EP

United Nations
Environment
Programme

Distr.
LIMITED

UNEP/OzL.Pro/ExCom/15/33
20 November 1994

ORIGINAL: ENGLISH

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

Fifteenth Meeting
Montreal, 13-16 December 1994

PROJECT PROPOSALS: MEXICO

This document includes the following project proposals and the Fund Secretariat's Comments and Recommendations. The project proposals have been grouped by project sector. The agency responsible for the implementation of the project is also indicated. The project proposals are presented in the order indicated below. The Fund Secretariat's Comments and Recommendations are presented at the front of the document.

Refrigeration

- Elimination of CFC in the manufacture of domestic refrigerators for the Mabe Group	UNDP
- Elimination of CFC in the manufacture of domestic refrigerators by the Vitro Group of companies	UNDP

Solvent

- Elimination of 1,1,1 TCA from the precision cleaning processes at Lucas Diesel	UNDP
- Elimination of CFC-113 from the textile cleaning processes at Procesadora y Revitalizadora	UNDP

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Mexico
PROJECT TITLE:	Elimination of CFC in the Manufacture of Domestic Refrigerators for the MABE Group (two refrigerator manufacturers: ASTRAL and ENRESA, and one compressor manufacturer: COMASA)
BUDGET:	US \$2,585,814 (Incremental Capital Cost) US \$1,588,831 (Incremental Operating Cost)
INCREMENTAL COSTS:	US \$4,174,645[1]
ODS PHASE-OUT:	327 MT of CFC-11 100 MT of CFC-12
COST EFFECTIVENESS:	US \$10.68 per Kg. ODP saved
PROJECT DURATION:	18 months
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY :	Ozone Protection Unit, National Institute of Ecology (INE)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. This project will eliminate CFC consumption in the manufacture of domestic refrigerators by the MABE Group of Companies. The project encompasses three enterprises within the MABE Group, ASTRAL and ENRESA, two manufacturers of refrigerators, and COMASA, a compressor manufacturer, in Mexico. Two of the enterprises (ASTRAL and ENRESA) are 100 per cent nationally owned, while the third enterprise (COMASA), is 65 per cent nationally owned. The total CFC phase-out by this project will be 327 MT of CFC-11 and 100 MT of CFC-12, representing about 53 per cent of ODS consumption in the domestic refrigeration sector.

2. The two refrigerator manufacturers currently use CFC-11 as a blowing agent in the production of rigid PU insulation foam for cabinets and doors, and CFC-12 as refrigerant. This project will result in conversion from CFC-11 to HCFC-141b, and CFC-12 to HFC-134a, respectively. HCFC-141b is a transitional substance. The choice of HCFC-141b is dictated by the strict energy standards applied in the country.

1. For the 34 percent export of ASTRAL to non-Article 5 countries, the related proportionate cost has been deducted from this figure. In respect of COMASA, adjusted to reflect the local ownership of 65 per cent.

3. COMASA will convert to HFC-134a compressor production in a joint venture with SANYO, a foreign partner. The joint venture will increase the production capacity threefold. Capital costs for COMASA have been prorated to reflect the existing capacity. COMASA will be compensated accordingly. The cost of conversion for COMASA in the project has reflected this situation. In addition, the foreign ownership of 35 per cent in COMASA has also been accounted for.

4. Funds requested will be used to change the existing production lines, and for re-design, testing, pre-production trials, and training. Incremental Operating Costs resulting from the change to the new technology are requested for the refrigerator manufacturers for a period of six months. This is a very cost-effective project in the domestic refrigeration sub-sector.

5. Currently, ASTRAL exports 34 per cent of its products to non-Article 5 countries and this share has been deducted by the implementing agency from the funding level being requested. Outcome of the deliberation of the Executive Committee on the issue of export may have an impact on the funding of the project.

6. United States Environmental Protection Agency (USEPA) have been assisting in the preparation of the project proposal for ASTRAL company.

SECRETARIAT'S RECOMMENDATIONS

7. The Fund Secretariat recommends approval of the project in the amount of US $4,174,645 to cover both the incremental capital and operating costs.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Mexico
PROJECT TITLE:	Elimination of CFC in the Manufacture of Domestic Refrigerators by the VITRO Group of Companies (two refrigerator manufacturers: Supermatic and Erna, one compressor manufacturer: Facosa)
BUDGET:	US $1,592,960 (Incremental Capital Cost) US $1,812,270 (Incremental Operating Cost)
INCREMENTAL COSTS:	US $3,405.230[1]
ODS PHASE-OUT:	375 MT of CFC-11 81 MT of CFC-12
COST EFFECTIVENESS:	US $8.21 per Kg. ODP saved
PROJECT DURATION:	18 months
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY :	Ozone Protection Unit, National Institute of Ecology (INE)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. This project will eliminate CFC consumption in the manufacture of domestic refrigerators by the VITRO Group of Companies. The project encompasses three enterprises within the VITRO Group, Supermatic and Erna, who manufacture refrigerators, and Facosa, a compressor manufacturer, in Mexico. All of them are 100 per cent nationally owned. The total CFC phase-out by this project will be 375 MT of CFC-11 and 81 MT of CFC-12, representing about 47 per cent of ODS consumption in the domestic refrigeration sector.

2. The two refrigerator manufacturers currently use CFC-11 as a blowing agent in the production of rigid PU insulation foam for cabinets and doors, and CFC-12 as refrigerant. Compressors are sourced from Facosa (56 per cent), and from EMBRACO, Brazil. This project will result in conversion from CFC-11 to HCFC-141b, and CFC-12 to HFC-134a, respectively. Facosa will convert to HFC-134a compressor production. HCFC-141b is a transitional substance. The choice of HCFC-141b is dictated by the strict energy standards applied in the country.

1. For the 24 percent export of Supermatic to non-Article 5 countries, the related proportionate cost has been deducted from this figure.

3. Funds requested will be used to change the existing production lines, and for re-design, testing, pre-production trials, and training. Incremental Operating Costs resulting from the change to the new technology are requested for the refrigerator manufacturers for a period of six months. This is a very cost-effective project in the domestic refrigeration sub-sector.

4. Currently, Supermatic exports 24 per cent of its products to non-Article 5 countries and this share has been deducted by the implementing agency from the funding level being requested. Outcome of the deliberation of the Executive Committee on the issue of export may have an impact on the funding of the project.

SECRETARIAT'S RECOMMENDATIONS

5. The Fund Secretariat recommends approval of the project in the amount of US $3,405,230 to cover both the incremental capital and operating costs.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Mexico
PROJECT TITLE:	1. Elimination of CFC-113 from the Textile Cleaning Process at Procesadora y Revitalizadora Company; 2. Elimination of 1.1.1 TCA from Precision Cleaning Processes at Lucas Diesel Company
BUDGET:	US $515,130 (Capital Costs) US $ 70,801[1]
INCREMENTAL COSTS:	US $239,337
ODS PHASE-OUT:	3.4 MT of CFC-113 (2.72 MT ODP) per year 28 MT of 1.1.1 TCA (2.8 MT ODP) per year
COST EFFECTIVENESS:	US $43.36 per Kg. ODP saved
PROJECT DURATION:	Procesadora: 6 months Lucas Diesel: 6 months
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY :	National Institute of Ecology
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. The two project proposals are addressed together in these comments.

2. Implementation of these two projects will result in an estimated annual phase-out of 3.4 MT of CFC-113 (2.72 MT ODP) and 28 MT of 1.1.1 TCA (2.8 MT ODP).

3. Phase out of ODS will be accomplished by replacing the current dry cleaning machines with vapour-tight dry cleaning equipment to use non-chlorinated hydrocarbon solvent at Procesadora Company and by replacing vapour degreasers with non-ODS aqueous cleaning equipment in Lucas Diesel Company.

4. Hydrocarbon emissions and waste water effluents will be prevented by installing recovery systems.

---

1. Calculated for four years of operation.

5. The cost-effectiveness is low but comparable with other projects approved by the Executive Committee in this sector.

SECRETARIAT'S RECOMMENDATIONS

6. The Fund Secretariat recommends approval of the two projects and approval of the incremental costs as follows:

Company	ODS Phased Out per Year	Capital Costs US $	Operating Costs US $	Total Incremental Costs per Company
Procesadora	3.4 MT CFC-113	70,455	882	71,337
Lucas Diesel	28 MT 1.1.1 TCA	444,675	60,919	168,000[1]
Total	3.4 MT CFC-113 28 MT 1.1.1 TCA	515,130	70,801	239,337

1. Adjusted according to contribution from enterprise amounted to US $346,594.

COUNTRY:	Republic of Mexico
PROJECT TITLE:	Elimination of 1,1,1 TCA from the Precision Cleaning Processes at Lucas Diesel
SECTOR COVERED:	Solvent Cleaning
ODS USE IN SECTOR:	1,500 MT of CFC-113 solvent in 1992 2,900 MT of 1,1,1 trichloroethane (TCA) in 1992 Total ODP-weighted consumption of ODS in 1992 = 1,490 MT
PROJECT IMPACT:	Elimination of 28 MT of TCA annually (2.8 ODP-weighted MT)
PROJECT DURATION:	6 months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	ODS Reduction Investment Cost: US$ 444,675 Incremental Operating Costs[1]: US$ 69,919 Total ODS Reduction Project Cost: US$ 514,594 Contribution from Enterprise: US$ 346,594
PROPOSED OTF FINANCING:	US$ 168,000 as grant
IMPLEMENTING ENTERPRISE:	Lucas Diesel
COORDINATING AGENCY:	National Institute of Ecology (INE)
IMPLEMENTING AGENCY:	UNDP

PROJECT SUMMARY

This project will eliminate the annual consumption of 28 MT of TCA by replacing Lucas Diesel's current TCA-based cleaning process with one that uses a non-ozone depleting, non-chlorinated aqueous detergent. Currently, the enterprise uses TCA in two batch vapor degreasers to remove heavy machine oils, metal filings, and other contaminants from metal engine components that otherwise would contaminate such products and degrade their quality. The new cleaning process will require the purchase and installation of equipment capable of cleaning with the new aqueous solution. The new equipment will include filtration and recycling equipment capable of reclaiming the maximum amount of water, detergent, and rust inhibitor. A vacuum drying system is also included as a part of this project application to ensure the complete removal of water from the enterprise's products.

[1] Net present value of the first four years of operating costs/savings.

PROJECT OF THE REPUBLIC OF MEXICO

ELIMINATION OF 1,1,1 TCA FROM THE PRECISION CLEANING PROCESSES AT LUCAS DIESEL

1. PROJECT OBJECTIVE

The objective of this project is to eliminate the annual consumption of 28 MT of TCA from Lucas Diesel's precision cleaning processes through the use of ultrasonic aqueous cleaning equipment and non-ozone-depleting, aqueous-based detergents with corrosion inhibiting additives.

2. SECTOR BACKGROUND

Two ozone-depleting substances, CFC-113 and TCA, are widely used in cleaning applications by Mexican industry. The ODS consuming industry consists of manufacturers of automotive products, electronic assemblies, textile cleaning, and adhesive and paint formulators. ODS solvents are used to clean both electronic components and metal parts. A large fraction of these companies are partly or wholly Mexican owned while the remainder are owned by multinational firms. In 1992, the ODS solvent using industries in Mexico consumed 1,500 MT of CFC-113 and 2,900 MT of TCA. A third ODS solvent, carbon tetrachloride, is not used in Mexico for cleaning.

3. ENTERPRISE BACKGROUND

Lucas Diesel is an 78 percent Mexican-owned manufacturer of diesel engine parts. The company's remaining 22 percent ownership is British. Lucas Diesel is a subsidiary of the Lucas Automotive Group, one of largest industrial organizations in the United Kingdom, and reported product sales of approximately US$ 18 million in 1992. Lucas Diesel employs approximately 400 people at its facility in Saltillo, and maintains the technical personnel necessary to successfully execute this project.

4. PROJECT DESCRIPTION

4.1 Process Soils

The cleaning processes used by Lucas Diesel are designed to remove hydrocarbon machine oils, metal filings, and other particulates deposited on metal engine components during their manufacture. Because the components are metallic, the alternative cleaning agent must be formulated to prevent corrosion of the parts being cleaned.

4.2 Present Process

Lucas Diesel consumes approximately 28 MT of TCA annually in two separate vapor degreasers to clean metal engine components such as fuel injectors and filters. The cleaning processes remove heavy machine oils, metal filings, and other contaminants that otherwise would contaminate the products and result in permanent degradation of product quality.

4.3 Proposed Alternative Process

For this project, Lucas Diesel will eliminate its consumption of TCA by replacing its existing vapor degreasing equipment with non-chlorinated, aqueous-based ultrasonic cleaning equipment. The capacity of the aqueous equipment is approximately the same as the existing vapor degreasers. The conversion to a non-ozone-depleting technology consists of the following elements:

- Purchase and installation of two ultrasonic aqueous cleaning machines
- Purchase of a reverse osmosis water recycling machine
- Training for use of the equipment
- Transportation and insurance for the equipment
- Contingencies
- Recurrent costs

Two 3-sump ultrasonic cleaning machines (1 washing bath, 2 rinsing baths, a hot-air dryer, and an oil/water separator) that use aqueous-based detergents with corrosion inhibitors are necessary to wash, rinse, and dry the metal engine components after the manufacturing process. The washing baths will contain water and detergent, agitated ultrasonically. The ultrasonic energy helps remove hydrocarbon oils and other contaminants from the engine components. The second and third baths will contain clean, filtered water, and serve as ultrasonic rinsing stages in the cleaning process. The drying systems will use hot, dry air to remove any moisture remaining on the metal components.

A reverse osmosis water recycling machine is required to maximize the reuse of the aqueous detergent. The new equipment also includes a vacuum dryer to ensure rapid evaporation of solvent from the parts being cleaned.

A minimum of eight hours of training, available in both English and Spanish, will be provided by the equipment supplier. Training is necessary to educate process personnel on the methods of equipment operation and regular equipment maintenance. Training is also necessary to facilitate any process development work. The cost of training will be included as part of the equipment cost.

To cover the cost of transportation and insurance during transport, the enterprise will pay approximately five percent of the capital cost of the new equipment. Because the cost of the cleaning equipment is approximately US$ 385,000, the cost of transport and insurance will be approximately US$ 19,250.

Contingencies are 10 percent of the subtotal cost for all goods and services. This amount is included to ensure that the project receives the necessary funding in case unforeseen costs arise.

To accommodate the new technology it will be necessary for Lucas Diesel to make several changes in its current operating practices. Annual savings resulting from the discontinued use of TCA US$ 40,600 (2,800 kg of TCA at US$ 1.45 per kg in 1994) and electricity US$ 6,480 (144,000 kwh of electricity at US$ 0.045 per kwh), will amount to US$ 47,080. The cost of the aqueous detergent, US$ 39,000 (15,000 kg at US$ 2.60 per kg in 1994), rust inhibitor, US$ 15,000 (3,000 kg at US$ 5.00 per kg), and the cost of electricity US$ 15,120 (336,000 kwh at US$ 0.045 per kwh), however, will add US$ 69,120. The operating costs associated with water use and filter maintenance will both increase since these items are a component of the new aqueous cleaning process, however these costs are not easily estimated and will be absorbed by the enterprise. Based on these cost components, the annual incremental cost is US$ 22,040, and over a four year period, discounted at 10 percent, is US$ 69,919.

5. TECHNOLOGY SELECTION

There are five major alternatives to the use of TCA for cleaning metal parts. The alternatives are aqueous cleaning, semiaqueous cleaning, gas plasma cleaning, non-chlorinated organic solvent cleaning, and chlorinated organic solvent cleaning. The key features of these alternatives are summarized below:

- **Aqueous** and **semiaqueous** ultrasonic cleaning are TCA alternatives that could be used to clean automotive engine components. Both alternatives are capable of dissolving hydrocarbon oils and removing undesirable particulates deposited on the components during the production processes. The implementation of these alternatives would require the use of corrosion inhibitors to ensure that sensitive metals are not damaged by exposure to aqueous or semiaqueous solutions. Both options would also require the use of filtration equipment to recycle the water used in the processes.

- **Gas plasma** cleaning is an environmentally benign method of removing hydrocarbon contamination from metal components. The gas plasma process produces virtually no hazardous waste products and only small quantities of water vapor and carbon dioxide as by-products. Gas plasma cleaning is particularly efficient in the removal of organic contamination from parts with small crevices and untapped drill holes. Because of the ability of the gas to oxidize and remove the contamination without the use of water or a solvent, it is not necessary to rinse the part after it has been cleaned. Gas plasma cleaning is not effective, however, at removing metal filings from components.

- **Non-chlorinated organic solvents** (e.g., n-methyl pyrollidone, Exxon Exxate^{TM}, and Petroferm Axarel^{TM} 2200) can remove hydrocarbon oils and particulates from metal parts as effectively as aqueous or semiaqueous cleaning. These solvents can also be filtered and recycled for repeated use. Non-chlorinated organic solvents are combustible, however, and safety precautions must be taken to minimize the potential fire risk associated with their use. In addition, these compounds are volatile organic compounds (VOCs), which are precursors to the formation of smog. As a result, special equipment must be used to minimize the emissions of these compounds to the atmosphere.

- **Chlorinated organic solvents** (i.e., trichloroethylene and methylene chloride) can also be used as TCA alternatives for automotive parts cleaning. Chlorinated solvents are non-flammable, but are considered toxic chemicals. As a result, it is recommended that vapor exposures to both trichloroethylene (TCE) and methylene chloride be limited to an average of 50 parts per million (ppm) over an eight hour period and that acute exposures not exceed 100 ppm.[2] To comply with these levels, both solvents must be used in well ventilated areas and only in conjunction with an employee exposure monitoring program. In addition, the solvent waste must either be recycled and re-used, or treated and disposed of as a hazardous waste.

