of operating savings) are shown in Table 1.

28. Because the proposed grants will only finance part of the investment costs, it is expected that the beneficiaries will put up own capital or obtain commercial loans to co-finance the projects. The firms will undertake the projects if they receive an acceptable financial return on their own capital as a result of the project. Thus, a comparison of the financial rate of return (FRR, as faced by the firm) and the 10% economic rate of return (ERR) should be conducted. If the FRR differs substantially from the ERR (due to exchange rate risk and technology risk associated with the conversion) and would be unacceptably low for the enterprise, the grant amount should be adjusted based on a minimum FRR. The minimum FRR would be calculated based on an objective analysis of the country's financial sector and should correspond to the best judgement of a reasonable return on capital expectation within the country's industrial sector. The actual size of the individual grants may therefore be adjusted slightly based on the financial analysis to be conducted by the financial intermediary.

PROJECT IMPLEMENTATION

29. The Ministry of Industries, in coordination with a financial intermediary, will be responsible for overseeing project implementation. The schedule for the project is:

1) Submission to Secretariat of ExCom:	January 11, 1993
2) ExCom Meeting:	February 22-24, 1993
3) Appraisal:	March 1993
4) Yellow Cover MOD Review:	March 1993
5) Negotiations:	April 1993
6) Bank Approval:	April 1993

TECHNICAL ASSESSMENT

30. Annex B includes the technical review conducted by Mr. Geno Nardini, Instituto Mexicano del Aerosol, A.C., and member of the Ozone Operations Resource Group.

Table 2: Laboratorios Windsor -- Investment Costs (US$)

HP Storage				**19,000 - 22,000**
Alternative 1				
permanent storage tanks	15,000			
tank foundations	4,000			
Alternative 2				
driveway extension	12,000			
supports and hoists	10,000			
Equipment				**121,000**
conveyers with opposed motors		14,000		
pipe supports		1,000		
piping for propellant		8,000		
piping for compressed air		3,000		
propellant accumulators		2,000		
gassing cylinders		30,000		
replacement seals		3,000		
bottle plastic molding		60,000		
Open Air Filling Rooms				**18,000**
support structure		4,000		
filling room concrete foundation		2,000		
explosion proof concrete retaining wall		3,000		
open mesh screening		1,000		
roof		2,000		
lot survey		3,000		
foundation and piping drawings		3,000		
Warehouse and Fire Fighting				**40,000**
warehouse adaptations		15,000		
fire fighting system		25,000		
Industrial Safety and Environmental Review				**31,000**
Engineering		18,000		
Training		8,000		
Environmental impact assessment		5,000		
Subtotal			**US$**	**229,000 - 232,000**
Price Contingencies (10%)		23,000		
Physical Contingencies (15%)		35,000		
TOTAL			**US$**	**287,000 - 290,000**

Table 3: Pro Quim -- Investment Costs (US$)

HP Storage				**3,000 - 6,000**
Alternative 1				
permanent storage tanks	4,000			
tank foundations	2,000			
Alternative 2				
container foundation	3,000			
Equipment				**9,900**
pipe supports		1,000		
piping for propellant		5,500		
piping for compressed air		2,400		
propellant accumulators		1,000		
Open Air Filling Rooms				**9,700**
filling room concrete foundation		1,500		
explosion proof concrete retaining wall		3,000		
open mesh screening		800		
roof		1,400		
foundation and piping drawings		3,000		
Warehouse and Fire Fighting				**5,500**
warehouse adaptations		4,000		
extinguishers		1,500		
Industrial Safety and Environmental Review				**29,000**
Engineering		16,000		
Training		8,000		
Environmental impact assessment		5,000		
Subtotal			**US$**	**57,100 - 60,100**
Price Contingencies (10%)		5,900		
Physical Contingencies (15%)		8,800		
TOTAL			**US$**	**71,800 - 74,800**

Table 4: Jaboneria Nacional -- Investment Costs (US$)

HP Storage				**14,000 - 19,000**
Alternative 1				
permanent storage tanks	15,000			
tank foundations	4,000			
Alternative 2				
container foundation	3,000			
Equipment				**62,800**
pipe supports		600		
piping for propellant		3,000		
piping for compressed air		1,200		
propellant accumulators		1,000		
conveyer		7,000		
new filling equipment		50,000		
Open Air Filling Rooms (civil)				**15,700**
filling room concrete foundation		1,500		
explosion proof concrete retaining wall		3,000		
open mesh screening		800		
roof		1,400		
support structure		3,000		
foundation and piping drawings		6,000		
Warehouse and Fire Fighting				**0**
(existing facilities are adequate)				
Industrial Safety and Environmental Review				**26,000**
Engineering		13,000		
Training		8,000		
Environmental impact assessment		5,000		
Subtotal			**US$**	**118,500 - 123,500**
Price Contingencies (10%)		12,100		
Physical Contingencies (15%)		8,200		
TOTAL			**US$**	**148,800 - 153,800**

Table 5: Camposa -- Investment Costs (US$)

HP Storage				**3,000 - 6,000**
Alternative 1				
permanent storage tanks	4,000			
tank foundations	2,000			
Alternative 2				
container foundation	3,000			
Equipment				**9,900**
pipe supports		1,000		
piping for propellant		5,500		
piping for compressed air		2,400		
propellant accumulators		1,000		
Open Air Filling Rooms				**9,700**
filling room concrete foundation		1,500		
explosion proof concrete retaining wall		3,000		
open mesh screening		800		
roof		1,400		
foundation and piping drawings		3,000		
Warehouse and Fire Fighting				**5,500**
warehouse adaptations		4,000		
extinguishers		1,500		
Industrial Safety and Environmental Review				**29,000**
Engineering		16,000		
Training		8,000		
Environmental impact assessment		5,000		
Subtotal			**US$**	**57,100 - 60,100**
Price Contingencies (10%)		5,900		
Physical Contingencies (15%)		8,800		
TOTAL			**US$**	**71,800 - 74,800**

PROFILE OF FIRMS IN THE AEROSOLS SECTOR

Note: Even thought not all of these firms currently use CFCs, all of them have used CFCs in the past and could use them in the future.