Aqueous ultrasonic cleaning was selected as the best alternative cleaning method for Lucas Diesel. Aqueous cleaning is environmentally safe, and will effectively remove machine oils and metal filings deposited in the small crevices of Lucas Diesel's products. Aqueous cleaning, however, will require the addition of corrosion inhibitors to the aqueous solution in order to minimize corrosion of the parts being cleaned.

[2] These exposure levels are recommended by the International Agency for Research on Cancer (IARC). The IARC does not consider TCE to be a carcinogen.

6. PROJECT COSTS[3]

6.1 Total Project Costs

As described below, and detailed in the relevant annexes, the total project cost is US$ 487,184. Because there are no non-ODS project investment costs associated with this project, the total project cost is also the incremental cost.

As detailed in Annex 1, the total investment cost is US$ 444,675. The components of this cost are the purchase and installation of two ultrasonic aqueous cleaning machines (US$ 305,000), one reverse-osmosis water filtration system (US$ 40,000), one vacuum dryer (US$ 40,000), transportation and insurance for the machines (US$ 19,250), and a contingency of 10 percent (US$ 40,425).

6.2 Operating Costs

Prior to the project, the annual operating cost exclusive of tax is US$ 47,080. After the implementation of the project, the annual operating cost will be US$ 69,120, resulting in an incremental operating cost of US$ 22,040. The first four years of incremental costs, discounted at 10 percent, amount to US$ 69,919. A detailed breakdown of operating costs is provided in Annex 2.

6.3 Unit Abatement Cost (UAC)

As calculated in Annex 3, the UAC for this project is US$ 13.57 per ODP-weighted kilogram of TCA phased out per year. This number is derived from annualized incremental capital costs of US$ 15,962, annual incremental operating costs of US$ 22,040, and savings of 2.8 MT (weighted) of TCA per year. Note that offsetting savings have been included in the calculation of incremental operating costs.

7. FINANCING PLAN

The enterprise requests reimbursement of a portion of the project costs, amounting to US$ 168,000. Other costs will be paid for by the enterprise and will amount to US$ 346,594.

[3] Unless otherwise noted, all costs in this section are economic, rather than financial costs. As such, taxes, duties, and OTF financing are not reflected.

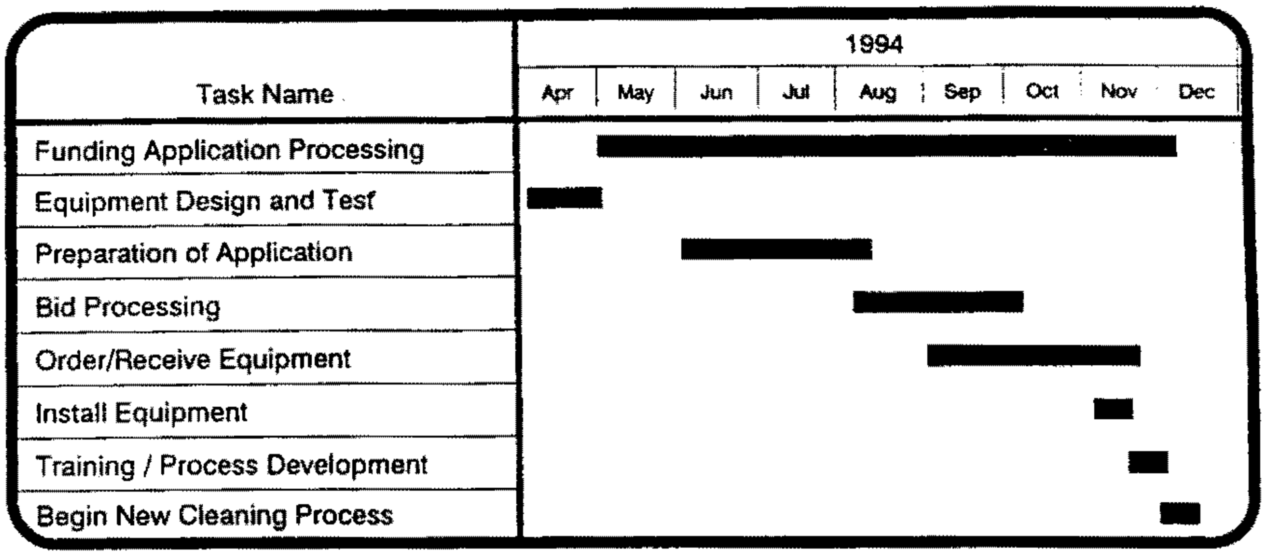
8. **PROJECT IMPLEMENTATION**

8.1 **Management**

UNDP will oversee the completion of this project.

8.2 **Schedule**

Proposed Schedule for Lucas Diesel



9. **PROJECT IMPACT**

This project will eliminate 28 MT of TCA per year at Lucas Diesel.

10. **ENVIRONMENTAL ASSESSMENT**

Under the current proposal, Lucas Diesel will use a non-ozone-depleting aqueous solution in two new batch cleaning machines. The cleaning processes will include the filtration and reuse of water, aqueous detergent, and rust inhibitor, to the maximum extent possible. Lucas Diesel will have to obtain the applicable permits required by SEDESOL to ensure that the operation of the new equipment conforms to federal, state, and city regulations. When cleaning with aqueous solutions, the cleaning solution must be filtered continuously to maintain cleaning effectiveness. Because of the selection of aqueous cleaning and the strict environmental practices of the enterprise, it is unlikely that the project will have an adverse environmental impact.

ANNEX 1

BREAKDOWN OF INVESTMENT COSTS

Estimated Costs in US Dollars

Equipment:	
1 Precision ultrasonic cleaner, installed	$145,000
1 General ultrasonic cleaner, installed	$160,000
1 Reverse-osmosis water recycling machine, installed	$40,000
1 Vacuum dryer, installed	$40,000
Transportation:	
Shipping and Insurance	$19,250
SUBTOTAL	$404,250
Contingency, 10 percent	$40,425
TOTAL INVESTMENT COST:	**$444,675**
CONTRIBUTION FROM ENTERPRISE:	**$346,594**
RESULTING INVESTMENT COST:	**$ 98,081**

ANNEX 2

BREAKDOWN OF INCREMENTAL OPERATING COSTS/SAVINGS

Estimated Costs in US Dollars

	Pre-Project	Post Project
Solvent Costs per Year:		
2,800 kg TCA ($1.45/kg)	$40,600	
15,000 kg aqueous detergent ($2.60/kg)		$39,000
3,000 kg rust inhibitor ($5.00)		$15,000
Electricity (US$ 0.045/kwh):		
144,000 kwh	$6,480	
336,000 kwh		$15,120
TOTAL PRE-PROJECT COSTS PER YEAR:	$47,080	
TOTAL POST-PROJECT COSTS PER YEAR:		$69,120
TOTAL ANNUAL INCREMENTAL COSTS:	**$22,040**	
NET PRESENT VALUE, 4-YEARS:	**$69,919**	

ANNEX 3

CALCULATION OF UNIT ABATEMENT COST

Estimated Costs in US Dollars

A. ODS SAVINGS:

Average Use of TCA per Year:	28 MT
ODP of TCA:	0.1
ODP Weighted Savings:	2.8 MT

B. INCREMENTAL CAPITAL COST:

Total from Annex 1:	$98,081
Equipment Life:	10 years
Discount Rate:	10%
Annualized Capital Cost:	$15,962

C. NET INCREMENTAL OPERATING COSTS PER YEAR: $22,040 *

D. UNIT ABATEMENT COST

	Cost per Year	Unit Cost per ODP Saved
Incremental Annualized Capital Cost:	$15,962	$5.70
Incremental Annual Operating Cost (Savings):	$22,040	$7.87
Unit Abatement Cost ($/kg):		$13.57

* Offsetting benefits are included in this amount; see Annex 2.

TECHNICAL REVIEW

I have reviewed the Mexico Project, **"Elimination of 1,1,1 TCA from the Precision Cleaning Processes at Lucas Diesel"**, from the solvent sector, based on discussions with the author, as well as review of the document.

1 Country of Origin — Mexico

2 Project Title — Elimination of 1,1,1 TCA from the Precision Cleaning Processes at Lucas Diesel

3 Sector — Solvents

4 Relationship to C.P. — The project addresses how this enterprise ODS phase out fits in with the ODS using solvent subsectors in Mexico. The project relates to the C.P. via the description of the solvents used and the amounts to be phased out, although It does not specifically write about the country programme.

5 Technology

Technical Soundness

This project substitutes effective ODS alternative technology choices for the solvent engine parts cleaning lines currently in use. It includes the process definition, qualification, and installation of aqueous cleaning technology, and it includes the use of ultrasonics to meet the needs of cleaning engine components, as described in the document.

The use of aqueous cleaning chemicals in the replacement technology choice will require the use of oil separation and water recycling to keep operating costs under good control. These are provided for in the project.

Safety

The use of aqueous cleaning chemicals is generally safer than the use of flammable and/or toxic substances, but aqueous detergents are still harsh chemicals in need of careful treatment to ensure safety in operation. Thus, in order to control acute exposure and the development of chronic exposure situations during routine operations, it is important that the use of protective equipment and handling procedures such as unloading, solution makeup, and waste transfer be spelled out; and people trained before they are permitted to become operators in the cleaning area. Periodic retraining is also recommended.

The use of hot air and vacuum drying has the potential for adding heat stress in the operating area, but can be readily controlled through the normal exhaust ducting included in the installation of the cleaning and drying equipment.

303 WEST LOCUST LANE, KENNETT SQUARE, PA 19348 Phone (610) 444-9058 Fax (302) 633-0440

6 Environmental Impact

It is unlikely that this project will have an adverse environmental impact. Lucas Diesel must first obtain Sedesol's requisite permits to ensure that the operation of the new equipment will conform to local and national standards. Also, the enterprise is capable of processing aqueous waste in an existing system, and plans to treat the effluent from the proposed cleaning operation in either their existing or a new system now in design.

7 Project Costs

The cost components identified in the project cover the equipment required, including ventilation improvements for exposure control, and operational cost components needed to run safely and under adequate environmental control. The cost of safety training and ongoing updates of that training are not included. These costs are not normally considered to be major elements in a project, and would not normally change the project cost materially.

8 Implementation Timeframe

The proposed implementation timeframe is feasible from an elapsed time standpoint. The actual date of startup, however, will be dependent upon the approval date.

9 Recommendation

The project is sound, needed, and has a level of unit abatement cost - about $13.57/Kg. ODP that is very good for the phase out of TCA. This very good level of cost effectiveness is due to the fact that the enterprise is willing to pay approximately two thirds of the total cost of the project. **Approval as proposed is recommended.**

CLINTON NORRIS

24 August 1994

COUNTRY:	Republic of Mexico
PROJECT TITLE:	Elimination of CFC-113 from the Textile Cleaning Processes at Procesadora y Revitalizadora
SECTOR COVERED:	Solvent Cleaning
ODS USE IN SECTOR:	1,500 MT of CFC-113 solvent in 1992 2,900 MT of 1,1,1 trichloroethane (TCA) in 1992 Total ODP-weighted consumption of ODS in 1992 = 1,490 MT
PROJECT IMPACT:	Elimination of 3.4 MT of CFC-113 annually (2.7 ODP-weighted MT)
PROJECT DURATION:	9 months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	ODS Reduction Investment Cost: US$ 70,455 Incremental Operating Costs[1]: US$ 882 Total ODS Reduction Project Cost: US$ 71,337
PROPOSED OTF FINANCING:	US$ 71,337 as grant
IMPLEMENTING ENTERPRISE:	Procesadora y Revitalizadora
COORDINATING MINISTRY:	National Institute of Ecology (INE)
IMPLEMENTING AGENCY:	UNDP

PROJECT SUMMARY

This project will eliminate the annual consumption of 3.4 MT of CFC-113 by replacing Procesadora y Revitalizadora's current CFC-based dry cleaning process with one that uses non-ozone depleting, non-chlorinated hydrocarbon solvents. Currently, the enterprise uses CFC-113 in a two bath Union dry cleaning machine to remove dirt and other contaminants from occasional formal wear such as wedding dresses and tuxedos. CFC-113 is used for this application because it is not an aggressive solvent and therefore will not damage lace, buttons, or sequins found on the delicate clothing. The best alternative to CFC-113 is the use of a non-chlorinated hydrocarbon solvent such as Exxon DF 2000. Exxon DF 2000 is a non-chlorinated, high purity aliphatic hydrocarbon solvent with zero ozone depletion potential (ODP). The product incorporates many of the best features of petroleum (Stoddard) solvents, such as good cleaning power, low residue and low corrosivity, while eliminating many of the concerns about Stoddard solvents such as low flash point, high odor and variable quality. The new cleaning process will require the purchase and installation of vapor-tight dry cleaning equipment capable of cleaning with flammable chemicals. The new machine will be a refrigerated two bath model capable of drying the clothing after the cleaning process and recovering the used solvent.

[1] Net present value of first four years of operating costs/savings.

PROJECT OF THE REPUBLIC OF MEXICO

Elimination of CFC-113 from the Textile Cleaning Operations at Procesadora y Revitalizadora

1. PROJECT OBJECTIVE

The objective of this project is to eliminate the annual consumption of 3.4 MT of CFC-113 from Procesadora y Revitalizadora's textile cleaning operations through the use of vapor-tight dry cleaning equipment and non-ozone-depleting, non-chlorinated hydrocarbons such as Exxon DF 2000.

2. SECTOR BACKGROUND

Two ozone-depleting substances, CFC-113 and TCA, are widely used in cleaning applications by Mexican industry. The ODS consuming industry consists of manufacturers of automotive products, electronic assemblies, textile cleaning, and adhesive and paint formulators. ODS solvents are used to clean both electronic components and metal parts. A large fraction of these companies are partly or wholly Mexican owned while the remainder are owned by multinational firms. In 1992, the ODS solvent using industries consumed 1,500 MT of CFC-113 and 2,900 MT of TCA. A third ODS solvent, carbon tetrachloride, is not used in Mexico for cleaning.

3. ENTERPRISE BACKGROUND

Procesadora y Revitalizadora is a 100 percent Mexican-owned dry cleaning company located in Nuevo Leon. The enterprise operates 12 facilities, 11 used for clothing drop-off and one used for dry cleaning. CFC-113 is used at the dry cleaning facility to remove dirt and other contaminants from occasional formal wear such as wedding dresses and tuxedos. Procesadora y Revitalizadora is a subsidiary of Presa, employs approximately 60 people, and earned approximately US$ 800,000 in 1993.

4. PROJECT DESCRIPTION

4.1 Process Soils

The dry cleaning process used by Procesadora y Revitalizadora is designed to remove dirt and other contaminants from occasional formal wear such as wedding dresses and tuxedos.

4.2 Present Process

Procesadora y Revitalizadora consumes approximately 3.4 MT of CFC-113 annually in a dry cleaning process designed to quickly and effectively remove dirt and other contaminants from occasional formal wear such as evening gowns and tuxedos. CFC-113 is ideal for this application because it is not an aggressive solvent and therefore does not damage formal wear. The dry cleaning equipment used by Procesadora y Revitalizadora is manufactured by the Union Corporation and exhibits a high rate of solvent loss. The high loss rate precludes the use of this machine with most CFC-113 alternatives because the alternatives are either too toxic or too costly to allow for such losses.

4.3 Proposed Alternative Process

For this project, Procesadora y Revitalizadora will eliminate the use of CFC-113 by replacing its existing Union dry cleaning machine with a vapor-tight machine designed for use with flammable chemicals. The capacity of the equipment to be purchased is approximately the same as the existing CFC-113 dry cleaning machine. The conversion to non-ozone-depleting technology consists of the following elements:

- Purchase and installation of one vapor-tight dry cleaning machine designed for use with non-ozone depleting, non-chlorinated hydrocarbons.
- Purchase of a filter system for solvent recycling
- Transportation and insurance for the equipment
- Contingencies
- Recurrent costs

A vapor-tight, two bath dry cleaning machine capable of using flammable, non-chlorinated hydrocarbon solvents is needed to wash and dry occasional formal wear. The machine contains equipment for the recovery and recycling of the original solvent, and a refrigeration coil to maintain a low evaporation rate in the wash and rinse stages. The new equipment also includes automatic fire protection features.

A filter system designed for operation with this equipment is included as a part of the project. The filter system allows for complete recycling of the cleaning solvent.

In order to cover the cost of transportation and insurance during transport, the enterprise will pay approximately five percent of the capital cost of the new equipment. Because the cost of the cleaning equipment and filter system is approximately US$ 61,000, the cost of transport and insurance will be approximately US$ 3,050.

Contingencies are 10 percent of the subtotal cost for all goods and services. This amount is included to ensure that the project receives the necessary funding in case unforeseen costs arise.

In order to accommodate the new technology, Procesadora y Revitalizadora will make several process changes in its operating practices. Annual savings, as a result of the discontinued use of CFC-113, will amount to US$ 31,722 (3,400 kg of CFC-113 at US$ 9.33/kg in 1994). The cost of the hydrocarbon solvent, however, will add US$ 27,000 per year (3,000 kg at US$ 9.00/kg in 1994). The annual cost of filter replacement is approximately US$ 5,000. Based on these cost components, the recurrent incremental cost over a four year period is US$ 882.