Company:	Laboratorios Windsor
City:	Quito
Products Manufactured:	personal deodorants, hair spray, shave cream, insecticides, room deodorants
Amount of CFCs Used (1992 projection):	60 tons/yr

Company:	Pro Quim, S.A.
City:	Quito
Products Manufactured:	insecticides
Amount of CFCs Used (1992 projection):	6 tons/yr

Company:	Jabonería Nacional
City:	Guayaquil
Products Manufactured:	personal deodorants
Amount of CFCs Used (1992 projection):	50 tons/yr

Company:	Camposa
City:	Guayaquil
Products Manufactured:	insecticides, insect repellents
Amount of CFCs Used (1992 projection):	5 tons/yr

Company:	Laboratorios Gil C. Ltda.
City:	Cuenca
Products Manufactured:	hair spray
Amount of CFCs Used (1992 projection):	4 tons/yr

Company:	Incoin Cia. Ltda.
City:	Cuenca
Products Manufactured:	perfumes, personal deodorants
Amount of CFCs Used (1992 projection):	2 tons/yr

Company:	Laboratorios Nice C. Ltda.
City:	Quito
Products Manufactured:	mousse, flying insect spray
Amount of CFCs Used (1992 projection):	12 tons/yr

Company:	Reckitt & Colman
City:	Guayaquil
Products Manufactured:	insecticides, room deodorants
Amount of CFCs Used (1992 projection):	0

Company:	Laboratorios Calbaq C. Ltda.
City:	Guayaquil
Products Manufactured:	insecticides, room deodorants (contractor for Reckitt & Colman)
Amount of CFCs Used (1992 projection):	4.8 tons/yr

Company:	Industrial Jabonera Ecuatoriana, S.A.
City:	Guayaquil
Products Manufactured:	N/A
Amount of CFCs Used (1992 projection):	2 tons/yr

Company:	Laboratorios H. G. C. A.
City:	Guayaquil
Products Manufactured:	cosmetic aerosols
Amount of CFCs Used (1992 projection):	27.5 tons/yr

Company:	Rene Chardon
City:	Quito
Products Manufactured:	hair spray
Amount of CFCs Used (1992 projection):	0

Company:	LIFE
City:	Quito
Products Manufactured:	insect spray, topical medicinal spray
Amount of CFCs Used (1992 projection):	0

Company:	Hoechst Eteco, S.A.
City:	Casilla
Products Manufactured:	hair spray
Amount of CFCs Used (1992 projection):	3 tons/yr

Company:	C. Ltda. Industrias Quimicos Nobel
City:	Quito
Products Manufactured:	shave cream
Amount of CFCs Used (1992 projection):	0.075 tons/yr

Company:	Laboratorios Negrete
City:	Not Available
Products Manufactured:	Deodorants
Amount of CFCs Used (1992 projection):	30 tons/yr

Company:	Envasadora de Productos Aerosol
City:	Guayaquil
Products Manufactured:	Hair Spray
Amount of CFCs Used (1992 projection):	20 tons/yr

Other Unidentified Firm	
Amount of CFCs Used (1992 projection):	15 tons/yr

F A X   M E M O R A N D U M

2/December/1992

TO: CESAR PLAZA — **Fax: 95 (202) 676 9373**

FROM: GENO NARDINI — **Fax: 52 (5) 399-9130**

Re: OORG Technical Review of Ecuador Aerosol Project

RECOMMENDATIONS:

The Ecuador aerosol projects are based on hydrocarbon propellants, which have been successfully substituted for CFCs in both developed and developing countries. The method of filling these flammable propellants (use of the "open air filling room") is used throughout Mexico, Guatemala, Argentina, Venezuela, etc.

Due to the collateral effect, converting 9 companies, more than 50% of Ecuador's aerosol industry, will undoubtedly result in 100% conversions, as companies filling CFCs will not be able to compete with the companies filling hydrocarbons.

The only problem areas here are the cost and availability of hydrocarbon propellants (HCs). If hydrocarbons are too expensive (at one time in El Salvador, the only supplier of hydrocarbon propellants sold at 90% of the price of CFCs), all economic incentive to convert disappears.

Obviously, availability of HCs is also a necessity, but apparently there is one possible supplier in Guayaquil, and at any rate considering the policies toward open trade that the Duran government has adapted, this should be resolved favorably.

The recommendation is that these projects be approved, but that disbursement of funds not take place until a local supplier of hydrocarbon propellants is functioning.

INFORMATION PROVIDED:

Information is adequate concerning the project detailed for Laboratorios Windsor. Similar information must be developed for the other 8 companies. To adequately address financial aspects of the project, actual sale price of aerosol grade hydrocarbon propellant in Ecuador must be provided.

TECHNICAL SOUNDNESS:

These projects substitute hydrocarbon propellants for CFC propellants, and over 6,000,000,000 aerosols are produced worldwide with hydrocarbon propellants in both developed and developing countries. The technology is established, the substitution is viable, and if done in the manner indicated in the project proposals, this technology is safe.

The not-in-kind substitution specifically recommended for Laboratorios Windsor is also proven and has worked around the world.

PRACTICAL EXPERIENCE:

These projects address individual company conversions when the hydrocarbon propellant supply situation is not fully resolved. Future projects in the aerosol sector should first make available the hydrocarbon propellants, as at least some companies will have sufficient capital and enough cost savings incentive to do their own conversions.

ENVIRONMENTAL ISSUES:

One of the strengths of these projects is that an environmental impact assessment is required. Hydrocarbons are volatile organic compounds (VOCs) and they contribute to global warming. As such they are not regulated federally anywhere in the world at this time, although CARB (California Air Resources Board) regulations on VOCs in the state of California are now affecting their use as aerosol propellants. These factors are not currently affecting usage in developing countries, but are a matter of future concern.