5. TECHNOLOGY SELECTION

There are four major alternatives to the use of CFC-113 as a textile cleaning agent. The alternatives are (1) hydrochlorofluorocarbons; (2) 1,1,1 trichloroethane; (3) perchloroethylene; and (4) non-chlorinated hydrocarbons. The key features of these alternatives are summarized below:

- **Hydrochlorofluorocarbons (HCFCs):** HCFCs, such as HCFC-141b and the isomers of HCFC-225, can potentially be used to clean occasional formal wear. HCFCs are ozone depleting solvents, but they have a lower ozone depletion potential (ODP) than CFC-113. Specifically, HCFC-141b has an ODP of approximately 0.11 and HCFC-225 has an ODP of approximately 0.03. HCFCs also exhibit a high vapor pressure and are therefore prone to rapid evaporation (more rapid than CFC-113). As a result, they must be used in equipment specifically designed to reduce their emissions to the atmosphere. Finally, HCFCs are an expensive class of chemicals, as their price can exceed that for CFC-113. This high cost, along with their high vapor pressure and the fact that they are ozone depleting substances, make HCFCs impractical alternatives to CFC-113 in dry cleaning operations.

- **1,1,1 Trichloroethane (TCA):** TCA can be used as a replacement for CFC-113 in most textile cleaning operations. TCA is an ozone depleting solvent with an ODP of 0.10. It is an aggressive solvent, however, that is capable of dissolving lace, buttons, sequins, and beads used in formal wear. For this reason, TCA cannot be used to clean occasional formal wear.

- **Perchloroethylene (PCE):** PCE is used extensively by dry cleaners in the U.S. to remove dirt and oil from a variety of different fabric types. PCE cannot be used to clean occasional formal wear, however, because it is also an aggressive solvent that can damage lace, buttons, sequins, and beads. Additionally, PCE is a toxic solvent that must be handled with care to ensure that workers are not injured.

- **Non-Chlorinated Hydrocarbons:** Non-chlorinated hydrocarbons are used throughout the U.S. dry cleaning industry to clean occasional formal wear without damaging lace, buttons, sequins, or beads found on the clothing. These compounds are flammable and therefore must be used in equipment designed with fire protection features such as automatic fire suppression equipment. Stoddard solvent, the most widely used non-chlorinated hydrocarbon in the textile industry, has a flashpoint of 40°C and a relatively high evaporation rate. It also leaves a lingering odor on the clothing it cleans. New proprietary non-chlorinated hydrocarbon mixtures (e.g., Exxon DF 2000) have been formulated to have a higher flashpoint (64°C in the case of Exxon DF 2000), less lingering odor, and a lower evaporation rate than Stoddard solvent.

Non-chlorinated hydrocarbons are the best CFC-113 alternatives for the cleaning of occasional formal wear by Procesadora. The solvents will remove hydrocarbon oils and other contaminants without damaging the formal wear. In addition, these solvents dry rapidly and are less expensive than CFCs or HCFCs. Because of the flammability of non-chlorinated hydrocarbon solvents, they should be used in vapor-tight equipment designed for use with flammable chemicals. In addition, the equipment should be capable of capturing and recycling the used solvent to promote cost savings. Procesadora should evaluate the use of low odor Exxon DF 2000 as a first alternative.

6. PROJECT COSTS[2]

6.1 Total Project Costs

As described below, and detailed in the relevant annexes, the total project cost is US$ 57,045. Because there are no non-ODS project investment costs associated with this project, the total project cost is also the incremental cost.

As detailed in Annex 1, the total investment cost is US$ 70,455. The components of this cost are the purchase and installation of one vapor-tight dry cleaning machine (US$ 55,000), one filter system for solvent recycling (US$ 6,000), transportation and insurance (US$ 3,050), and 10 percent contingency (US$ 6,405). Training for use of the equipment is not necessary because the new machine operates in essentially the same manner as the existing machine.

6.2 Operating Costs

Without the project, the annual operating cost exclusive of tax is US$ 31,722. After the implementation of the project, the annual operating cost will be US$ 32,000, resulting in an incremental operating cost of US$ 278 the first year. Given the lifetime of the equipment of 10 years and a discount rate of 10 percent, the net present value of the first four years of incremental operating cost is US$ 882. A more detailed breakdown of operating costs is provided in Annex 2.

6.3 Unit Abatement Cost (UAC)

As calculated in Annex 3, the UAC for this project is US$ 4.24 per ODP-weighted kilogram of CFC-113 phased out per year. This number is derived from annualized incremental capital costs of US$ 11,466, annual incremental operating costs of US$ 278, and savings of 2.7 MT (ODP-weighted) of CFC-113 per year. Note that offsetting savings have been included in incremental operating costs.

7. FINANCING PLAN

The enterprise requests reimbursement of the complete project costs, which are estimated to be US$ 71,337.

8. PROJECT IMPLEMENTATION

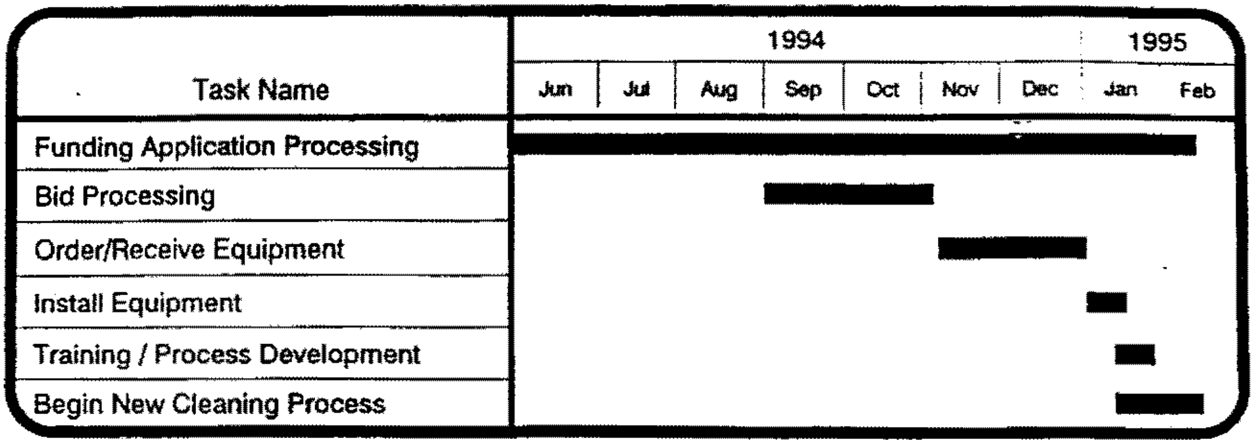
8.1 Management

UNDP will oversee the completion of this project.

[2] Unless otherwise noted, all costs in this section are economic, rather than financial costs. As such, taxes, duties, and OTF financing are not reflected.

8.2 Schedule

Proposed Schedule for Procesadora y Revitalizadora



9. PROJECT IMPACT

The project will eliminate 3.4 MT of CFC-113 per year at Procesadora y Revitalizadora.

10. ENVIRONMENTAL ASSESSMENT

Under the current proposal, Procesadora y Revitalizadora will use a non-chlorinated hydrocarbon solvent in a new vapor-tight dry cleaning machine. Because these solvents may have flammability and VOC concerns, Procesadora y Revitalizadora will acquire equipment that is designed for use with flammable, evaporative, solvents and that has been designed to meet National Fire Protection Agency standards.

When cleaning with hydrocarbon solvents, the cleaning solvent must be replaced regularly to maintain cleaning effectiveness. The spent solvent that is to be disposed may be hazardous and must be handled properly.

It is unlikely that the project will have an adverse environmental impact. Procesadora y Revitalizadora will have to obtain the applicable permits required by SEDESOL to ensure that the operation of the new equipment conforms to federal, state, and city regulations.

ANNEX 1

BREAKDOWN OF INVESTMENT COSTS

Estimated Costs in US Dollars

Equipment:	
1 Vapor-tight petroleum solvent dry cleaning machine, installed	$ 55,000
1 Filter system for solvent recycling	$ 6,000
Transportation:	
Shipping and Insurance	$ 3,050
SUBTOTAL	$ 64,050
Contingency, 10 percent	$ 6,405
TOTAL INVESTMENT COST:	$ 70,455

ANNEX 2

BREAKDOWN OF INCREMENTAL OPERATING COSTS/SAVINGS

Estimated Costs in US Dollars

	Pre-Project	Post Project
Solvent Costs per Year:		
3,400 kg CFC-113 ($ 9.33/kg)	$ 31,722	
3,000 kg Exxon DF 2000 ($ 9.00/kg)		$ 27,000
Filter Maintenance		$ 5,000
TOTAL PRE-PROJECT COSTS PER YEAR:	$ 31,722	
TOTAL POST-PROJECT COSTS PER YEAR:		$ 32,000
TOTAL INCREMENTAL COSTS PER YEAR:	$ 278	

ANNEX 3

CALCULATION OF UNIT ABATEMENT COST

Estimated Costs in US Dollars

A. ODS SAVINGS:

Average Use of CFC-113 per Year:	3.4 MT
ODP of CFC-113:	0.8
ODP-Weighted Savings:	2.7 MT

B. INCREMENTAL CAPITAL COST:

Total from Annex 1:	$ 70,455
Equipment Life:	10 years
Discount Rate:	10%
Annualized Capital Cost:	$ 11,466

C. NET INCREMENTAL OPERATING COSTS:* $ 278

D. CALCULATION OF UNIT ABATEMENT COST:

	Cost per Year	Unit Cost per ODP Saved
Incremental Annualized Capital Cost:	$ 11,466	$ 4.24
Incremental Annual Operating Cost:	$ 278	$ 0.10
Unit Abatement Cost ($/kg):		$ 4.34

* Offsetting benefits are included in this amount; see Annex 2.

TECHNICAL REVIEW

I have reviewed the Mexico Project, **"Elimination of CFC-113 from the Textile Cleaning Processes at Procesadora y Revitalizadora"**, from the solvent sector, based on discussions with the author , as well as review of the document.

1 Country of Origin — Mexico

2 Project Title — Elimination of CFC-113 from the Textile Cleaning Processes at Procesadora y Revitalizadora

3 Sector — Solvents

4 Relationship to C.P. — The project addresses how this factory ODS phase out fits in with the ODS using solvent subsectors in Mexico. The project relates to the C.P. via the description of the solvents used and the amounts to be phased out, although It does not specifically write about the country programme.

5 Technology

Technical Soundness

This project substitutes effective ODS alternative technology choices for the solvent textile cleaning operation to be replaced. It includes the process definition, qualification, and installation of cleaning technology that will meet the unique needs of cleaning formal wear, as described in the document.

The use of flammable solvent in the replacement technology choice will somewhat restrict the equipment choices, but they will be effective and can be used safely if appropriate procedures are followed. The equipment must be vapor tight, and generally uses either vacuum or inert gas for safe operation. The need for safe operating equipment is specifically recognized in the project.

Safety

The use of flammable and potentially toxic solvents must provide for low exposure levels, both acutely and chronically, and operating procedures and equipment settings that prevent air/solvent mixtures which are potentially flammable. Thus, in order to control exposure and the creation of flammable situations during routine functions, it is important that handling such as loading, unloading, solution makeup, and solvent transfer procedures (including spent materials) be spelled out and people trained before they are permitted to become operators in the cleaning area. Periodic retraining is also recommended.

Provisions for safe maintenance must also be made, e.g. the use of spark proof tools and the measurement of flammable mix concentrations before entering the cleaning basket area of the equipment.

Appropriate operating interlocks, which should be installed as part of the equipment design, should be periodically checked for functioning and they should never be allowed to be bypassed if they begin to malfunction.

6 Environmental Impact

It is unlikely that this project will have an adverse environmental impact. Procesadora y Revitalizadora must obtain the necessary permits from Sedesol. Also, the project commits that "Procesadora y Revitalizadora will acquire equipment that is designed for use with flammable, evaporative, solvents and that has been designed to meet National Fire Protection Agency standards."

7 Project Costs

The cost components identified in the project cover the equipment required, including ventilation improvements for exposure control, and operational cost components needed to run safely and under adequate environmental control. The cost of safety training and ongoing updates of that training are not included. These costs are not normally considered to be major elements in a project, and would not normally change the project cost materially.

8 Implementation Timeframe

The proposed implementation timeframe is feasible from an elapsed time standpoint. The actual date of startup, however, will be dependent upon the approval date.

9 Recommendation

The project is sound, needed, and has a level of unit abatement cost - about \$4.34/Kg. ODP that is very good. **Approval as proposed is recommended,** with the proviso that the safety and environmental issues will be addressed.

CLINTON NORRIS

23 August 1994

PROJECT COVER SHEET

(11 Nov 94)

COUNTRY: MEXICO

PROJECT TITLE: Elimination of CFC in the Manufacture of Domestic Refrigerators for the MABE Group

SECTOR COVERED: DOMESTIC REFRIGERATOR MANUFACTURING

ODS USE IN SECTOR: 882 tons of CFCs per year (see note 2)

Three Participating Companies: (see note 1)	TOTAL	COMASA Compr.Man	ASTRAL Refr.Man	ENRESA Refr.Man
ODP-Tons eliminated (see note 2)	391	0	344	47
Incremental Capital Cost (US$)	2,585,814	1,188,724	816,090	581,000
Incremental Operational Cost (US$) (see note 3)	1,588,831	0	1,302,798	286,033
TOTAL PROJECT COST (US$)	4,174,645	1,188,724	2,118,888	867,033
UNIT ABATEMENT COST (US$/kg)	5.1	N/A	4.2	8.1

Note 1: Compr.Man = Compressor Manufacturer ; Refr.Man = Refrigerator Manufacturer
Note 2: CFC consumption data are based on figures for the 12-month period July 93 - June 94
Note 3: Operational Costs were calculated for a six-month duration, to be paid upfront.
Note 4: ASTRAL and ENRESA are 100% Mexican owned. Since July 94, COMASA is 65% Mexican. In addition, ASTRAL is exporting 34% of its production to non-article-5 countries. The above amounts were already reduced to take these two facts into account.

PROJECT DURATION: 1 year.
ECONOMIC LIFE: 10 years.

NATIONAL COORDINATING BODY: SEDESOL - Ozone Protection Unit National Institute of Ecology (INE)

IMPLEMENTING AGENCY: UNDP
APPRAISAL DATE: July 1994

PROJECT SUMMARY:

This project will eliminate the use of CFC's in the existing two domestic refrigerator manufacturers of the MABE holding. Three companies will participate, one of which is a compressor manufacturer, while the others produce domestic refrigerators. CFC 11 used as a blowing agent for producing thermal insulating foams in the two refrigerator manufacturing plants will be replaced by HCFC 141b. The companies are aware that HCFC 141b is an interim technology. Equipment acquisitions will be made in view of the fact that they may be used with HFCs or cyclopentane with minor retrofit costs only. CFC 12 used as refrigerant will be replaced by HFC 134a by changing the existing production lines for CFC 12 compressors and refrigerators into lines producing HFC 134a equipment. The project will eliminate 391 ODP tons/yr. Funds requested will be used to change the existing production lines, the cost of testing, pre-production trials, and training, as well as incremental operational costs resulting from the conversion to the new technology (6 months).

TECHNICAL ASSESSMENT:

The project was prepared by Mr. Stuart Kelly and Mr. Aristides Gabella in collaboration with SEDESOL / INE as the Government Counterpart. The project has been reviewed and is supported by Dr. Lambert J.M. Kuijpers and Mr. Martiem Janssen from RE/GENT-Eindhoven and by Mr. Bert Veenendaal. Their comments are attached.

PROJECT OF THE GOVERNMENT OF MEXICO

ELIMINATION OF CFC IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS FOR THE MABE HOLDING

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFC used at the existing manufacturers of domestic refrigerators of the MABE Group of companies. The CFC's which will be eliminated include CFC 11 used as a blowing agent for producing thermal insulating foams as well as CFC 12 used as a refrigerant in the production of domestic refrigerators.

2. SECTOR BACKGROUND.

Mexico's Country Programme (CP) for the reduction of Ozone Depleting Substances (ODS) was approved in February 1992.

It is estimated that for the period July 93 - June 94, total CFC 11 consumption for the manufacture of thermal insulation foams was approximately 1500 tons. Of this, about 700 tons were used in the manufacture of domestic refrigerators.

During that same 12-month period, total CFC 12 consumption for refrigeration and airconditioning applications was estimated to be 4,410 tons, out of which approximately 180 tons were used for the manufacture of domestic refrigerators.

Uninhibited growth in the manufacturing of domestic refrigerators would lead to a total estimated CFC consumption of 1200 tons in the year 2000. SEDESOL is seeking a reduction in the use of CFCs in the manufacture of domestic refrigerators beginning in 1995. Approval of this project would bring the actual implementation of this strategy well in line with the target.

It is estimated that about 1,400,000 domestic refrigerators were manufactured during the period July 93 - June 94. A growth of 5 to 7 % is anticipated in this sector. The Mexican market for manufacture of domestic refrigerators is shared between two company holdings, the MABE Group and the VITRO group. Each holding includes two refrigeration manufacturing companies, one compressor plant and a number of other service and related companies. Another project is presently being developed to address the CFC phaseout in the VITRO group and approval and implementation of both projects will eliminate the use of CFCs in the domestic refrigeration manufacturing sector in Mexico in 1996.

3. ENTERPRISE BACKGROUND

Combined production at ASTRAL and ENRESA for the period June 93 - July 94, amounted to about 844,822 domestic refrigerator units, representing approximately 60% of domestic refrigerator production in Mexico. It is noted that there is a commercial trading agreement between ASTRAL/ENRESA and General Electric USA, but the present legal corporate ownership is that these two companies are 100% Mexican owned and thus eligible for 100% funding of incremental costs. However, in July 1994 a joint venture compressor technology agreement has been signed between COMASA and SANYO Corp, Japan. This agreement gives SANYO Corp a 35% capital share in COMASA. This project is thus prepared on the basis that ASTRAL and ENRESA are eligible for 100% funding of incremental costs while COMASA is only eligible for 65%.

COMASA supplied about 63% of the compressors used by ASTRAL and ENRESA in 1993. The balance of their compressor requirements are imported from SICOM (Tecumseh, Brazil), EMBRACO (Brazil) and SANYO (Thailand).

During the review of the project, questions were raised on the extend to which the existing technology agreement with GE would enable MABE to carry out this project. Detailed information was obtained from MABE, and is attached to this document as annex D. The following paragraph summarizes this information.

MABE pays a considerable amount per year to use the GE brand name and for technology transfer. While this payment does not cover matters rated as "strictly confidential" it does cover matters rated as "confidential". Request for "strictly confidential" materials involve additional payment. MABE uses this technology transfer material constantly and people of the "MABE Technology Centre" regularly spend time at GE on matters relating to all areas of technology and development. In addition, GE sends relevant experts to MABE for each project that MABE generates so that GE can oversee these endeavors. All materials used in manufacturing refrigerators must comply with GE specifications, MABE uses GE recommended equipment and GE standards for product testing, and they comply with the same US or International Norms as GE. There are also 3 monthly cross checks between MABE and GE laboratories on tests and results. As can be seen, GE takes very good care to protect their own trade mark and good name, as many of the MABE Group bears the GE name and logo.

Pages 4 and 5 provide additional information on the three MABE companies participating in this project.

COMASA

Full Company Name:	Consorcio Manufacturo S.A. de C.V.
Plant Located in:	San Luis Potosi
Ownership:	65% Mexican
No. of Compressors Models:	8
Current Production Capacity:	720,000 units p.a.
1993 Production Volume:	592,000 units
incl: Sales to Astral/Enresa:	440,483 units
Dom. Refr. Servicing:	121,917 units
Commercial Refrig.:	29,600 units
Contact Persons:	Mr. C.P.J. Matias Vazquez Orta Mr. Salvador Ponce de Leon
Tel/Fax:	Tel. 24.52.75 or 24.52.79 Fax. 24.63.24

Other Information:
COMASA was founded in 1968 with a plant in Mexico City. The present plant in San Luis Potosi was built in 1977 and the product facilities were merged in the San Luis Potosi factory in 1986. At this time the company was a 50:50 Joint Venture between the MABE Group and the VITRO Group. The company was restructured in 1991 with the MABE Group retaining the factory and part of the manufacturing equipment. The MABE Group also owned HERMETICIDAD, a compressor company licensing technology from Tecumseh USA and in 1992, the MABE Group rationalized their compressor interests in the one facility at San Luis Potosi.

COMASA presently manufacture compressors using dated Tecumseh and Mitsubishi technology. The Mitsubishi models account for 76% of production. COMASA currently complies with both Tecumseh and Mitsubishi Standards throughout all stages of their manufacturing operation. New compressor technology for HFC 134a is being obtained under a joint venture technology agreement with Sanyo which will give SANYO Corp a 35% capital share in COMSASA.

Subject to funding from the MLF, COMASA plans to commence the manufacture of HFC 134a compressors during the second half of 1995. However, they may accelerate HFC 134a compressor availability according to the requirements of ASTRAL and ENRESA by importing parts from SANYO and assembling them at COMASA.

COMASA also manufacture hermetic compressors for companies in the commercial refrigeration sector. 1993 production in this sector was approximately 29,600 CFC 12 compressors. The balance of COMASA's 1993 compressor production, some 121,917 compressors, were used as replacements in repairs and servicing of the existing refrigerator population. While projects in commercial refrigeration may be prepared in the near future, there will be NO request from COMASA for additional incremental costs.

ASTRAL

Plant located in:	Queretaro
Ownership:	100% Mexican
Nr of models made:	10 refrigerator models
Nr of Production Lines	3
Refrig Units for 7/93-6/94:	732,413
Contact Person:	Ruben Tinoco Ojanguren
Tel / fax:	tel: 52-42-18.48.76 fax: 18.48.73

INDUSTRIAS ASTRAL has three production lines, one of which was started in 1977, the next one in 1991, and the last one in 1994. About 46% of their production is for export to the USA, Caribbean, Central and South America. They use compressors from COMASA, Tecumseh and Sanyo. ASTRAL employs about 1,400 employees. A lot of emphasis is put on the energy efficiency of the refrigerators produced. Brand names produced at ASTRAL include EASY, KELVINATOR, GE, ASTRAL, KENMORE, MABE, etc.

ENRESA

Plant located in:	Tlalnepantla
Ownership:	100% Mexican
Nr of models made:	2 refrigerators, 3 drinking fountains (no foam in fountains)
Nr of Production Lines:	1 for refrigerators, 1 for fountains
Refrig Units for 7/93-6/94:	76,909 refrig. + 35,500 fountains
Contact Person:	Ruben Tinoco Ojanguren
Tel / fax:	tel: 52-42-18.48.76 fax: 18.48.73

Ensambladora de Refrigeradores (ENRESA) was established in 1988. 10% of its production is for export (mostly Latin America). From the compressors used, 10% is from EMBRACO, 90% is from COMASA (also from MABE-Holding). ENRESA uses in-house technology with some inputs from General Electric (USA). It sells its refrigerators under several brand names such as KELVINATOR, GE, REGINA, TROPIGAS and IEM. ENRESA has approximately 306 employees.

4. PROJECT DESCRIPTION

The two domestic refrigerator manufacturing companies of the MABE holding presently use CFC 11 for the production of rigid insulation foam needed for the refrigerator cabinets and doors, and use CFC 12 as refrigerant. The total consumption during the period July 1993 - June 1994, and the ODP tons that will be eliminated by this project, are shown in the following table:

	CFC 11 in tons	ODP tons eliminated (see note *)	CFC 12 in tons	Total ODP tons eliminated
ASTRAL	287	256	88	344
ENRESA	40	35	12	47
	327	291	100	391

Note *: Second column of figures for CFC 11 takes the ODP of HCFC 141b into account (ODP = 0.11).

4.1. Replacement of CFC 11 with HCFC 141b.

The two companies will transfer to HCFC 141b as an interim step to an ODS-free system. The machines for injecting the rigid insulation foam should be high pressure machines that will be able to process the higher viscosities and mixing requirements of the low ODS systems and also any of the developing ODS-free systems. This will require equipment replacement and training at ASTRAL and ENRESA. A more detailed description of the existing foam injection equipment is given in para 5.1.3.

The two companies will require test-runs before being able to start industrial production with the new technology. These activities will include training of staff in worker-safety related to HCFC 141b.

Operational Cost for six months are requested to cover the transitional period.

4.2. Replacement of CFC 12 with HFC 134a.

Both companies will change to HFC 134a. This conversion requires the use of HFC 134a compressors and the associated new synthetic lubricants, re-design of the refrigeration systems to cater for the difference in thermodynamic performance of HFC 134a versus CFC 12, prototyping, testing and optimization of each refrigerator model, and pilot scale manufacture and testing before full scale conversion of production to HFC 134a for each model. The conversion will result in changes in manufacturing procedures for which production line supervisor and operator training will be required.

The different properties of HFC 134a, the need to avoid cross-contamination with CFC 12, and the phased nature of the conversion of refrigerator production from CFC 12 to HFC 134a, means that new system evacuation, refrigerant charging, and leak detection equipment will be required. A more detailed description of the existing equipment on which the technology change will impact is provided in para 5.2.3.

Key to the success of CFC 12 elimination is the local availability of HFC 134a compressors. MABE's compressor manufacturer COMASA has committed to the conversion of their compressor manufacturing operations to be able to provide the necessary volume of HFC 134a compressors. While incremental capital costs are requested for COMASA, incremental operating costs are passed on to the refrigerator manufacturers.

Operational costs for six months are requested to cover the transitional period.

5. TECHNOLOGY

5.1. Replacement of CFC 11 with HCFC 141b.

5.1.1. CFC 11 Replacement - OVERVIEW

There are currently three main directions in the development of CFC free systems for thermoset insulation foams:

- o CFC 11 > partial water/HCFC 141b > ?
- o CFC 11 > partial water/HCFC 22, 142b > HFC 134a, 152a
- o CFC 11 > partial water/ (Cyclo)pentane

In addition, compounds such as perfluoroalkanes, HCFC 123, fluorinated ethers and 2-chloropropane have been suggested, but the technology is not mature. Furthermore, the products are only available in limited quantities, and toxicological testing is not complete and, therefore, safety in use cannot be evaluated.

The first option, the liquid solution is the one which will be applied in this project, and employs technology that is closely related to the existing one. The final step in this process is not yet decided. One potential solution is HFC 356, but full water blown foam with improved cell structure remains an option, specifically in "lesser demanding" systems such as water heaters, where dimensional changes, although costly, are possible.

The second one, the "gas" solution, utilizes a gaseous mixture of physical blowing agents, always requires new equipment, and extensive adjustments. The final step in this process is seen as the introduction of gaseous HFC's.

The third option, cyclopentane technology, has recently been introduced commercially in Germany. Cyclopentane is flammable and this means a careful review of manufacturing operations with respect to the safe handling of a flammable foam blowing agent. Its use may not be a practical option in the existing work-environments of some enterprises. Several companies currently offer cyclopentane packages, including equipment.

5.1.2 CFC 11 Replacement - SELECTION

Based on economic and environmental considerations, cyclopentane appears to be the best choice for domestic refrigerator applications. It combines an attractive price with zero ODP properties. However, the related consumption of electricity virtually prohibits its use in Mexico, where strict energy standards apply. In addition, Mexico has considerable appliance exports to the USA where similar standards exist. At this time, only foams produced with CFC 11 or HCFC 141b are capable to meet these requirements. None of the low boiling blowing agents (LBBAs) can currently perform with the required energy efficiency and are therefore not acceptable in the Mexican and USA markets.

HCFC 22/142b was considered but is also marginal in energy performance.

The use of HCFC 141b is identified by the companies as an alternative that is:

- o Proven technology in processing/product performance,
- o Environmentally acceptable,
- o Readily available in the Mexican market,

In addition, flammability is not a major risk to production facilities and personnel.

Present documentation on the forecast on potential drop-in successors of CFC 11 and HCFC 141b (liquid HFCs), leads one to the conclusion that not too far in the future, a non-flammable two stage drop-in route for refrigeration foams is likely to come out with minimal incremental capital cost:

liquid CFCs > liquid HCFCs > liquid HFCs

As it is not yet known when liquid HFCs will be commercially available at this time, the project will provide for high pressure equipment such as to allow subsequent use of LBBAs. The choice of high pressure foam dispensing equipment will thus facilitate the subsequent step to a truly ODP-free system without major additional capital costs.

5.1.3 CFC 11 Replacement - IMPACT ON PRODUCTION PROCESS

The use of reduced ABA/141b technology, with higher related viscosity of the polyol blend will be facilitated through the employment of high pressure foam production equipment.

HCFC 141b is moderately flammable. For the intended purpose, the blends should not cause any risk, but a monitoring check at commissioning will be performed to ensure safe exposure levels.

Densities may have to be adjusted to obtain proper insulation values.

The liner material should be modified to be resistant to HCFC 141b. The companies intend to use high impact polystyrene (HIPS) in combination with an ethylene vinyl alcohol (EVOH) protective layer.

It is recommended to dedicate one small foam dispensing machine for pilot scale production which will avoid costly interruption of the regular production.

The relevant existing equipment on which the technology change to HCFC 141b will impact is as follows:

<u>ASTRAL:</u>

- In line 1 there are two dispensing Machines, one (HENNECKE) that supplies material to 15 low pressure mixing heads for the cabinets, and the other (CANNON) that supplies one high-pressure machine for the doors.

- In line 2 there are two high-pressure dispensing machines (both HENNECKE). The one for the door insulation employs two mixing heads.

- In line 3 there are three dispensing machines. One is for the cabinets and supplies 5 high-pressure mixing heads. The two others are for the doors and each supplies one high-pressure mixing head.

- There is one mixing station for lines 1 and 2, and another one for line 3.

<u>ENRESA:</u>

- ENRESA has a high-pressure HENNECKE. For the filling of the doors, they have a low-pressure HENNECKE HK135 with one mixing head. There is also a back-up CANNON low-pressure machine for which replacement will not be requested.

- ENRESA uses one pre-mixing station.

5.2. Replacement of CFC 12 with HFC 134a.

5.2.1. CFC 12 Replacement - OVERVIEW

HFC 134a has become universally accepted as the replacement for CFC 12 in the manufacture of domestic refrigerators. HFC 134a is widely available and the technology is mature, having already been introduced commercially in many of the Developed Countries.

Whilst hydrocarbon refrigerants are being used on a limited basis in at least one Developed Country, the technology is not considered as sufficiently developed to consider transfer to Mexico at the present time. Safety issues associated with the use of flammable hydrocarbon refrigerants, and the absence of suitable compressors on a commercial scale further mitigate against the adoption of this technology.

HFC 152a might be considered as another candidate for CFC 12 replacement in domestic refrigerators. However, HFC 152a is also flammable, the technology has not been developed commercially, and there are some questions around it's stability in refrigerator systems. Furthermore, compressors for use with HFC 152a are not commercially available.

5.2.2. CFC 12 Replacement - SELECTION

The selected technology is HFC 134a. The CFC 12 based refrigerator technology used by ASTRAL and ENRESA originated from General Electric Corporation, USA. The new HFC 134a based technology is based on know-how from General Electric Corporation with assistance from equipment and refrigerant suppliers. The MABE Group has a modern, well equipped, Technology Development Center located in Queretaro and are well versed in all of the issues relating to the use of HFC 134a. They commenced their HFC 134a technology development activities in early 1993 and have already produced CFC free versions of several models for test purposes.

For the manufacture of CFC 12 compressors, COMASA currently uses technology supplied from both Tecumseh and Mitsubishi. The technology for the new HFC 134a compressors will be supplied by Sanyo. COMASA thus has access to the necessary technology and is capable of successfully implementing this project to manufacture HFC 134a compressors.

5.2.3. CFC 12 Replacement - IMPACT ON PRODUCTION PROCESS

HFC 134a, like CFC 12, is non flammable. HFC 134a has also been the subject of extensive toxicological testing and is considered safe in use in industrial applications provided the suppliers recommended occupational exposure levels are not exceeded. At the present time this means ensuring that exposure levels do not exceed 1000 parts per million on an 8-hour time-weighted average basis. This is the same as the Occupational Exposure Limit (OEL) / Threshold Limit Value (TLV) for CFC 12 and thus no changes from current practices are required.

There will be an approximately 10% reduction in the mass charge of

HFC 134a compared with CFC 12 for a refrigerator system of the same capacity. This is taken into account in the calculation of the incremental operational cost (see annex B).

It is well understood that the chemical stability of HFC 134a/synthetic lubricant systems in domestic refrigerators, and hence the long term performance of the appliance, is sensitive to moisture content and certain chlorinated impurities. This requires that CFC 12 and HFC 134a handling equipment be carefully segregated, and it also calls for better evacuation of the system prior to refrigerant charging. In order to ensure both thorough evacuation and complete dehydration prior to refrigerant charging, many refrigerator manufacturers have opted to source their compressors "dry", charged with nitrogen, and without lubricant. This is a major change from current practice and requires that the refrigeration manufacturer installs the necessary lubricant storage, handling, drying, testing, and charging equipment. This is the case for both ASTRAL and ENRESA.

COMASA will not, therefore, require new lubricant handling and charging equipment but they will need dry nitrogen charging equipment.

The conversion from CFC 12 to HFC 134a will take place on a model by model/production line by production line basis, so that both manufacturers will be producing both CFC 12 and HFC 134a refrigerators during the implementation phase of this project. This is feasible as both ASTRAL and ENRESA have several production lines.

The above considerations mean that within this project there is a requirement for new system evacuation equipment, new lubricant storage, handling, drying, testing, and charging equipment, as well as new refrigerant charging equipment at both ASTRAL and ENRESA.

As a consequence of the substantial changes to current practice, and the defined need for system cleanliness and low moisture content, there will be the need for a careful re-assessment of production procedures and personnel re-training as appropriate. Provision for this is also made in the project.

Leak detection of the refrigeration system is an integral part of the manufacturing process. The use of HFC 134a requires that new leak detection equipment, suitable for use with HFC 134a, be employed.

The relevant existing equipment on which the technology change to HFC 134a will impact is as follows:

<u>COMASA</u>

Current washing and degreasing, welding and dehydration equipment used in the manufacture of CFC 12 compressors include the following items. It should be noted that all equipment dates from 1977 and rebuild/retrofit is not considered feasible due to both the extensive process changes required for the HFC 134a technology and the age of the equipment.

- Washing Equipment.

  - "DURR" machine for degreasing, rinsing, phosphate treatment and rinsing, including pumps and heating system.

  - "DURR" machine for compressor shell pre-wash treatment inclusive of conveyor, pumps and heating system.

  - "DURR" machine for washing cast iron components.

- Welding Equipment.

  - "FAARSOEL" P.200-300 spot welding machine, 300KVA for terminal glass.

  - "FAARSOEL" 3-head spot welding machine, 75 KVA each head for spring support welding.

  - "MAHESA" arc welding machine and integral power source.

Dehydration Equipment.

  - "DURR" fan assisted compressor dehydration oven and accessories.

ASTRAL

- 3 x PCU (Production Control Units) automatic refrigerant charging units with dual injection heads and vacuum pumps.