SAFETY ISSUES:

These projects base safety on the "open air filling room" widely used in developing countries with warm climates; and on intensive safety training similar to what is used in developed countries. Safety appears to be adequately addressed here.

COST EFFECTIVENESS:

The projects address cost effectiveness in an approximate and global manner, which is all that can be done until actual cost information is available from authorized importers. The estimates used are in line with the experience in other countries.

ADDITIONAL COMMENTARIES:

To avoid bias due to the fact that this reviewer participated in an earlier mission to Ecuador, these project proposals were independently reviewed by Mr. Jorge Corona, chemical engineer and past president of the Mexican Aerosol Institute, who has indicated that he is in fundamental agreement with the conclusions of this review.

Respectfully submitted,

Geno Nardini

PROJECT COVER SHEET

COUNTRY:	Ecuador
PROJECT TITLE:	Reduced CFC Insulating Foams in Refrigerator Manufacturing
SECTORS COVERED:	Rigid Polyurethane Foams
ODS CONSUMPTION IN SECTOR:	51 MT of CFC-11 in 1992
PROJECT IMPACT: (OBJECTIVE)	Phase out 25.5 MT of CFC-11
PROJECT DURATION:	1 Year
TOTAL PROJECT COST:	US$ 665,000
PROPOSED OTF GRANT: (INCREMENTAL COST)	US$ 665,000
COST EFFECTIVENESS:	US$ 26.10/KG ODP
NATIONAL COORDINATING AGENCY:	Ministry of Industries
IMPLEMENTING AGENCY:	World Bank/UNDP
APPRAISAL DATE:	March 1993

PROJECT SUMMARY

Reduced CFC Insulating Foams in Refrigerator Manufacturing

GRANTEE: Ecuador

COST: US $665,000

BACKGROUND

1. Approximately 51 metric tons (MT) of CFC-11 will be consumed by the three manufactures of domestic refrigerators in Ecuador in 1992 representing about 11 percent of total ODP weighted consumption of ozone depleting substances (470 MT). If uncontrolled, it is estimated that CFC-11 consumption in this application would grow at 2 percent annually. CFC-11 helps create the insulating foam by forming gas bubbles in a polyurethane material which is then blown in refrigerator cabinets supported by molds. The project's objective is to reduce CFC-11 consumption 51 MT to 25.5 MT per year by replacing CFC-11 with a new foam system containing carbon dioxide and water.

2. This project and one in the aerosols sector are of high-priority to the government as they were the two investment initiatives included in the first phase of "Ecuador's Proposed Program for Implementing the Montreal Protocol," the country program (CP) approved at the sixth meeting of the Executive Committee of the Multilateral Fund under the Montreal Protocol (ExCom) in February, 1992.

PROJECT DESCRIPTION

3. The criteria used for selecting the carbon dioxide\water system among six other options are: industrial safety, commercial availability, cost-effectiveness, performance, and compatibility with future technologies. Annex A presents a description of the technology options considered and an evaluation based on these five criteria.

4. As shown in Table 1, the carbon dioxide\water system met all the evaluation criteria. The last criterion, compatibility with future technologies, is important because investment in a partial reduction of CFC-11 should not be duplicated when eliminating the remaining 25.5 MT consumed annually in refrigerator insulation foam. In approximately five years, new technology is expected to be introduced in Ecuador to completely phase out use of CFC-11. The project makes efficient use of resources because the equipment introduced in the project is compatible with the future technology.

TABLE 1: SUMMARY ASSESSMENT OF OPTIONS

CRITERIA / Option	SAFETY	COMMERCIAL AVAILABILITY	COST - EFFECTIVENESS	PERFORMANCE	COMPATIBILITY WITH FUTURE TECHNOLOGIES[a]
Carbon Dioxide/Water (Partial)	Yes[b]	Yes	Yes	Yes	Yes[c]
Carbon Dioxide/Water (Complete)	Yes[b]	Yes	Yes	No	-
HCFCs (High boiling point)	n.a.[d]	No	No	Yes	Yes[c]
HCFCs (Low boiling point)	n.a.	No	No	Yes	Yes
HFCs	n.a.	No	No	Yes	-
Other Blowing Agents	n.a.	No	n.a.	n.a	-
Non-foam insulating technology	n.a.	No	No	Yes	-

a This criterion applies only to technologies that utilize CFC-11 or HCFCs, which will be phased out under current and likely future revisions of the Montreal Protocol; "-" means not applicable.
b Assumes that high pressure injection machines are used, or, if low pressure injection machines are used, measures are taken to protect workers from methylene chloride (see the discussion of safety in Annex A).
c Assumes that no low-pressure injection machines are used.
d n.a. indicates lack of sufficient information for assessment.

5. The existing refrigerator plants require some or all of the following equipment changes to adapt to the carbon dioxide\water system:

- mold modifications, such as adding heaters;
- adding an oven to heat portions of the mold or refrigerator cabinet;
- replacing existing low-pressure foam injection machine with a high-pressure machine; and,
- new ancillary equipment, such as mixing equipment for the foam components.

6. In addition, the change requires trials of the new technology on the plant assembly line. These trials result in down time on production lines for several days.

7. The project would be implemented by three privately-owned refrigerator manufacturing firms: Indurama, S.A. (Indurama), Electrodomesticos Durex, C.A. (Durex), and Ecuatoriana de Artefactos, S.A. (Ecasa).

8. Indurama is located in Cuenca. Indurama makes seven models of refrigerators with CFC-blown foam with an output of 19,000 units per year. Although the company has not tried the low-CFC foam technology, an oven and mixing equipment are available. However, the current injection equipment with the company is inadequate for the new technology. To adopt the carbon dioxide\water technology, Indurama needs to modify its molds, and to obtain a high-pressure foam injection machine.