- 90 Sargent Welch vacuum pumps, 21 m^3 per hour capacity

- 6 Leybold Inficon HLD 3000 electronic R12 refrigerant leak detectors

ENRESA

- 2 x PCU automatic refrigerant charging units with dual injection heads and vacuum pumps.

- 40 Sargent Welsh vacuum pumps, 21 m^3 per hour capacity

- 4 Leybold Inficon HLD 3000 electronic R12 refrigerant leak detectors

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS

6.1.1. Capital Cost for the Manufacture of HFC 134a Compressors (COMASA) (US$).

The following table takes into account COMASA's anticipated production increase. The figures on the left reflect the investment which will be carried out by COMASA for a projected production increase to 1.8 million units per annum in 1998. The figures on the right are the ones applied for, and are obtained by re-assessing what funds would be needed if the production would remain at existing production levels. The figures were further reduced during further discussions.

Description	Total Cost	US$ Requested
Spot Welding Machines (3 units)	156,700	N/A
Tube Bending and Forming Machine (1 unit)	207,100	N/A
5-Stage Degreasing, Cleaning/Chemical Treatment	2,490,684	821,926
Dehydration Ovens (2 units)	2,075,519	684,921
One Leak Test System and Nitrogen Charging system	205,612	67,892
Training	10,000	10,000
Trials	10,000	10,000
Contingencies (10% of Capital Cost)	515,561	166,255
TOTAL INCREMENTAL CAPITAL COST:	5,671,176	1,828,806
TOTAL REQUESTED (65% Mexican owned)	3,686,264	1,188,724

Justification for the above request was obtained for the relatively high capital cost for COMASA, further to questions raised by the independent technical reviewer. This justification is attached to this document as annex E, and summarized in the following paragraphs.

The current process at COMASA is depicted in diagrams attached to annex E. The equipment all dates from 1977 and rebuild/retrofit is not considered feasible due both to the extensive process changes involved in the new technology, and to the age of the equipment. All costs are the real costs associated with the particular aspect of technology change from R12 to R134a compressor manufacture. The equipment specified is therefore necessary to meet the manufacturing standards and norms imposed on COMASA by their technology partner. In addition, order confirmation to purchase the equipment specified in the project were already issued by COMASA. This in itself demonstrates that the equipment in the project proposal is the actual equipment needed to successfully make the technology change.

It should be noted that COMASA is going through a two-phase restructuring of their compressor manufacturing operations. The first phase is concerned with upgrading their basic compressor technology to be able to comply with new energy efficiency standards which will come into effect in Mexico later this year. The second phase is the conversion to the manufacture of R134a compressors. The total capital cost is considerable, and a part of phase 1 has been financed by SANYO Corp of Japan, taking a 35% capital share in COMASA in exchange for compressor technology and equipment supply. This project proposal does not include any of the costs associated with the basic technology upgrade to meet the new energy efficiency standards.

MABE recently placed equipment orders covering aspects of both phases totalling US$ 8,260,000 and copies of the order forms were given, illustrating COMASA's commitment to the change to R134a compressor production, as well as meeting the newly established performance standards as described above.

Degreasing, Cleaning, Chemical Treatment Equipment (COMASA).

One of the most important requirements for a successful use of R134a is component cleanliness. With COMASA's existing equipment it is not possible to guarantee the cleanliness of the compressor and its components and investment in new "washing" equipment is required. COMASA analyzed various options taking their production volume and quality of cleanliness into account and they selected the equipment described as follows:

	US$
1 x 5-stage spray-pretreatment complete with gas heated drying oven, conveyer system and jigs	504,583
1 x 5-stage spray-pretreatment with gas heated drying oven, conveyor system and basket-holding jigs . . .	452,345
1 x 3-stage ultrasonic dip-pretreatment complete with crane, drying oven feeding and discharge conveyor and free programmable process controller	353,430
1 x 8-stage dip-pretreatment complete with 2 cranes, blow-off zone, drying oven, feeding and discharging conveyors and free programmable process controller	569,046
1 x 8-stage dip-pretreatment complete with 2 cranes, blow-off zone, drying oven, feeding and discharging conveyors and free programmable process controller	611,279
	2,490,684

The requested amount was reduced to take the anticipated production increase into account (please see the beginning of this section).

Welding Equipment (COMASA).

The present method of welding the compressor suction and discharge tubes is based on silver solder/gas flux process. This is a "dirty" process considered unsuitable in the manufacture of R134a compressors. New spot welding machines are therefore required for this operation. There is a consequent change in the required form of the suction and discharge tubes at the point of join and that is why a new tube bending machine is required. More details of what is involved are in annex E, but are summarized as follows:

	US$
1 x Projection Welding Machine (Tube Discharge Shell to Shell A)	48,500
1 x Projection Welding Machine (Tube Suction Shell to Shell A)	54,100
1 x Projection Welding Machine (Tube Charge Shell to Shell A)	54,100
1 x Tube Bending Machine (Bend Suction and Discharge Tunes)	207,100
	363,800

Dehydration Equipment (COMASA).
In the existing process the compressor is first dried and afterwards hermetically sealed. This method does not guarantee achieving the low level of residual humidity required for a R134a compressor. To be able to comply with the low humidity levels it is necessary to first seal the compressor, and then dry it. Longer drying times and higher temperatures are necessary, and taking the production volumes into account, the existing equipment is not capable of meeting the requirements. The new dehydration equipment is as follows:

	US$
1 x Dehydration Oven for C-BZN compressors complete with conveyer and hot air blow-out unit	791,866
1 x Dehydration Oven for C-QN compressors complete with conveyer and hot air blow-out unit	1,283,653
	2,075,519

The requested amount was reduced to take the anticipated production increase into account (please see the beginning of this section).

Leak Test System and Nitrogen Charging Units (COMASA).
COMASA's compressor manufacturing operation will be changed for R134a compressors so that the compressors are "dehydrated" after assembly. After manufacture and dehydration of the R134a compressors, COMASA must guarantee supply to the end-user in a "dry" condition. They will be supplying both "lube free" compressors (to ASTRAL/ENRESA) and compressors "with lube" to other end-users in the commercial refrigeration sector and for repairs and servicing. To preserve the low residual humidity condition during a reasonable "shelf life" for the compressors, they must be over-pressurized with dry nitrogen and be capable of maintaining this over-pressure for several months. Very effective pressure is therefore required followed by charging with dry nitrogen. This is a requirement for the R134a compressors not previously needed for the R12 compressors and the cost is then fully incremental.

6.1.2. Capital Cost for the Refrigerator Manufacturers - CFC 11

ASTRAL	US$
High Pressure Foaming Machine and 15 Mixing Heads (See note 1)	500,000
Training (250 US$ per person, 80 people)	20,000
Test Trials (100 US$ per trial, 3 trials per model, 10 refr. models)	3,000
Machine for Pilot Series (See note 2)	90,000
Contingencies (10% of capital cost)	61,000
Subtotal Incr. Capital Cost for CFC 11; ASTRAL	674,000
Minus 34% due to export to USA	444,840

Note 1: A possibility to use one mixing head moving from one fixture to the other using a computer-controlled system was investigated. Compelling arguments were given by MABE's Technology Center explaining why such this cheaper solution cannot be utilized in the case of ASTRAL. These explanations are attached in annex H.

Note 2: The company cannot afford to shut down production lines over an extended period, or this would lead to very high cost of conversion. The more cost-effective solution is to manufacture a pilot series on a small pilot machine. In this way, all formulations can be adjusted without any business interruption. It should be noted that this option should be considered as a decision on a case by case basis. MABE has four production lines with substantial different products. In this case, separated pilots are more cost-effective. However in case of less production lines, more similar products, other technologies or planned capacity expansion, the cost-effectiveness of a pilot machine may be different. MABE agreed with the fact that this pilot machine would remain property of the UNDP, so that it may be used in similar projects funded by the Multilateral Fund, once the trial testing at ASTRAL are finalized.

ENRESA	US$
High Pressure Foaming Machine and Mixing Heads (1 unit + 1 mixing head)	150,000
Training (500 US$ per person, 20 people)	10,000
Test Trials (1000 US$ per trial, 3 trials per model, 2 refrig. models)	6,000
Contingencies (10% of capital cost)	17,000
Subtotal Incr. Capital Cost for CFC 11; ENRESA	183,000

There are no exports from ENRESA to non-article-5 countries.

6.1.3. Capital Cost for the Refrigerator Manufacturers - CFC 12.

ASTRAL	US$
Refrigerant/Lube Charging Equipment	
2 units to be replaced:	180,000
1 unit to be retrofitted:	19,000
Vacuum Pumps (10 items -- new, US$ 2,500 each, see note 3)	25,000
Vacuum Pumps (80 items -- retrofitted, US$ 400 each)	32,000
R-134a Leak Detection Equipment (6 items)	30,000
Lube Drier, dehydration system, tank and charging valves	
1 unit to be replaced:	118,000
1 unit to be retrofitted:	70,000
Training	15,000
Reliability Test Trials, etc.	22,500
Contingencies (10% of capital cost)	51,000
Subtotal Capital Cost for CFC 12; ASRAL	562,500
Minus 34% due to export to USA	371,250

ENRESA	
Refrigerant/Lube Charging Equipment (2 units):	180,000
Vacuum Pumps (5 items - new, US$ 2,500 each):	12,500
Vacuum Pumps (35 items - retrofitted, US$ 400 each):	14,000
R-134a Leak Detection Equipment (4 items):	20,000
Lube Drier, incl dehydration system, tank and charging valves (1 item):	118,000
Training	10,000
Reliability Test Trials, etc.	7,500
Contingencies (10% of capital cost)	36,000
Subtotal Capital Cost for CFC 12; ENRESA	398,000

There are no exports from ENRESA to non-article-5 countries.

Note 3: It should be stressed that a detailed count was made of existing vacuum pumps during project formulation missions, and that this count corresponds to the numbers of pumps requested. It should also be noted that retrofit/modification of existing pumps was considered. While reservations were expressed by the companies about retrofitting, it was pointed out that this has been successfully carried out in other plants which are using the same pumps as are being used in ASTRAL and ENRESA. However, if ASTRAL and ENRESA do not wish to use this amount to retrofit their vacuum pumps, they can of course apply the amounts proposed to the purchase of new pumps.

6.1.4. Total Capital Cost (US$).

The totals of the above three tables are summarized as follows:

	TOTAL	COMASA	ASTRAL	ENRESA
Capital Cost	3,646,306	1,828,806	1,236,500	581,000
% Ownership	----	65	100	100
% Export USA	----	0	34	0
Requested	2,585,814	1,188,724	816,090	581,000

6.2 INCREMENTAL OPERATIONAL COSTS

The calculation is based on a six month period using production data based on July 93 - June 94 figures. This was done further to a decision at the 13th Executive Committee Meeting held in Montreal in July 1994. These funds would be paid upfront.

The following provides some clarification as to the COMASA Compressor manufacturer. The tables of annex C shows that both the refrigeration manufacturers intend to buy both COMASA and imported compressors. The prices of the present COMASA CFC 12 compressors are somewhat higher than imported ones. The reason of the higher cost for COMASA compressors is because COMASA is geared to the size of the Mexican market and that their production levels are 10 to 20 times lower than similar companies such as in the USA and in Brazil.

Annexes B and C provide detailed explanations on how the incremental operational costs were obtained, and are summarized in the following tables. In line with recent guidance from the Executive Committee, incremental operational costs are only claimed by the two refrigerator manufacturers.

Detailed calculations are given in annex B.1.1 and B.2.1. The figures already take into account that only 65% of COMASA is owned by article-5 countries and that ASTRAL is exporting 34% of its production to the USA.

	TOTAL	ASTRAL	ENRESA
Operational Cost CFC 11	537,433	448,547	88,886
Operational Cost CFC 12	1,051,398	854,251	197,147
Total Operational Cost	1,588,831	1,302,798	286,033

6.3 UNIT ABATEMENT COST

6.3.1 Individual Unit Abatement Costs for the Two Refrigerator Manufacturers (US$/Kg)

	ASTRAL	ENRESA
a. Capital Investment Costs	816,090	581,000
b. Capital Recovery Factor (10% p.a.)	0.16275	0.16275
d. Incremental Operating Costs	1,302,798	286,033
e. ODS Reduction (ODP Kgs)	344,000	47,000
f. Unit Abatement Cost (US$/Kg) [(a*b + d)] / e	4.2	8.1

6.3.2 Unit Abatement Cost for the Total Project encompassing all Three Companies (US$/Kg)

	TOTAL FOR COMASA/ASTRAL/ENRESA
a. ODS Reduction Capital Costs	2,585,814
b. Capital Recovery Factor (10% p.a.)	0.16275
d. Incremental Operating Costs (1996)	1,588,831
e. ODS Reduction (ODP Kgs 1993)	391,000
f. UNIT ABATEMENT COST (US$/Kg) [(a*b + d)] / e	5.1

7. FINANCING PLAN

The companies are requesting reimbursement to the amount of the project costs of US$ 4,174,645. See above tables and Annex A for distribution of funds according to company.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP will oversee the successful implementation of this project, and will provide technical assistance during project execution.

8.2 SCHEDULE

TASK	TIME TO COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
Approval	x					
Procurement preparation	xx	x				
Vendor selection		xx				
2. Installation						
Arrival, Customs,		xx				
Machine installation		x	x			
3. Start-Up						
Machine start-up			x			
Trials, training			xxx			
Certification			x	xx		

9. PROJECT IMPACT

This project will eliminate the use of 427 tons of CFC's (391 ODP tons) per year. This data is based on figures for the period July 93 - June 94. Taking a 6 % growth till the year 2000, the ODP tons eliminated during the period 1993-2000 amounts to 3584.

10. ANNEXES

ANNEX A: SUMMARY BUDGET TABLE
ANNEX B: INDIVIDUAL COMPANY INCREMENTAL OPERATIONAL COSTS
ANNEX C: CLARIFICATION ON CALCULATION OF AVERAGES FOR COMPRESSORS
ANNEX D: CLARIFICATION ON TECHNOLOGY AGREEMENT WITH GE
ANNEX E: JUSTIFICATION FOR THE CAPITAL COST FOR COMASA
ANNEX F: GOVERNMENT SUBMITTAL LETTER - LETTER REGARDING OWNERSHIP
ANNEX G: TECHNICAL REVIEWS
ANNEX H: ADDITIONAL INFORMATION ON FOAMING MACHINE

ANNEX A : SUMMARY BUDGET TABLE

Note: Figures below already take 65% Article-5 ownership of COMASA and 34% export to USA for ASTRAL into account.

		Total	COMASA Compr.Manuf.	ASTRAL Refr.Manuf.	ENRESA Refr.Manuf.
a. ODP Tons Eliminated	CFC-11	291	0	256	35
	CFC-12	100	0	88	12
	Both	391	0	344	47
b. Incremental Capital Cost	CFC-11	627,840	0	444,840	183,000
	CFC-12	1,957,974	1,188,724	371,250	398,000
	Both	2,585,814	1,188,724	816,090	581,000
c. Incremental Operational Cost	CFC-11	537,433	0	448,547	88,886
	CFC-12	1,051,398	0	854,251	197,147
	Both	1,588,831	0	1,302,798	286,033
d. Total Incremental Cost (d = b + c)	CFC-11	1,165,273	0	893,387	271,886
	CFC-12	3,009,372	1,188,724	1,225,501	595,147
	Both	4,174,645	1,188,724	2,118,888	867,033
e. Capital Conv. Factor (10 yrs)		0.16275	0.16275	0.16275	0.16275
f. Unit Abatement Cost f=(b*e+c)/(a*1000)	CFC-11	2.2	N/A	2.0	3.4
	CFC-12	13.7	N/A	10.4	21.8
	Both	5.1	N/A	4.2	8.1
g. Cost-Effectiveness g = d / a	CFC-11	4.0	N/A	3.5	7.8
	CFC-12	30.1	N/A	13.9	49.6
	Both	10.7	N/A	6.2	18.4

Annex B.1.1 -- Calculation of the Incremental Operating Cost for ASTRAL

1. The Elimination of CFC-11 as Blowing Agent for Thermal Insulatin Foams.

ASTRAL === ASTRAL === ASTRAL === ASTRAL ==	CFC-11	HCFC-141b	Difference
Use per kg of Foam produced.			
a. kg Polyol	0.3704	0.4348	0.0644
b. kg MDI	0.5000	0.4760	(0.0240)
c. kg Blowing Agent	0.1296	0.0892	(0.0404)
Prices in US$			
d. Polyol (US$/kg)	1.8840	1.8840	0.0000
e. MDI (US$/kg)	1.9510	1.9510	0.0000
f. Blowing Agent (US$/kg)	1.9482	3.4127	1.4645
g. Polystyrene for Liner (US$/m2)	0.0009	0.5900	0.5891
Cost per kg of foam produced			
h. = a x d. Polyol	0.6978	0.8192	0.1213
i. = b x e. MDI	0.9755	0.9287	(0.0468)
j. = c x f. Blowing Agent	0.2525	0.3044	0.0519
k. = h+i+j, Total per kg foam	1.9258	2.0523	0.1264
Material used per Refrigerator			
l. kg of foams per unit (average)	3.0235	3.3249	0.3014
m. m2 of polystyrene per unit (average)	1.4444	1.4746	0.0301
Cost per Refrigeration Unit			
n. = l x k. for foams	5.8227	6.8235	1.0008
o. = m x g. for polystyrene	0.0013	0.8700	0.8687
p. = n + o. Total per unit	5.8240	7.6935	1.8695
q. Nr of Refrigerator Units/year			732,413
r. Total Incremental Cost per year (US$)			1,369,233
s. Savings Related to Cleaning of Mixing Heads			(10,000)
s. Operational Cost for a six-month period (r + s) / 2			679,617
t. Operational Cost taking 34% Export to USA into account			448,547

Note: Production data is based on July 93 - June 94 figures.