9. Durex is located in Guayaquil, the primary port and industrial city in Ecuador. Durex makes twelve models of refrigerators with CFC-11, using ten different molds. The company's output of these refrigerators is about 30,600 per year. Durex has performed one trial with the new technology. The trial failed due to inadequate injection equipment and insufficient heating of the molds. Durex does not have mixing equipment or ovens. Thus, to adopt the carbon dioxide\water technology, Durex needs to modify its molds by including mold heaters, add an oven for pre-heating of doors, replace existing injection machine with a high-pressure foam injection machine, and add new mixing equipment.

10. Ecasa is located in Quito and has twelve molds that require modifications. The company used to employ fiber glass as insulating medium but is expected to begin producing refrigerators with CFC-11 blown foam by the end of 1992. An oven is already available in this facility. The injection equipment currently with the company is inadequate for the new technology. Thus, Ecasa needs to modify its molds, replace injection equipment with a high pressure injection machine, and add new mixing equipment.

11. Training of plant managers and workers will be provided by both the suppliers of the equipment and the carbon dioxide\water system.

12. The three companies have expressed interest in the carbon dioxide\water technology because it serves as an interim step towards the phaseout of CFC-11. However these firms lack incentives to undertake the associated investments in the short term due to current unlimited availability of CFC-11. On the basis of the immediate reduction achievable by the project and in view of its future contribution to the full elimination of CFC-11 in this application, the project meets the objectives of the Multilateral Fund. Ecuador is a Party operating under paragraph 1 of Article 5. Based on the information provided above, the project meets the Executive Committee's Implementation Guidelines for Project Selection (UNEP/OzL.Pro/ExCom/3/18/Rev. 1 Annex III).

PROJECT COSTS

13. Total costs this project are estimated to be US$665,000. These costs represent the one-time incremental capital costs required to implement the equipment changes in each plant and training:

Plant	One-time Incremental Cost (US$)	
Indurama	$ 130,000	
Durex	$ 226,000	
Ecasa	$ 176,000	
Subtotal		$ 532,000
Price Contingency (10%)		$ 53,200
Physical Contingency (15%)		$ 79,800
TOTAL		$ 665,000

14. The raw material costs of the carbon dioxide\water system are about the same as the current system. In addition, other operating costs, such as labor and electricity are also expected to remain unchanged. The detailed cost items used to arrive at the above incremental costs per plant are provided in Table 2.

15. The total cost for the project is higher than the US$ 100,000 estimated in the CP. The high pressure foam injection machines accounts for about 80% of the difference (US$ 434,000); however, these machines carry additional benefits: (i) they are compatible with the future likely substitutes (i.e., high pressure blowing agents); (ii) the machines eliminate any need for workers to handle toxic solvents for cleaning the injection nozzle; and, (iii) the machines produce a foam that insulates better and thus improves the refrigerators' energy efficiency. The rest of the difference is accounted for by increases in the estimated costs for mold modifications and blending equipment.

PROJECT IMPLEMENTATION

16. The Ministry of Industries, in coordination with a financial intermediary, will be responsible for overseeing project implementation. The schedule for the project is:

1) Submission to Secretariat of ExCom:	January 11, 1993
2) ExCom Meeting:	February 22-24, 1993
3) Appraisal:	March 1993
4) Yellow Cover MOD Review:	March 1993
5) Negotiations:	April 1993
6) Bank Approval:	April 1993

TECHNICAL ASSESSMENT

17. Annex B includes the technical review conducted by Mr. Michael Jeffs, ICI Polyurethane, and member of the Ozone Operations Resource Group.

TABLE 2: SUMMARY OF INCREMENTAL COSTS OF ADOPTING LOW-CFC FOAM TECHNOLOGY AT THREE REFRIGERATOR PLANTS IN ECUADOR

COMPONENT OF CALCULATION	US $		
	INDURAMA	**DUREX**	**ECASA**
ONE-TIME COSTS			
1. Mold modifications			
a. Number of molds	7	10	12
b. Cost per mold	3,000	7,000	3,000
c. Total cost (1a x 1b)	21,000	70,000	36,000
2. Technical assistance from equipment and material suppliers			
a. Number of days' assistance	5	10	7
b. Cost per day	500	n.a.	n.a.
c. Total cost (2a x 2b)	2,500	n.a.[1]	n.a.[1]
3. Cost of new equipment			
a. Injection equipment	106,500	120,700	120,000
b. Blending equipment	0	20,000	20,000
c. Pre-heating tunnel for doors	0	15,000	0
d. Total cost (3a+3b+3c)	106,500	155,700	140,000
5. Total one-time cost (1c+2c+3d)	130,000	225,700	176,000
6. Total costs rounded to the nearest US$1000	130,000	226,000	176,000

[1]n.a.: not available. The equipment cost estimates for these two facilities include training costs.

ANNEX A - SELECTION OF TECHNOLOGY OPTION

Criteria for Selection

1.The criteria used to select among various technologies for reducing CFC-11 in this project are:

- **Industrial Safety**: It is important to consider possible industrial hazards presented by chemicals involved in the new technologies. Some of the chemicals may be toxic or flammable.

- **Commercial availability of the technology:** Supplies of equipment, parts and raw materials in Ecuador should be ensured.

- **Cost-Effectiveness:** All incremental costs should be considered. This includes both one-time costs and recurrent costs. One-time costs are those that occur just once, when the technology is first adopted. They include costs for such items as mold modifications, plant trials, technical assistance, and new equipment. Recurrent costs are those that are incurred continuously as long as the technology operates. They include costs such as raw materials, labor, and energy. Prices of blowing agents are an important component of raw material costs. Table A.1 provides information on the prices of blowing agents.[1]

- **Performance:** The technology option must be able to (i) reduce CFC consumption; (ii) produce a foam of good insulating power; and (iii) impart mechanical strength and stability to the refrigerator cabinet.

- **Compatibility with future technologies:** To further reduce the consumption of ozone depleting substances CFC-11 and the HCFCs will eventually be phased out. An option for immediate action will be incompatible with the future change if it requires a large investment that will be retired prematurely when that change is made.

2. In addition, any manufacturing process needs to be evaluated for its environmental impacts, such as local air pollution, global atmospheric effects, and contamination of water. In particular, the substitutes for CFC-11 have varying global warming potential (GWP). However, this factor did not affect this decision because only one effective technology is available. Environmental impacts of the selected option are not significantly different than the existing technology.

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[1] The cost of blowing agent per pound of foam depends on both the cost per pound of blowing agent and pounds of blowing agent required per pound of foam.

Table A.1 - PRICES OF BLOWING AGENTS (US$/KG)[2]

BLOWING AGENT	FROM PRODUCER	FROM DISTRIBUTOR
CFC-11	2.33-2.88	4.36
HCFC-22	2.31	3.50
HCFC-123	Not available	12.21
HFC-141b	5.50-6.00	8.80
HCFC-142b	Not available	Not available
HCFC-134a	15.40-22.00	24.13
HFC-152a	Not available	4.18

Description of Options

3. Seven options were considered for reducing the CFC-11 content of insulating foams in refrigerators in Ecuador. Each of these is described below.

- **Partial replacement of CFC-11 with carbon dioxide/water**: This method is carried out by changing the relative proportions of the two parts of the conventional liquid foam formulation. Also, water is added to the formulation. Carbon dioxide, which is generated in a reaction between water and isocyanates, evolves in gaseous form and acts as a blowing agent. Therefore, the amount of CFC-11 in the formulation can be decreased by 30%-50%.

- **Complete replacement of CFC-11 with carbon dioxide/water**: This is accomplished through the same means as partial replacement of CFC-11 with carbon dioxide/water, except that more water is used. With this method, sufficient carbon dioxide is generated to form the foam with no CFC-11 being present.

- **Replacement of CFC-11 with high-boiling point HCFCs**: In this option, all of the CFC-11 in the formulation is eliminated and replaced with HCFC-123 or HCFC-141b. These HCFCs have normal boiling points near that of CFC-11 (75 degrees Fahrenheit), a characteristic that allows them to be handled in liquid form in much the same way as CFC-11.

- **Replacement of CFC-11 with low-boiling point HCFCs**: This method eliminates all of the CFC-11 in the foam by replacing it with HCFC-142b or an HCFC-22/HCFC-

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[2] Prices given are approximate ones obtained from fluorocarbon suppliers in the United States. Prices do not include taxes, duties, freight and are subject to change over time.

142b blend. These HCFCs have normal boiling points much lower than room temperature, which means that they exist as gases at room temperature and pressure. Because of this, the gases and the formulations that contain them can be handled only in equipment capable of withstanding high pressure.

- **Replacement of CFC-11 with HFCs**: In this option, all of the CFC-11 is replaced with HFC-134a, HFC-125, or HFC-152a. These substances also have low boiling points and therefore, equipment used in this method must be capable of withstanding high pressure.

- **Replacement of CFC-11 with other blowing agents**: There are several other substances that are being considered as possible substitutes for CFC-11. They are neither HCFCs nor HFCs and include substances with high and low boiling points. Examples of substances with low-boiling points include air, helium, argon, and sulfur hexafluoride. Examples of substances with high boiling points include pentane, methyl formate, dimethoxymethane, propylene oxide, tert-butyl methyl ether, and fluorinated ethers.

- **Use of insulating technology other than foams**: Another option is to replace the foam itself with some other insulating medium such as vacuum panels. These are hollow panels or chambers that have been evacuated. The vacuum does not conduct heat, and hence the panel serves as an effective insulator.

Evaluation of Options

4. Table A.2 presents the evaluation of the seven technology options considered.

Selection of Option

5. The only technology that meets all the requirements and can be recommended for immediate action to reduce CFC-11 in rigid insulating foams for refrigerators is the partial replacement of CFC-11 with carbon dioxide/water. The complete replacement of CFC-11 with carbon dioxide/water is also available, but the resulting foam does not perform effectively.

Table A.2: Evaluation of Options

CRITERIA OPTIONS	SAFETY	COMMERCIAL AVAILABILITY	COST EFFECTIVENESS	PERFORMANCE	COMPATIBILITY WITH FUTURE TECHNOLOGIES
CARBON DIOXIDE/ WATER (PARTIAL)	This technology does not introduce new hazards into workplaces or households. It may, however, remove a hazard from the workplace. When high pressure injection equipment replaces low pressure injection equipment in implementing the technology, methylene chloride (which may harm human health) will no longer be required for cleaning the injection nozzle after each refrigerator cabinet is filled with foam. The nozzles of high pressure injection machines do not require cleaning.	This technology is currently available and has been adopted by European refrigerator manufacturers. It is being sold by some foam suppliers to refrigerator manufacturers in developing countries.	There are no recurrent incremental costs. The cost of raw materials is unchanged because the mix of raw materials changes (water is added and polyol concentration increases) to offset the CFC-11 savings. There are no increases in energy or labor costs. One-time costs include those associated with injection machines, mold modifications, mixing tanks and plant trials.	No change when high pressure equipment is used.	High pressure injection equipment is compatible with future measures.
CARBON DIOXIDE/ WATER (COMPLETE)	The evaluation is the same as for this criterion in the immediately preceding technology.	The evaluation is the same as for this criterion in the immediately preceding technology.	The evaluation is the same as for this criterion in the immediately preceding technology.	Although this method eliminates all the ozone-depleting potential, it results in a drastic reduction in insulating power that makes the foam inadequate for refrigeration appliances in which heat loss through cabinet walls is critical. This option is not practical because heat loss through cabinet walls must be kept to a minimum in household refrigerators to keep operating costs acceptably low.	The evaluation is the same for this criteria in the immediately preceding technology.

Table A.2: Continued ...