Annex B.1.2 -- Calculation of the Incremental Operating Cost for ASTRAL

2. The Elimination of CFC-12 as Refrigerant.

ASTRAL === ASTRAL === ASTRAL === ASTRAL ==	CFC-12	HFC-134a	Difference
1. Refrigerant			
a. Price per kg Refrigerant	2.13	7.50	
b. Kg per Refrigerator (average)	0.12	0.108	
c. Number of Refrigerators per year (see note)	732,413		
d. Cost for Refrigerant d= a x b x c	187,205	593,255	406,050
2. Compressors			
a. Cost per Compressor (see note)	37.89	39.83	
b. Number of Compressors per year (see note)	732,413		
c. Cost for Compressors c = a x b	27,751,129	29,172,010	1,420,881
3. Condensors			
a. Cost per Condensor			
b. Number of Condensors per year	732,413		
c. Cost for Condensor c = a x b			0
4. Filter/Dryer			
a. Cost per Filter/Dryer	0.56	0.62	
b. Number of Filter/Dryers per year	732,413		
c. Cost for Filter/Dryer c = a x b	410,151	454,096	43,945
5. Capillary Tubes			
a. Cost per Capillary Tube	0.32	0.42	
b. Number of Capillary Tubes per year	732,413		
c. Cost for Capillary Tube c = a x b	234,372	307,613	73,241
6. Compressor Lubricant			
a. Price per litre of Lubricant	0.00	4.00	
b. Litres of Lubricants/compressor (average)	0.00	0.22	
c. Number of compressors	732,413		
d. Cost for Lubricant d = a x b x c	0	644,523	644,523
e. Total per year			2,588,641
f. Operational Cost for a six months period			1,294,320
g. Operational Cost taking 34% export to USA into account			854,251

Note: All figures in this table are based on a weighted average of the refrigerator models produced. For averages for compressors, see annex C. Production data are based on July 93 - June 94 figures.

Annex B.2.1 -- Calculation of the Incremental Operating Cost for ENRESA

1. The Elimination of CFC-11 as Blowing Agent for Thermal Insulatin Foams.

ENRESA === ENRESA === ENRESA === ENRESA ==	CFC-11	HCFC-141b	Difference
Use per kg of Foam produced.			
a. kg Polyol	0.3704	0.4348	0.0644
b. kg MDI	0.5000	0.4760	(0.0240)
c. kg Blowing Agent	0.1296	0.0892	(0.0404)
Prices in US$			
d. Polyol (US$/kg)	1.8840	1.8840	0.0000
e. MDI (US$/kg)	1.9510	1.9510	0.0000
f. Blowing Agent (US$/kg)	1.9482	3.4127	1.4645
g. Polystyrene for Liner (US$/m2)	0.0009	0.5900	0.5891
Cost per kg of foam produced			
h. = a x d. Polyol	0.6978	0.8192	0.1213
i. = b x e. MDI	0.9755	0.9287	(0.0468)
j. = r x f. Blowing Agent	0.2525	0.3044	0.0519
k. = h+i+j, Total per kg foam	1.9258	2.0523	0.1264
Material used per Refrigerator			
l. kg of foams per unit (average)	3.9603	4.3551	0.3948
m. m2 of polystyrene per unit (average)	1.6667	1.7535	0.0868
Cost per Refrigeration Unit			
n. = l x k. for foams	7.6268	8.9377	1.3109
o. = m x g. for polystyrene	0.0015	1.0346	1.0331
p. = n + o. Total per unit	7.6283	9.9723	2.3440
q. Nr of Refrigeration Units/year			76,909
r. Total Incremental Cost per year (US$)			180,272
s. Savings related to cleaning of mixing heads			(2,500)
t. Operational Cost for a six months period t = (r+s)/2			88,886

Note: Nr of Refrigeration units for the CFC-11 table do not include water fountains since these do not utilize foam. Production data are based on July 93 - June 94 figures

Annex B.2.2 -- Calculation of the Incremental Operating Cost for ENRESA

2. The Elimination of CFC-12 as Refrigerant.

ENRESA === ENRESA === ENRESA === ENRESA ==	CFC-12	HFC-134a	Difference
1. Refrigerant			
a. Price per kg Refrigerant	2.13	7.50	
b. Kg per Refrigerator (average, see note)	0.1048	0.09612	
c. Number of Refrigerators per year (see note)	112,409		
d. Cost for Refrigerant d= a x b x c	25,092	81,036	55,943
2. Compressors			
a. Cost per Compressor (see note)	37.89	39.83	
b. Number of Compressors per year (see note)	112,409		
c. Cost for Compressors c = a x b	4,259,177	4,477,250	218,073
3. Condensors			
a. Cost per Condensor			
b. Number of Condensors per year	112,409		
c. Cost for Condensor c = a x b	0	0	0
4. Filter/Dryer			
a. Cost per Filter/Dryer	0.56	0.62	
b. Number of Filter/Dryers per year	112,409		
c. Cost for Filter/Dryer c = a x b	62,949	69,694	6,745
5. Capillary Tubes			
a. Cost per Capillary Tube	0.27	0.40	
b. Number of Capillary Tubes per year	112,409		
c. Cost for Capillary Tube c = a x b	30,350	44,964	14,613
6. Compressor Lubricant			
a. Price per litre of Lubricant (US$)	0.00	4.00	
b. Litres of Lubricant/compressor (average)	0.00	0.22	
c. Number of compressors	112,409		
d. Cost of Lubricant per compressor d = a x b x c	0	98,920	98,920
e. Total per year			394,294
f. Operational Cost for a six month duration			197,147

Note: Number of units include refrigerators and water fountains. All figures in this table including the charge in kg, compressor prices etc, are based on a weighted average

of the refrigerator and water fountain units produced. For averages for compressors, see annex C. Production data are based on July 93 - June 94 figures.

ANNEX E : Price averages for Compressors

Prices of CFC-12 Compressors reported by each company

	Price per unit	Nr of Compressors	Total USD
COMASA Compressors for Refrigerators	41.63	414,003	17,234,945
COMASA Compressors for Fountains	29.88	22,508	672,539
Imported Compressors for Refrigerators	32.72	258,697	8,464,566
Imported Compressors for Fountains	29.88	3,972	118,683
	37.89 <	699,180	26,490,733

Calculation of Average Incremental Costs for Compressors

	Price per unit	Nr of Compressors	Total USD
COMASA Compressors for Refrigerators	2.10	414,003	869,406
COMASA Compressors for Fountains	1.90	22,508	42,765
Imported Compressors for Refrigerators	1.70	258,697	439,785
Imported Compressors for Fountains	1.50	3,972	5,958
	1.94 <	699,180	1,357,914

Note 1: Prices of most imported compressors are lower than prices of locally made compressors. This is due to the fact that production volumes at COMASA compressors are 10 to 20 times lower than production at factories in USA or Brazil. However, the after tax prices look much more favourable for COMASA than the figures shown above.

Note 2: This price was calculated based on the incremental operational cost that COMASA will be faced with to switch from CFC-12 compressors to HFC-134a compressors. The incremental cost arrived at is 2.1 US$ for refrigerators and 1.9 for the water fountains.

Note 3: All prices were provided by the various companies concerned, and verified by SEDESOL (INE).

4/2

URGENT FACSIMILE MESSAGE

To: Martien Janssen RE/GENT PO Box 6034 5600 HA Eindhoven The Netherlands Fax No. (31) 40 503677	REFAC CONSULT Postal Address 134 Killiney Road Devonshire Court #03-134 Singapore 0923 Telephone (65) 235 3991 Fax (65) 235 3991
From: Stuart Kelly	Date: 18 August 1994 Page: 1 of 5

Dear Martien

REVIEW OF MABE GROUP, MEXICO, REFRIGERATOR/COMPRESSOR PROJECTS

Further to our telephone conversation of 16 August I requested additional information from MABE Group regarding both the capital investments costs associated with COMASA's change from R12 to R134a compressor technology, and the question of a formal technology agreement with General Electric (GE).

I still await the response on the COMASA investments costs and have a conference call arranged for tonight, Thursday 18 August, Singapore time. I will fax you whatever relevant information I can obtain before Friday afternoon Netherlands time.

Regarding the technology agreement with GE I attach a copy (in Spanish!) of the response from the MABE Technology Centre in Queretaro on this subject. I do not know whether you can read Spanish, or have access to someone who can translate the information for you, so let me give you some of the important points (sense rather than strictly literal translation):

"MABE pays 5 million dollars per year to GE to use the GE name and for technology transfer"

"This payment does not cover matters rated as strictly confidential but it does cover confidential matters" "Request for strictly confidential material involves additional payment"

"MABE uses this technology transfer agreement constantly and there already exists a programme where MABE Technology Centre people regularly (6 months every 4 years) spend time at GE on matters relating to all areas of technology and development"

"GE sends 4 relevant experts to MABE for each project that MABE generate and they have a relationship with GE such that the latter oversees these endeavors"

"All materials used in manufacturing refrigerators (etc.) must comply with GE specifications, MABE uses GE recommended equipment and GE standards for product testing, and they comply with the same US or International Norms as GE"

"There are 3 monthly cross checks between GE and MABE laboratories on tests and results (MABE even send equipment to GE for independent assessment)"

... and much more of the same or similar information confirming the very close technical relationship that exists between GE and MABE, including the point I made in my fax that GE take very good care to protect their own trade mark and good name as many of the MABE Group products bear the GE name and logo.

You will see from the MABE fax that they also sent an extremely detailed work programme for the CFC elimination project at ASTRAL, which they say is similar to project programmes that they have for ENRESA and COMASA. I think this was supplied in response to your comment that the 1 year time frame looked "tight". The total ASTRAL project programme covers 10 pages and I do not think it is necessary to send you that, but I can confirm to you that the target date for COMPLETION of CFC elimination (both foam and refrigeration) at ASTRAL is 1 September 1995!

Best wishes and kind regards

SWKelly
Stuart Kelly

A|2d

TECNOLOGIA Y DESARROLLO

August 16th 1994

FAX FAX FAX FAX FAX FAX

TO: JACQUES VAN ENGEL
COMPANY: UNDP

RECEIVED AUG. 17 1994 (1550)

-> cc S. Kelly 65-235.3991

FROM: LUIS ALZATI

COMPANY: MABE TECHNOLOGY CENTER

TOTAL OF PAGES (INCLUDING THIS ONE) 13

SUBJECT: ANSWER TO YOUR FAX DATED AUGUST 15 AND 16TH 1994

JACQUES:

TE ESTOY CONTESTANDO EN ESPAÑOL PARA MAYOR RAPIDEZ DE MI PARTE.

DE ACUERDO A LA TRANFERENCIA QUE SE HACE DE TECNOLOGIA DE G.E HACIA MABE TE PUEDO COMENTAR LO SIGUIENTE:

MABE PAGA ANUALMENTE 5 MILLONES DE DOLARES A G.E. POR USO DE MARCA Y TRANSFERENCIA DE TECNOLOGIA.

ESTE PAGO NO CUBRE CUESTIONES CLASIFICADAS COMO ESTRICTAMENTE CONFIDENSIALES, PERO LAS CONFIDENCIALES SI.

SI LLEGARAMOS A REQUERIR ALGO CLASIFICADO COMO ESTRICTAMENTE CONFIDENCIAL ESTO SE PAGARA A PARTE.

NUESTRA GENTE SE CAPACITA CONSTANTEMENTE, YA QUE EXISTE UN PROGRAMA DE MANDAR 6 MESES A CADA GENTE A G.E. APLIANCE CADA 4 AÑOS Y ESTO SE HACE EN TODAS LAS AREAS DE TECNOLOGIA Y DESARROLLO.

Mex

Acceso "B" No. 406
Parque Industrial Jurica 76120
Querétaro, Qro. MÉXICO

Phone: 18 48 76
Fax: (42) 18 48 73

G.E. MANDA 4 EXPERTOS EN LA MATERIA PARA CADA PROYECTO QUE S. GENERE EN MABE Y TENGA RELACION CON G.E. PARA VIGILAR SI SEGUIMIENTO.

PARA TODOS LOS MATERIALES QUE SE UTILIZAN EN LA MANUFACTUR DE REFRIGERADORES, ESTUFAS Y LAVADORAS DEBERAN DE CUMPLIR CON LA ESPECIFICACIONES DEL EMPIS DESK MANUAL (A GUIDE TO G.E. MATERIAL PART AND FINISH DESIGNATIONS).

POR OTRO LADO TODOS LOS MODELOS SON PROBADOS SEGUN SUS EI QUE SON NORMAS PARA PROBAR SUS PRODUCTOS E INCLUSIVE LC LABORATORIOS QUE SE TIENEN EN TECNOLOGIA Y DESARROLLO SON CO EQUIPO QUE ELLOS RECONMENDARON E INCLUSIVE NOS VENDIERON.

ADEMAS DEBEMOS CUMPLIR CON TODAS LAS NORMAS DE E.U.A. COM SON EL DOE (CONSUMO DE ENERGIA), FDA (NORMAS SOBRE ALIMENTOS), UL NORMAS DE SEGURIDAD), ETC.

CADA 3 MESES SE MANDAN APARATOS PARA PROBARSE EN LC LABORATORIOS DE G.E. Y ESTAS SON CONFIRMADAS CON NUESTRC RESULTADOS EN AQUI EN MEXICO.

CADA MES SE TIENE UNA VISITA TECNICA A NUESTRAS PLANTAS DI GRUPO DONDE SE VENDEN SUS MARCAS.

TENEMOS ACCESO A BANCOS DE INFORMACION MUNDIALES ATRAVES E COMPUTADORAS.

LOS DISEÑOS DE LOS PRODUCTOS DE G.E. DEBERAN SER APROBADOS PC ELLOS Y EN ALGUNAS OCASIONES ELLOS NOS MANDAN LOS PLANOS.

SE ASISTE CONSTAMENTE A LAS CONFERENCIAS DE CFC'S EN EUA COM SON LA DE BALTIMORE, WASHINGTON,ETC.

CONFERENCIAS DE COMPRESORES COMO LA DE PURDUE EL MES PASADC

SE TIENE UN SISTEMA ELECTRONICO ATRAVES DE SATELITE Y POR MED DE LAS COMPUTADORAS LLAMADO SISTEMA CERO DONDE SE PUEI CONSULTAR A TODOS LOS EXPERTOS DE G.E. PARA SOLUCION DE PROBLEMAS CONSULTAS TECNICAS.(DENTRO DEL PAGO ANUAL)

G.E. MONITOREA CONSTANTEMENTE LOS INDICADORES QUE ARRC NUESTRO CENTRO DE SERVICIO (SERVIPLUS) Y SE ATACAN LOS PROBLEM CON MAYOR INDICE A ESTOS INDICADORES SE LES LLAMA INDICE LLAMADAS DE SERVICIO. ESTO TAMBIEN LO HACE EN LOS ESTADOS UNIDOS.

TODO ESTO SE RESPALDA CON EL NUEVO CENTRO DE TECNOLOGIA Y DESAROLLO DE MABE QUE CUENTA CON 150 GNETES DEDICADAS AL DISEÑO, DIBUJO E INVESTIGACION.

COMO SE PUEDE OBSERVAR G.E. TIENE UN ESPECIAL CUIDADO EN MANTENER EL PRESTIGIO DE SU MARCA QUE LLEGA INCLUSIVE A CAMBIAR MILES DE REFRIGERADORES SI SE TIENE ALGUN DEFECTO DE FUNCIONAMIENTO.

ASI MISMO TE MANDO COPIA DEL PROGRAMA QUE ESTAMOS SIGUIENDO PARA LA ELIMINACION DE CFC'S EN INDUSTRIAS ASTRAL Y QUE ES SEMEJANTE PARA ENRESA, COMASA, PROTAL Y TAMBIEN SE TIENEN PROGRAMAS DE APOYO A LOS PROVEEDORES PARA DESARROLLAR LOS NUEVOS REQUERIMIENTOS.

MAS TARDE TE ENVIARE LO DE COMASA Y OTROS PUNTOS.

SIN MAS POR EL MOMENTO DE ME DESPIDO DE TI Y ESTOY A TUS ORDENES PARA CUALQUIER COMENTARIO AL RESPECTO.

ATENTAMENTE

ING LUIS ALZATI
INV Y DES

7/24

URGENT FACSIMILE MESSAGE

To: Martien Janssen RE/GENT PO Box 6034 5600 HA Eindhoven The Netherlands Fax No. (31) 40 503677	REFAC CONSULT Postal Address 134 Killiney Road Devonshire Court #03-134 Singapore 0923 Telephone (65) 235 3991 Fax (65) 235 3991
From: Stuart Kelly	Date: 19 August 1994 Page: 1 of 14

Dear Martien

REVIEW OF MABE GROUP, MEXICO, REFRIGERATOR/COMPRESSOR PROJECTS

Herewith as promised, further background to the capital investment costs associated with the conversion from R12 to R134a technology for the compressor manufacturer, COMASA.