CRITERIA OPTIONS	SAFETY	COMMERCIAL AVAILABILITY	COST EFFECTIVENESS	PERFORMANCE	COMPATIBILITY WITH FUTURE TECHNOLOGIES
CARBON DIOXIDE/ WATER (PARTIAL)	This technology does not introduce new hazards into workplaces or households. It may, however, remove a hazard from the workplace. When high pressure injection equipment replaces low pressure injection equipment in implementing the technology, methylene chloride (which may harm human health) will no longer be required for cleaning the injection nozzle after each refrigerator cabinet is filled with foam. The nozzles of high pressure injection machines do not require cleaning.	This technology is currently available and has been adopted by European refrigerator manufacturers. It is being sold by some foam suppliers to refrigerator manufacturers in developing countries.	There are no recurrent incremental costs. The cost of raw materials is unchanged because the mix of raw materials changes (water is added and polyol concentration increases) to offset the CFC-11 savings. There are no increases in energy or labor costs. One-time costs include those associated with injection machines, mold modifications, mixing tanks and plant trials.	No change when high pressure equipment is used.	High pressure injection equipment is compatible with future measures.
HCFCs (HIGH BOILING POINT)	HCFC-123 and HCFC-141b are not harmful to human health when used in a manufacturing process that is properly ventilated and controlled. The issue of methylene chloride use applies in this option the same way as in both above options.	HCFC-141b foam systems are available. However, appliance manufacturers are not yet using them widely. HCFC-123 systems are unavailable.	The costs of this technology are not yet known; however, it is likely to be more expensive than the above technologies because HCFC-123 and HCFC-141b are priced higher than CFC-11. Moreover, additional recurrent costs may result from the chemical incompatibility between these HCFCs and the refrigerator cabinet liners. The composition of the liners , usually composed of polystyrene or ABS (acrylonitrile-butadiene-styrene) might have to be changed to a more expensive material to prevent blistering and	Foams made with HCFC-123 and HCFC-141b would provide approximately the same insulating capacity as foams made with the current technology. They would have 80%-98% less ozone-depleting potential.	The evaluation is the same as for this criterion on the first technology.

Table A.2: Continued ...

CRITERIA OPTIONS	SAFETY	COMMERCIAL AVAILABILITY	COST EFFECTIVENESS	PERFORMANCE	COMPATIBILITY WITH FUTURE TECHNOLOGIES
CARBON DIOXIDE/ WATER (PARTIAL)	This technology does not introduce new hazards into workplaces or households. It may, however, remove a hazard from the workplace. When high pressure injection equipment replaces low pressure injection equipment in implementing the technology, methylene chloride (which may harm human health) will no longer be required for cleaning the injection nozzle after each refrigerator cabinet is filled with foam. The nozzles of high pressure injection machines do not require cleaning.	This technology is currently available and has been adopted by European refrigerator manufacturers. It is being sold by some foam suppliers to refrigerator manufacturers in developing countries.	There are no recurrent incremental costs. The cost of raw materials is unchanged because the mix of raw materials changes (water is added and polyol concentration increases) to offset the CFC-11 savings. There are no increases in energy or labor costs. One-time costs include those associated with injection machines, mold modifications, mixing tanks and plant trials.	No change when high pressure equipment is used.	High pressure injection equipment is compatible with future measures.
HCFCs (LOW BOILING POINT)	There is little concern over the health effects of HCFC-22, because it has been used for years with few problems in other applications when properly managed to prevent catastrophic discharges. HCFC-123 is also safe when properly managed.	Foam manufacturers are still testing foam systems made with low-boiling HCFCs. Thus, the technology remains unavailable to refrigerator manufacturers.	The costs of this technology are not yet known. However, the costs are likely to be higher than those of the preceding option. This is due to additional costs associated with the handling of raw materials that contain the blowing agent at higher pressure.	The thermal conductivity is higher for HCFC-142b and HCFC-22 than for the high-boiling point HCFCs, resulting in less effective insulation. However, the insulation would be more effective than that made with complete replacement with carbon dioxide/water. The resulting foam would have an ODP 95% lower.	The technology would be compatible with future technologies for ozone protection because it cannot be used with low pressure injection equipment.

Table A.2: Continued ...

CRITERIA OPTIONS	SAFETY	COMMERCIAL AVAILABILITY	COST EFFECTIVENESS	PERFORMANCE	COMPATIBILITY WITH FUTURE TECHNOLOGIES
CARBON DIOXIDE/ WATER (PARTIAL)	This technology does not introduce new hazards into workplaces or households. It may, however, remove a hazard from the workplace. When high pressure injection equipment replaces low pressure injection equipment in implementing the technology, methylene chloride (which may harm human health) will no longer be required for cleaning the injection nozzle after each refrigerator cabinet is filled with foam. The nozzles of high pressure injection machines do not require cleaning.	This technology is currently available and has been adopted by European refrigerator manufacturers. It is being sold by some foam suppliers to refrigerator manufacturers in developing countries.	There are no recurrent incremental costs. The cost of raw materials is unchanged because the mix of raw materials changes (water is added and polyol concentration increases) to offset the CFC-11 savings. There are no increases in energy or labor costs. One-time costs include those associated with injection machines, mold modifications, mixing tanks and plant trials.	No change when high pressure equipment is used.	High pressure injection equipment is compatible with future measures.
HFCs	There is little concern over the toxicity of HFC-152a, because this substance has been used in other applications for many years with no problems. HFC-152a presents a safety hazard to workers and consumers because it is flammable. Recently, it has been determined that both HFC-125 and HFC-134a are safe.	Foam manufacturers are still testing foam systems made with HFCs. Thus, the technology remains unavailable to refrigerator manufacturers.	The costs of this technology are not yet known in detail. However, the costs are likely to be similar to those of the preceding option. HFCs do not attack liner materials, so costs for more expensive liner materials could be avoided. However, this savings would be offset by increases in raw materials costs due to the fact that HFCs are more expensive than the HCFCs (the exception to this is HFC-152a, which costs about the same as CFC-11).	The thermal conductivity is higher for HFCs than for the low-boiling point HCFCs, resulting in less effective insulation. However, the insulation would be more effective than that made with complete replacement with carbon dioxide/water. The technology would result in foam with zero ozone-depleting potential.	This criterion does not apply to this technology. Because the technology completely eliminates ozone-depleting potential, no future measures would be required.