IMPORTANT NOTE:

THERE ARE SOME CHANGES TO THE CAPITAL COSTS RESULTING FROM THE EXTENSIVE DISCUSSIONS WITH COMASA OVER THE PAST 24 HOURS. THE COSTS ARE DETAILED IN THE FOLLOWING COMMENTS AND I INCLUDE A REVISED TABLE OF COMASA INCREMENTAL CAPITAL COSTS, BEFORE AND NOW, FOR EASY REFERENCE. THE CHANGES ARE INSIGNIFICANT WITH RESPECT TO TOTAL COSTS (A REDUCTION OF 38,236.00 US$ IN THE CAPITAL FUNDING REQUESTED FOR COMASA) AND UAC etc. HOWEVER, THESE CHANGES WILL OF COURSE BE INCORPORATED IN A COMPLETE REVISION OF THE FIGURES IN THE PROJECT PROPOSAL.

1. EXISTING PROCESS AND EQUIPMENT FOR R12 COMPRESSOR MANUFACTURE

The current process is depicted diagramatically in the attached Schematic A. and a list of the "relevant" existing equipment is also provided in Annex A. This equipment all dates from 1977 and rebuild/retrofit is not considered feasible due both to the extensive process changes involved in the new technology, and due to the age of the equipment.

Some comments are appropriate relating to the existing equipment and the impact of process changes involved in moving to R134a compressor production;

8/24

Degreasing, Cleaning, Chemical Treatment Equipment

We all agree that one of the most important requirements to ensure the successful use of R134a is component cleanliness. With COMASA's existing equipment it is not possible to guarantee the cleanliness of the compressor and its components and investment in new "washing" equipment is required to provide the necessary assurances on cleanliness. COMASA analised various cleaning process options taking into account their production volume and the quality of cleanliness that is required (meeting the norms of their technology partner) and they selected the equipment that is in the project proposal. This equipment and the costs are described below in 2.

Welding Equipment etc.

The present method of welding the compressor suction and discharge tubes is based on silver solder/gas flux process. This is a "dirty" process considered unsuitable in the manufacture of R134a compressors. New spot welding machines are, therefore, required for this operation. There is a consequent change in the required form of the suction and discharge tubes at the point of join and that is why a new tube bending machine is required. This equipment and the costs are described below in 2.

Deydration Equipment

In the existing process the compressor is first dried, and afterwards it is hermetically sealed. With this process there is no guarantee of achieving the low level of residual humidity required for a R134a compressor. To be able to comply with the low residual humidity requirements it is necessary to first seal the compressor, and then dry it. To succeed in dehydrating the sealed compressor longer drying times and higher temperatures are necessary and taking into acount both production volume and the required specification for residual humidty, the existing process equipment is not capable of meeting the requirements. Suitable equipment has been defined and a description and the costs are provided bleow in 2.

2. NEW PROCESS AND EQUIPMENT FOR R134a COMPRESSOR MANUFACTURE

First it should be noted that COMASA are going through a two-phase re-structuring of their compressor manufacturing operations. The first phase is concerned with upgrading their basic compressor technology to be able to comply with new energy efficiency Standards which will come into effect in Mexico later this year. The second phase is the conversion to the manufacture of R134a compressors.

9/24

The total capital cost to the MABE Group is considerable and I do not have all the details but a part of the first phase has been financed by SANYO Corporation of Japan taking a 35% capital share in COMASA in exchange for compressor technology and equipment supply. (COMASA is actually now "MABE-SANYO Compressors S.A. de C.V.").

MABE-SANYO Compressors recently placed compressor manufacturing equipment orders covering aspects of both phases totalling US$ 8,260,000 and this does NOT include the new spot welding equipment and tube bending machine! The R12 to R134a conversion project incremental capital costs total US$ 5,671,200, but becasue of the SANYO Corporation share in COMASA only US$ 3,686,280 is requested from the MLF.

For your information I attach a copy of the relevant equipment order confirmation form. This illustrates COMASA's committment to the change to R134a compressor production, to doing it with clearly defined quality and performance Standards that have already been established, and selecting the necessary equipment to enable them to meet these Standards.

The project proposal does NOT include any of the costs associated with the basic technology upgrade to meet the new energy efficiency Standards.

The new process for R134a compressors is depicted diagramatically in the attached Schematic B. The necessary "relevant" replacement equipment and the individual item prices are as follows:

Welding Equipment etc.

The total cost of the new welding facilities to be installed by COMASA is US$ 1,340,000 and details of what is involved are provided in the attached Annex C. The equipment requested in the MLF project proposal for the change to manufacture R134a compressors is as follows:

1 x Projection Welding Machine (Tube Discharge Shell to Shell A)

US$ 48,500.00

1 x Projection Welding Machine (Tube Suction Shell to Shell A)

US$ 54,100.00

1 x Projection Welding Machine (Tube Charge Shell to Shell A)

US$ 54,100.00

10/22

1 x Tube Bending Machine (Bend Suction and Discharge Tunes)

US$ 207,100.00

TOTAL COST US$ 362,800.00

Degreasing, Cleaning, Chemical Treatment Equipment

The new degreasing, cleaning, and chemical treatment equipment requested in the MLF project proposal is as follows:

1 x 5-stage spray-pretreatment complete with gas heated drying oven, conveyor system and jigs.

US$ 504,583.00

1 x 5-stage spray-pretreatment complete with gas heated drying oven, conveyor system and basket holding jigs.

US$ 452,346.00

1 x 3-stage ultra sonic dip-pretreatment complete with crane, drying oven, feeding and discharge conveyor and free programmable process controller.

US$ 353,430.00

1 x 8-stage dip-pretreatment complete with 2 cranes, blow-off zone, drying oven, feeding and discharging conveyors and free programmable process controller.

US$ 569,046.00

1 x 8-stage dip-pretreatment complete with 2 cranes, blow-off zone, drying oven, feeding and discharging conveyors and free programmable process controller.

US$ 611,279.00

TOTAL COST US$ 2,490,684.00

Daydration Equipment

The new daydration equipment requested in the MLF project proposal is as follows:

1 x Dehydration Oven for C-BZN compressors complete with conveyor and hot air blow-out unit.

US$ 791,866.00

11/24

1 x Dehydration Oven for C-QN compressors complete with conveyor and hot air blow-out unit.

US$ 1,283,653.00

TOTAL COST US$ 2,075,519.00

Leak Test System & Nitrogen Charging Unit

After manufacture the "dry" compressors will be leak tested and charged with dry nitrogen to preserve the "low residual humidity" condition. This is new equipment and that requested in the project is as follows:

1 x Leak Test System with test tank, blow-off zone, pressure distribution system, and nitrogen charging equipment.

TOTAL COST US$ 205,612.00

3. COMASA INCREMENTAL CAPITAL COSTS

Description	Cost in US$ (PREVIOUS)	Cost in US$ (LATEST)
A. Production Machinery & Equipment.		
Spot Welding Machines (3 units)	303,000	156,700
Tube bending & forming machine (1 unit)	209,000	207,100
Five Stage Degreasing, Cleaning, & Chemical Treatment system	2,241,000	2,490,684
Dehydration Ovens (2 units)	2,067,000	2,075,519
Leak Test System & Nitrogen Charging system (1 unit)	369,000	205,612
SUB TOTAL	5,189,000	5,135,615
B. Training & Trials.		
Training	10,000	10,000
Trials	10,000	10,000
SUB TOTAL	20,000	20,000
CONTINGENCIES (10% of Capital Cost)	521,000	515,561
TOTAL INCREMENTAL CAPITAL COST	5,730,000	5,671,176
TOTAL REQUESED FROM MLF (65% Mexican Owned)	3,724,500	3,686,264

12/24

I trust that this information meets your requirements but please do not hesitate to contact me if you have any queries. I understand that you are going away for the next two weeks and we, therefore, need to try and finalise your review comments today (or this weekend) if possible. I shall be at home all evening should you wish to call me. If necessary we can also have further contact with the MABE Technical Centre Friday morning Mexican-time. Do you have weekend fax or telephone number where we can contact you if that becomes necessary?

With apologies for all typing errors etc.!!

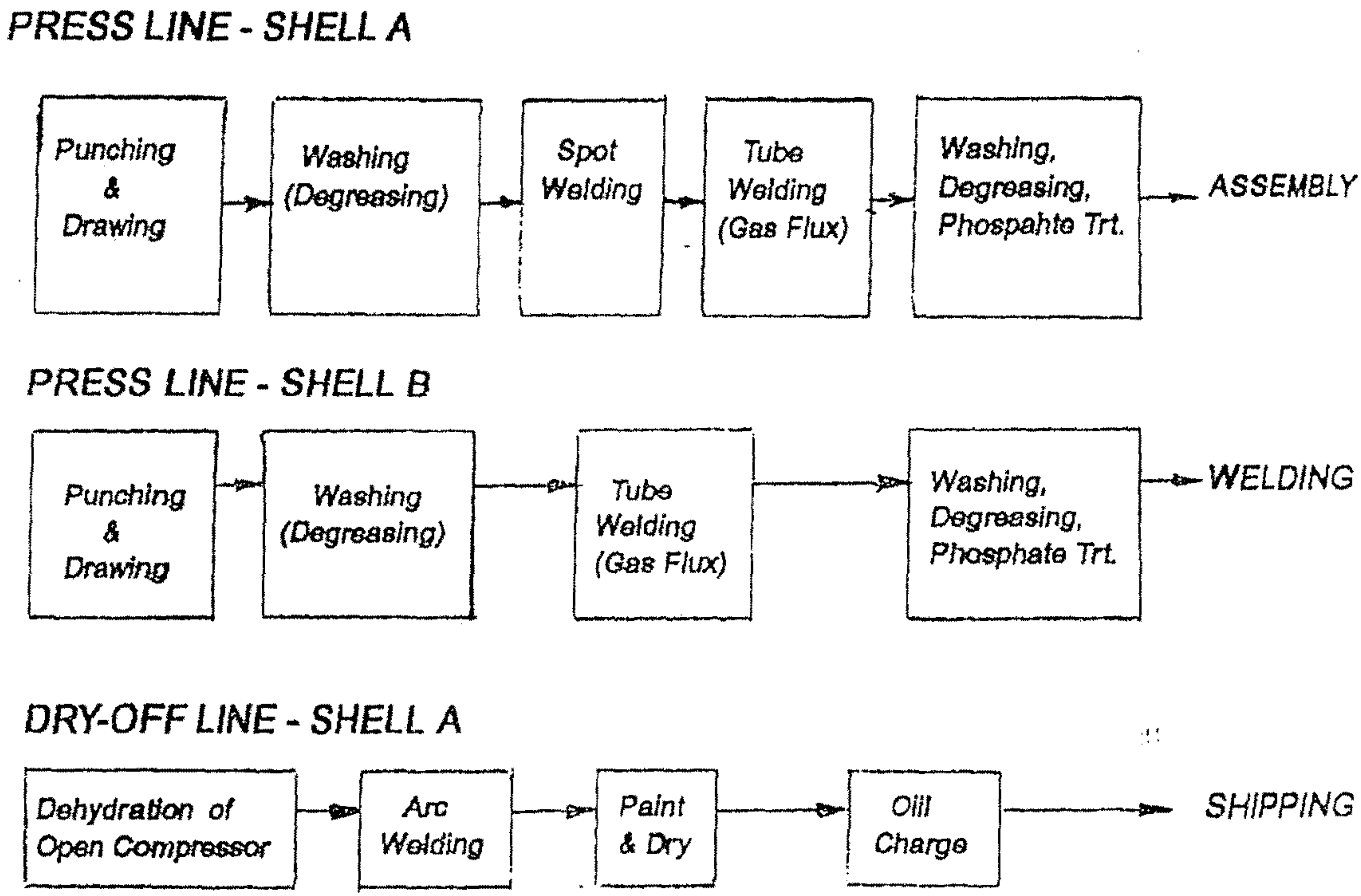
Best wishes and kind regards

Stuart Kelly

Stuart Kelly

SCHEMATIC A.

COMASA - Current Compressor Production Process



13/24

14/22

ANNEX A.

COMASA - CURRENT WASHING & DEGREASING, WELDING, AND DEYDRATION EQUIPMENT USED IN THE MANUFACTURE OF CFC 12 COMPRESSORS

Washing Equipment

"DURR" machine for degreasing, rinsing, phosphate treatment and rinsing, including pumps and heating system.

"DURR" machine for compressor shell pre-wash treatment inclusive of conveyor, pumps and heating system.

"DURR" machine for washing cast iron components.

Welding Equipment

"FAARSOEL" P.200-300 spot welding machine, 300KVA for terminal glass.

"FAARSOEL" 3-head spot welding machine, 75 KVA each head for spring support welding.

"MAHESA" arc welding machine and integral power source.

Dehydration Equipment

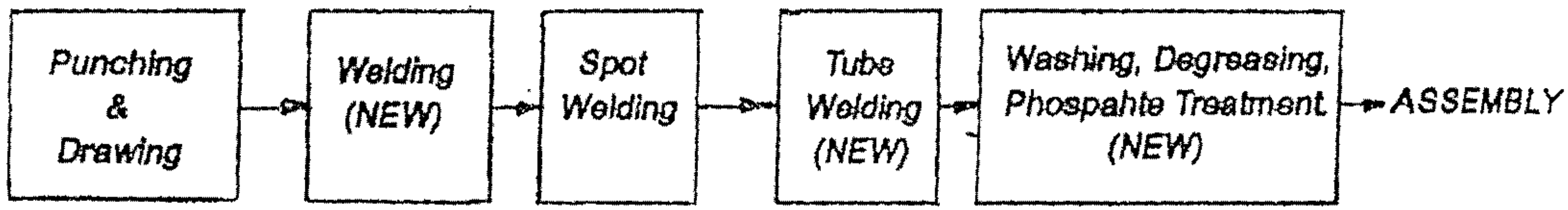
"DURR" fan assisted compressor dehydration oven and accessories.

Note: All above equipment dates from 1977 and rebuild/retrofit is not considered feasible due to both the extensive process changes required for the HFC 134a technology and the age of the equipemnt.

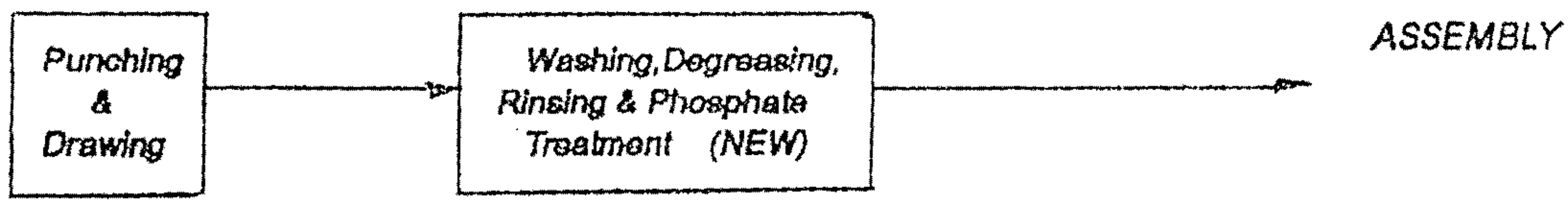
SCHEMATIC B.

COMASA - Future R134a Compressor Production Process

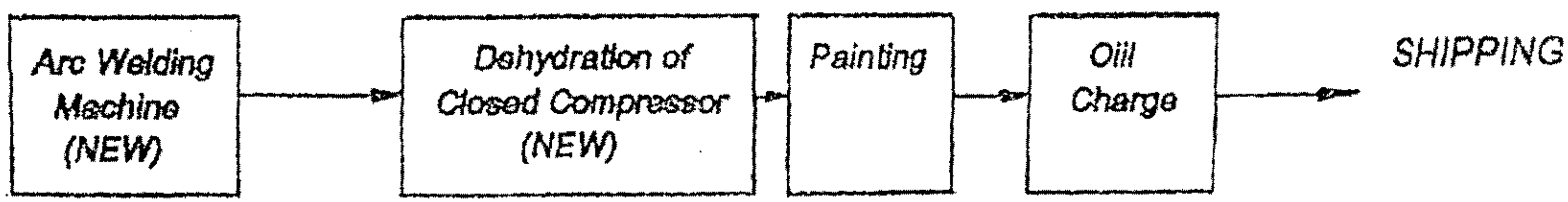
PRESS LINE - SHELL A



PRESS LINE - SHELL B



DRY-OFF LINE



16/21

INSTITUTO NACIONAL DE ECOLOGIA
DIRECCION GENERAL DE NORMATIVIDAD AMBIENTAL
Río Elba No. 20, 1er. Piso
Col. Cuauhtémoc, 06500
México D.F.

A.O.O.-DGNA. 7861

Ciudad de México a, 16 AGO 1994

SR. FRANK PINTO
Principal Technical Advisor
Montreal Protocol Unit
United Nations Development Programme
1 United Nations Plaza
New York, 10017
New York

México ha participado activamente en los esfuerzos para proteger la capa de ozono. Un componente importante de estos esfuerzos es la asistencia técnica y financiera a la industria para la eliminación de los CFCs y, en este sentido, la participación del PNUD ha sido sin duda de gran valor, reflejándose en la conclusión de los proyectos de fabricantes de refrigeradores domésticos con los cuales será posible eliminar totalmente el consumo de CFCs de este sector en México.

Al respecto nos complace enviar el proyecto de la empresa Mabe debidamente revisado por la empresa y esta Dirección General a mi cargo. Lo anterior a efecto de que los proyectos se sometan a consideración del Comité Ejecutivo del Fondo Multilateral del Protocolo de Montreal, por su amable conducto.

Para fines administrativos, anexo a éste enviamos documentación relativa a la participación mexicana de Astral, Enresa y Comasa.

Sin otro particular, agradecemos de antemano su amable atención y les reiteramos nuestro agradecimiento por su valioso apoyo en la eliminación de los CFCs en México.

A T E N T A M E N T E
SUFRAGIO EFECTIVO. NO REELECCION
EL DIRECTOR GENERAL

ING. GABRIEL QUADRI DE LA TORRE

vta.