Table A.2: Continued ...

CRITERIA OPTIONS	SAFETY	COMMERCIAL AVAILABILITY	COST EFFECTIVENESS	PERFORMANCE	COMPATIBILITY WITH FUTURE TECHNOLOGIES
CARBON DIOXIDE/ WATER (PARTIAL)	This technology does not introduce new hazards into workplaces or households. It may, however, remove a hazard from the workplace. When high pressure injection equipment replaces low pressure injection equipment in implementing the technology, methylene chloride (which may harm human health) will no longer be required for cleaning the injection nozzle after each refrigerator cabinet is filled with foam. The nozzles of high pressure injection machines do not require cleaning.	This technology is currently available and has been adopted by European refrigerator manufacturers. It is being sold by some foam suppliers to refrigerator manufacturers in developing countries.	There are no recurrent incremental costs. The cost of raw materials is unchanged because the mix of raw materials changes (water is added and polyol concentration increases) to offset the CFC-11 savings. There are no increases in energy or labor costs. One-time costs include those associated with injection machines, mold modifications, mixing tanks and plant trials.	No change when high pressure equipment is used.	High pressure injection equipment is compatible with future measures.
OTHER BLOWING AGENTS	This technology is at an earlier stage of development. Therefore, little information is available on safety aspects.	The technology is not commercially available.	Little information on costs is available.	The technology would reduce the ozone-depleting potential of the foam to zero. Little information is available on insulating effectiveness.	This criterion does not apply to this technology. Because the technology completely eliminates ozone-depleting potential, no future measures would be required.
NON-FOAM INSULATING TECHNOLOGY	This technology is at an earlier stage of development. Therefore, little information is available on safety aspects.	The technology is not commercially available.	Little information on costs is available. However, the one-time costs, at least, are likely to be high because a different structure and manufacturing method for the refrigerator cabinets would have to be adopted.	The technology would reduce the ozone-depleting potential of the foam to zero. Little information is available on insulating effectiveness.	This criterion does not apply to this technology. Because the technology completely eliminates ozone-depleting potential, no future measures would be required.

Polyurethanes

Mr. C. Plaza
Task Manager LATEN
World Bank

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9th December, 1992

ECUADOR REFRIGERATORS SUB PROJECT

Dear Mr. Plaza,

Thank you for your note of 7/12/92.

I attach another copy of my report, with the error on P2 corrected. This should clear away any misunderstanding.

The "cost effectiveness" comparison was made with other projects with annual CFC savings in the range 175 to 2,200 tes. I am not sure if all of these had been costed in the same degree of detail as the case under consideration here.

Referring to your final point - I agree that discussion of a single production unit, except in the hypothetical sense, is not relevant. However, this is a supporting argument in this case since it helps to explain the seemingly high cost / unit saving of ODS.

I hope the above comments are useful.

Yours sincerely,

Dr. G. M. F. Jaffe
GMFJ/kd

cc : Mr. T. W. Waltz

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3rd December, 1992

ECUADOR - REFRIGERATORS SUB PROJECT

Review of Project by Dr. G. M. F. Jeffs. OORG

1. **RECOMMENDATION**

The project is supported. This judgement is reached despite the high costs per unit of ODS saved because the technology proposed is well proven, energy efficiency would be, at least, maintained and the equipment changes will enable the factories to subsequently phase out the use of CFC 11.

2. **RELEVANCY AND ADEQUACY OF INFORMATION**

In reviewing the project further information was sought and obtained on the need to replace the current dispensing equipment at the Indurana, Dunex and Ecasa factories. This had to be more fully researched since this item amounted to 54% of the total proposal (before contingencies).

3. **TECHNICAL SOUNDNESS**

The project proposal covers the replacement of polyurethane rigid foam insulation for refrigerators which is based on a high level of CFC 11 by alternative foam systems using approximately half of the amount of CFC 11 supplemented by CO_2 generated by the water-isocyanate reaction. This is normally termed reduced CFC technology. Such technology is well proven elsewhere and has been in use in W. Europe for 4 years.

The main issue to consider in this instance was the cost of re-equipping the three factories with high pressure (hp) dispensing equipment to replace the current low pressure (lp) equipment. One of the advantages of hp equipment is improved foam quality and optimised thermal insulation efficiency for a given blowing agent. It is therefore considered justifiable to replace the current lp dispensers to maintain insulation efficiency with the reduced CFC technology and subsequent CFC-free technologies.

It should be noted that hp dispensers are the worldwide industry standard, for the reason given above.

It should be noted that if the technology route chosen to replace reduced CFC 11 blowing is that based on HCFC 22 / HCFC 142b then additional expenditure will be necessary.

The training and experience gained will be useful in the next step of complete CFC elimination.

4. LESSONS FROM EXPERIENCE

Project proposals should no longer include the HCFC 123 option. It is not being considered by any developed country refrigerator producers because of the current low TLV of 10 ppm (provisional level) and is unlikely to be produced in other than minor quantities.

The project is fundamentally straight forward with the merit of looking ahead to full CFC elimination.

5. ENVIRONMENTAL ISSUES

The technology change, in the first instance, still uses CFC 11 but will make significant savings in its use and is a stepping stone to full CFC elimination. The adoption of hp dispensing equipment eliminates the need for methylene chloride to clean the mixing heads.

6. SAFETY ISSUES

Provided training and service back-up is provided by the hp dispenser suppliers there are no additional safety issues.

7. COST EFFECTIVENESS

In the reviewer's experience CFC replacement projects in the foam area run at 1 to 2 $/kg ODS per year. This project is well above that band at 6.5 $/kg ODS per year, mainly because of the dispenser issue already covered.

The fundamental problem is the low level of production at two of the factories, totalling about 50,000 units per year (no production information at Ecasa). These levels could be reached by a single production unit with the associated capital cost savings.

G. M. F. Jeffs
GMFJ/kd

cc : Mr. T. W. Waltz, ENVGC

The World Bank/IFC/MIGA
OFFICE MEMORANDUM

DATE: January 28, 1993 11:30am

TO: Tom Waltz (TOM WALTZ)
TO: Ken Newcombe (KEN NEWCOMBE)

FROM: Cesar Plaza, LATEN (CESAR PLAZA)

EXT.: 38598

SUBJECT: Ecuador MP Projects-Reply to Comments Received from MP Secretaria

Tom:

Thank you for sending us the comments from the Secretariat on Ecuador's proposed projects. The following may clarify Mr. Hiro Wakai's queries.

General Comments

Somehow we must impress upon the Secretariat that while the Country Program (CP) constitutes the original base document, all subsequent documents produced as a result of further project preparation activities (including feasibility studies and field work) are necessarilly updated to reflect more accurate and realistic data. Thus, it does not make sense to review proposed projects in light of the CP and imply there are inconsistencies with the recent proposal. As we found out during project preparation while some items in the CP had been over estimated the opposite was true for others. This is usually the case in the process of project identificaction. Thus, our project proposal incorporates, where required, pertinent adjustments not only on costs but also on scope and objectives (e.i. the training component). With this in mind, our response is as follows:

AAA Institutional Strengthening

List of equipment and estimated cost of operating expenses are based on detailed review carried out during pre-appraisal and represent minimun needs. Total cost is in fact $105,172 less than what was indicated in the CP (385,000-279,828) and the amout of grant requested ($204,000) is 47 per cent less than what was originally envisaged as grant for this component.

BBB Training and Technological Dissemination.

Para 1. While it is true this sub project will be (it already is) executed by UNDP, it is part of the CP and as such it should be considered as an integral element of the proposal. Obviously funds should be allocated to UNDP's account.

Para 2. The objectives and scope of this sub project were enhanced to reflect actual needs and make more efficiente use of funds. As originally proposed in the CP (for Phase 1 of the Program) this sub project was limited to "material handling training of refrigerant conservation". For such objective the estimated cost ($100,000) would have been adequate. However, field work findings revealed it would not have been prudent to circunscribe training to a very small area of concern and reduced audience while ignoring the main objectives of the Protocol whithin the national context of protecting the ozone layer. Thus, as presented, while the objective would be to provide technical information to all sectors using controlled substances it would also disseminate information about ozone protection to other interested official entities and to the public in general. Thus the reason for the increase in cost to $250,000. However, let's keep in mind that $100,000 were already approved back in March 1992, so that we are now only requesting the incremental portion ($150,000) as a result of project enhacement.

While it is correct to asume that specific technical training is included in each of the investment project proposals, such training would be designed to cover "plant specific subjects" such as material handling and operation of new equipment in each plant. However, costs shown under the Training and Dissemination Sub Project in the areas of aerosol and foams are for training of a more general nature and would be aimed at wider audiences.

The equipment requested for implementation of this project at a cost of $28,600 is not the same as the equipment listed under the institutional strengthening component. We are talking about two different activities to be carried out by different staff (the training coordinator and a secretary). Therefore, it is not doble counting

CCC Conversion of Aerosols Plants to Hydrocarbon Propellants

Para. 2 At this point in time we do not know what the actual cost of hydrocarbon propellants would be in Ecuador since there have not been imports in the past. As in other Bank MP projects, our analysis is based on international prices plus surcharges that we think would be applicable to Ecuador. More precise estimates in this regard are expected after project appraisal.

Para. 3 Since we had detailed estimates for four plants and we needed to make provisions for other 14 potential beneficiaries, an average cost of the known 4 plants was calculated and used to project the estimate for the other 14 as a group. This was clearly explained in my EM of last week. However, we should have explained the methology in the text of the sub project (under Table 1 "Incremental Costs for Ecuador's Aerosol Plants". We are sending you a corrected hard copy of page 4 of the aersols sub project.

Para. 4 I agree that it would be more cost effective to provide training to technical staff of all the plants at the same time, however, this is not feasible for the following reasons: i) investment for each plant is based on a "tailor made" design. Thus, plant layout and equipment to be installed would be different in each case, not to mention internal operating procedures; ii) plants are in different geographical locations; and iii) it is not expected that all plants would como into the program at the same time.

Para 5. Environmental impact assessment would be required from each plant to determine the potential negative impact on the environment the project may have and to determine remedial actions. This is a Bank requirement and it is common sense since we would be dealing with highly flameable substances. It has nothing to do with the technical feasibility of the technology proposed but rather with possible adverse impacts of such technology on the environment, and with corrective actions.

The $300,000 allocated in March by the ExCom were for preparation of feasibility studies. We did not use them. We resorted instead to MP operating funds allocated for project preparation. I was unaware of the existence of $6,000 as bilateral contribution of the USA for this purpose. However, US EPA did contribute for project preparation with about $50,000 under a bilateral agreement with the GOE.

Para. 6 Physical contingencies (15% of total project costs) are included to cover costs of additional pieces of equipment or of additional infrastructure modification (or construction) impossible to forsee until actual project execution starts. The use of this coefficient is common practice in the preparation of Bank projects.

Para.7 Yes. Mr Nardini's comments were incorporated.

DDD Reduced CFC in Insulating Foams for Refrigerators

Para. 2 We did not use these funds. The feasibility study was carried out (at a much lower cost) with our own MP operating funds and with the assistance of US EPA.

In the implementation of Phase 1 of the CP, the Bank will be responsible of coordinating execution of the investment and institutional strengthening sub projects while UNDP is already in charge of executing the Training and Technological Dissemination sub project.

Para. 3 The incremental cost of $665,000 for the foams project has nothing to do with the $100,000 assigned (and already disbursed) to UNDP for training. These figures are not related.

Para. 4 Yes. Mr. Jeff's comments were taken into consideration the project's design.