17/24

orqanización mabe

SECRETARIA DE DESARROLLO SOCIAL.
SEDESOL.
DIRECCION GENERAL DE NORMATIVIDAD AMBIENTAL.
RIO ELBA No. 20, 1ER. PISO,
COLONIA CUAUHTEMOC
C.P. 06500, MEXICO, D.F.

ATN.: ING. GABRIEL QUADRI DE LA TORRE.

LIC. ALEJANDRO ALVAREZ ESTRADA, en representación de Industrias Astral, S.A. de C.V., Ensambladora de Refrigeradores, S.A. de C.V. y Consorcio Manufacturero, S.A. de C.V., señalando como domicilio para oír y recibir toda clase de documentos y notificaciones el ubicado en Prolongación Ingenieros Militares 156, Colonia San Lorenzo Tlaltenango, México, D.F., C.P. 11210, y autorizando para los mismos efectos a los CC. Ing. Ruben Tinoco, Ing. Luis Arzate, Lic. Ramiro Sánchez Cruz, Lic. Carlos García Tellez así como los señores Juan Gutiérrez Pérez y Gerardo Lara Orozco, ante usted con el debido respeto comparezco para exponer que:

En base a la plática sostenida el día de hoy y en relación a su requerimiento de exhibir documentación que acredite la estructura del capital social de mis representadas consistente en: escrituras constitutivas o en su defecto última reforma a la escritura constitutiva.

Con el objeto de que se sirvan aprobar el proyecto en el protocolo de Montreal relativo al fondo multilateral a través del programa de las Naciones Unidas para el desarrollo (PNUD) y con el objeto de que se sirvan presentar formalmente los proyectos de las empresas del grupo MABE, anexo al presente se servirá encontrar escrituras constitutivas de las empresas denominadas Industrias Astral, S.A. de C.V., Ensambladora de

181
72!

2

organización mabe

refrigeradores, S.A. de C.V. y Consorcio Manufacturero, S.A. de C.V., mismos que contienen la información requerida y de la cual se desprende las tres empresas cuentan con un capital 100% mexicano.

Por lo que respecta a la coinversión a realizarse con Sanyo me permito hacer de su conocimiento que se trata de una empresa nueva cuya denominación social es Mabe Sanyo, S.A. de C.V. persona moral distinta e independiente a Consorcio Manufacturero, S.A. de C.V. en la cual para su creación Sanyo aporta el 35% del capital social y Consorcio Manufacturero, S.A. de C.V. aporta el 65% restante.

Por lo anteriormente expuesto:

A ESTA H. SECRETARIA, atentamente pido se sirva:

UNICO.- Tenerme por presentado en tiempo y forma en los términos del presente escrito, exhibiendo la información requerida.

PROTESTO LO NECESARIO.

LIC. ALEJANDRO ALVAREZ ESTRADA.
GERENTE JURIDICO CORPORATIVO.

México, D.F., a 08 de Agosto de 1994.

c.c.p. Ing. Francesco Castronovo.

19/2

RE GENT

FAX

To	Jacques van Engel Environmental and Natural Resources Group, BPPE UNDP New York, N.Y. 10017 tel +1 212 906 5782 fax +1 212 906 6947	From	Martien Janssen RE/GENT P.O. Box 6034 5600 HA Eindhoven The Netherlands tel +31 40 503797 fax + 31 40 503677
Date	19/08/94	Pages	4 (including this one)
cc	Stuart Kelly Lambert Kuijpers		

Subject Review Colombian Refrigerator/Compressor projects

Dear Mr. van Engel,

Discussions with Stuart Kelly and additional information supplied by the MABE group removed most of my doubts regarding the MABE project. You will find my review enclosed.

I discussed shortly the VITRO project with Stuart and if it is OK to you I will review this project approximately 3 weeks from now (I will be on holiday next two weeks). If you need more urgently a reply please contact Lambert Kuijpers.

With friendly greetings,

Martien Janssen

20/26

Country of origin: MEXICO

Project title: Elimination of CFC in the Manufacture of Domestic Refrigerators for the MABE Group

Sector/sub-sector Domestic refrigeration

Relationship to country program (UNDP)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

In domestic refrigeration, HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.

The compressor manufacturer (COMASA) has a technology agreement with SANYO (who even has a share of 35 % in COMASA). Therefore an adequate technology transfer can be expected and a successful implementation of the conversion project.

From the project description it appears that the two appliance manufacturers (ASTRAL and ENRESA) do not have a real "technology transfer partner" specific for the HFC-134a conversion. However, from additional information obtained from the UNDP consultant and from the MABE group itself it is made clear that a very strong cooperation exists between the two companies and General Electric. A transfer of technology is guaranteed due to this cooperation. Moreover, the fact that ASTRAL and ENRESA can even use the GE brand name demonstrates the interest General Electric has in a correct technology transfer. Next to this both manufacturers have already built up HFC-134a experience (development work and test production). Altogether it can be concluded that a successful project implementation can be anticipated.

Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

Environmental impact

HFC-134a has an ODP of zero and a GWP of 0.27. In a domestic refrigeration application a GWP of this magnitude is negligible.

21/22

Project costs

Incremental capital costs:

Compressor manufacturer:

- Welding and tube bending machines are at first sight not essential for the conversion process. However, due to the fact that the equipment currently in use can not reach the required standards for HFC-134a (cleanliness) the new equipment requested becomes essential.
- Other equipment requested is essential for the conversion process. However, it is noted that expensive equipment is listed (cleaning and dehydration in the order or 4.5 Million USD). This is more expensive than in other, similar projects. From additional information supplied it appears that this is related to the current low technology level in the COMASA factory which makes the conversion process much more expensive than in a more up to date factory. Parallel to the conversion to HFC-134a other investments to upgrade the technology in the factory are taking place, paid by the manufacturer itself (assisted by Sanyo as a shareholder).

Appliance manufacturer:

- The equipment requested by the manufacturers is essential for the conversion process.
- The vacuum pumps claimed are expensive (5000 USD each) but it has been demonstrated by the manufacturers that this is a valid amount for complete vacuum pump systems.

Incremental operational costs:

- The operational costs claimed are reasonable.
- It is correct that the operational costs are claimed only by the appliance manufacturers and not by the compressor manufacturer.
- It is important to note that only half a year of operational costs are being claimed.

The funding requested correctly takes into account the ownership of the companies.

If the UAC values are calculated for the appliance manufacturers for only the refrigerant part a value of 32 USD/kg/year is obtained for ASTRAL and 43.1 for ENRESA. Both values are relatively high compared to other projects.

Implementation timeframe

The proposed implementation time frame (totally one year) is probably a bit tight.

22/24

Relevance and adequacy of information provided

The project description contained most of the necessary information for a review. Sufficient additional information has been supplied by the manufacturers and consultant.

Recommendation:

Approval

Janssen M.J.P.,
Eindhoven,
the Netherlands

Kuijpers L.J.M.,
University Eindhoven,
the Netherlands

TECHNICAL REVIEW

23/24

1. COUNTRY: MEXICO

2. PROJECT TITLE: ELIMINATION OF CFC IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS FOR THE MABE HOLDING (foam part)

3. (SUB)SECTOR: Foams

4. CP RELATIONSHIP: Not known

5. TECHNOLOGY: The choice of technology of the company is the use of HCFC-141b. Other technologies were considered but did not provide the energy efficiency required under Mexican regulations.

   HCFC-141b constitutes a "transition" technology. The equipment will be capable to handle the expected next generation of zero ODP HFC technologies.

   The technology will be implemented with the help of chemical suppliers.

   The operational cost for HCFC-141b are higher than for cyclopentane. The investment cost, conversely, are lower. In addition, cyclopentane cannot meet the local as well as export requirements on energy efficiency.

6. ENVIRONMENTAL: HCFC-141b has an ODP of 0.11 and a GWP of 0.12 (relative to CFC-11). Although "moderately flammable, the compound does not pose a fire risk. Toxicological properties are such that it can be used without extensive IH precautions.

7. PROJECT COSTS: All cost components included in the project are essential for the conversion program. The level of service and the existing capacity will be maintained. The project does not include elements that could reasonable be expected to be present prior to conversion.

   EQUIPMENT: The project is based on replacement of baseline equipment. Additional equipment request do not serve the production directly but reduce the cost of conversion. No retrofit is possible or feasible. The fate of replaced equipment is not addressed (scrapping is recommended). There is no salvage value. The

Mexico
MABE

W!W

existing capacity will remain unchanged.

START-UP/ COMMISSIONING: Training cost are appropriate. No commissioning costs are included.

OPERATING COSTS: Operating cost are requested. From comparison with other projects, such an increase could be expected based on higher required densities and higher formulation costs. The formulations and price information originate from the chemical supplier. The transition period is within the options allowed.

OTHER COSTS: Other costs includes trial costs, a pilot machine to minimize shut down for pilot series and 10% contingency. These cost are supported.

COST EFFECTIVENESS: The unit abatement cost are reasonable (USD 12.70 compared with Colombia 13.20 and Sharp-Roxy/Malaysia 16.50).

8. IMPLEMENTATION: Adequate

9. RECOMMENDATION: The project is recommended for approval as proposed

PREPARED BY: Bert Veenendaal, UNDP Foam Sector Expert

DATE: June 13, 1994

ANNEX H: JUSTIFICATION FOR MABE AS TO WHY FOAMING UNIT WITH ONE MOVING HEAD IS NOT FEASIBLE

ITEM 3.- ABOUT THE FOAMING MIXING HEADS.WE ARE NOT BE ABLE TO USE ONLY ONE FOAMING HEAD BECAUSE:

a).- WE WOULD HAVE TO USE FLEXIBLE PIPING AND ITS LENGTH CAN NOT BE BIGGER THAN 9 METERS.PROBABLY THE LENGTH WE ARE GOING TO NEED WOULD BE BIGGER THAN 15 METERS.

b).- THERE IS A MEZANINE,ON THIS WE HAVE SETTLED THE EQUIPMENTS.THE MEZANINE BOLTS ARE LOCATED AT 50 CM FROM THE WORK STATION,AND THIS WOULD BLOCK THE RUNNING OF THE INJECTION GUN.

c).- OUR CURRENT GUN HAS A VERY LARGE NOZZLE,FOR THIS REASON THE FOAMING HEAD CAN NOT BE POSITIONED ON THE FOAMING CAVITY OF THE CABINET.

d).- TO USE THE NEW FOAMING HEADS WE WOULD HAVE TO CHANGE OUR COMPRESSOR SUPPORT DESIGN.THE FOAMING HEAD MUST HAVE SOME FEATURES THAT CAN SUPPORT THE REFRIGERATOR´S SIDES AND BACK.

e).- THE HEADS WEIGTH (70 LBS) MUST HAVE A HEAVY CARRY SYSTEM WHICH WOULD ALLOW TO HAVE A WHOLE SUPPORT SYSTEM ON THAT ZONE.

f).- THE INJECTION ZONE IS CLOSER TO THE EXIT ZONE,WHERE THE SIZE OF THE CABINET ALREADY FOAMED WOULD NOT ALLOW THE PASS OF THE CARRY SYSTEM.

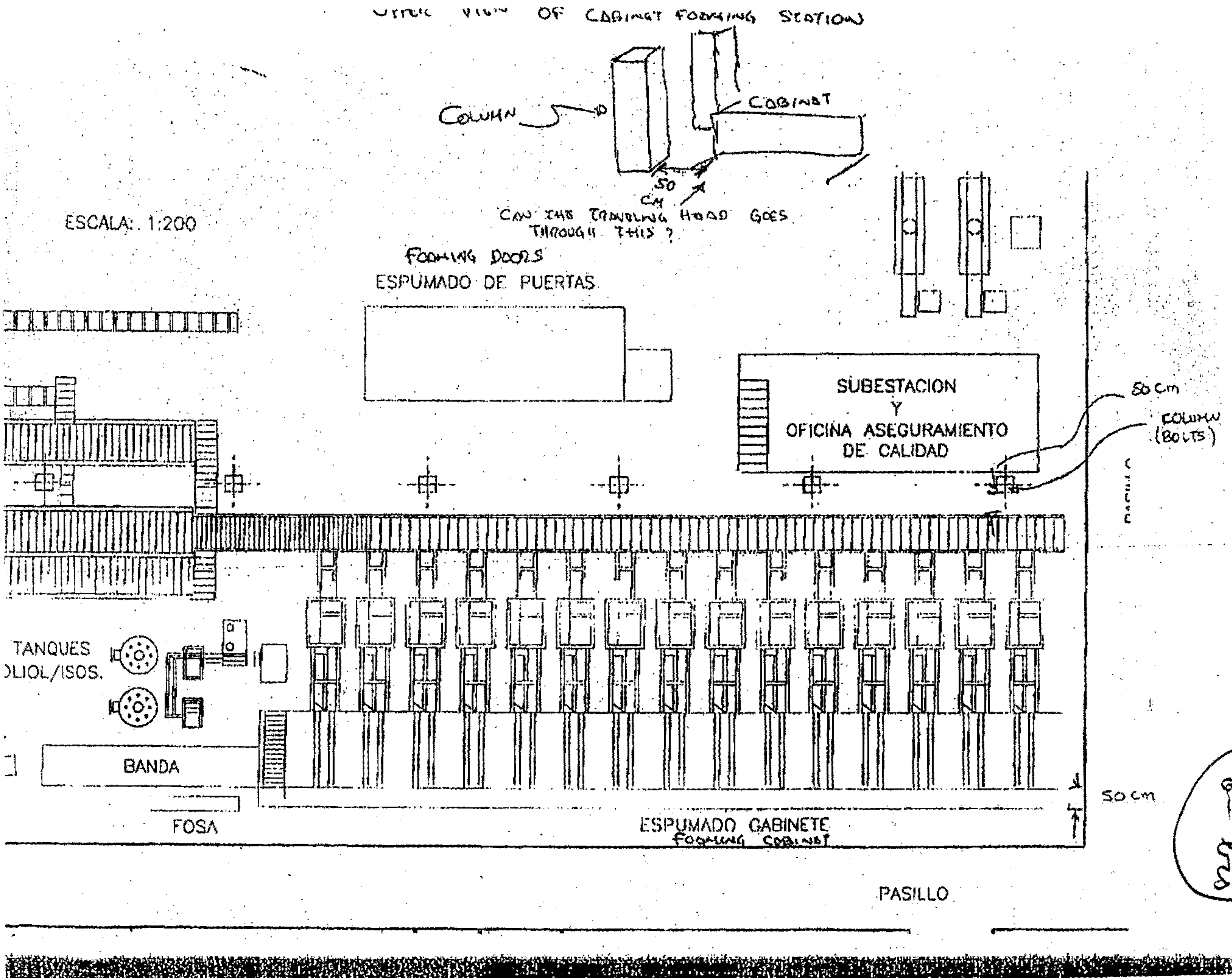
g).- THE INJECTION POINT HAS ONE ALLOWANCE OF 1/4" FROM THE GUN,FOR THIS REASON WE MUST HAVE A SYSTEM WITH A VERY HIGH GRADE OF ACCURACY.

h).- WITH THIS SYSTEM WE EXPECT A DECREASE ON PRODUCTION RATE.OUR CURRENT PRODUCTION CYCLE IS 3.25 MINUTES,WITH THE NEW SYSTEM WE WOULD HAVE PRODUCTION CYCLES OF 10.5 MINUTES.

j).- ANOTHER OPTION IS MAKING MOVING FOAMING WORKSTATION, (ALL NEW)BUT IT WOULD BE VERY EXPENSIVE.

k).-WE ALREADY HAVE ONE SYSTEM LIKE THIS AT LINE 1,AND THE PRODUCTIVITY IS VERY LOW;FOR THIS REASON WE ARE THINKING IN CHANGE TO ANOTHER SYSTEM,VERY SIMILAR TO OUR CABINETS SYSTEM.

l).- WE MAKE ONE INVITATION TO ALL THIS EQUIPMENT SUPPLIERS TO VISIT US AND MAKE THE QUOTATION ACCORDING WITH OUR NECESITIES


OF CABINET FORMING STATION
COLUMN
CABINET
50 CM
CAN THE TRAVELING HEAD GOES THROUGH THIS ?
ESCALA: 1:200
FOAMING DOORS
ESPUMADO DE PUERTAS
SUBESTACION
Y
OFICINA ASEGURAMIENTO
DE CALIDAD
50 cm
COLUMN (BOLTS)
TANQUES
OLIOL/ISOS.
BANDA
FOSA
50 cm
ESPUMADO GABINETE
FOAMING CABINET
PASILLO

ANNEX II

ANNEX H;

Lematic Ltd.

P.O.BOX 2915 VERDUN STREET BEIRUT-LEBANON

Tel :(00961) 1-864135/36 - 602161
(001) 212-4782081 (Via 4782483 USA)

Fax: (00961) 1-865219/21 - 603042
(001) 212-4781670 (Via USA)

Tlx : 23131-22073-44100-40275 LE

To : UNDP
Attn : MR. JACQUES VAN ENGEL
Fax : 212-906-6947
Country: U.S.A.

Fax No.: 3540
Date : NOV.11.94
Ttl Pgs : 2

RECEIVED NOV. 11 1994

2085

REF.: YR FAX DATED 19.OCT.1994 REGARDING FOAM MACHINES AT A PLANT IN MEXICO .

- WE RECEIVED YR FAX DATED 19.OCT.1994 AND WE THANK YOU FOR YR HELP AND SUPPORT FOR OUR REQUEST TO REGISTER OUR COMPANY TO PARTICIPATE IN INTERNATIONAL BIDDING FOR CFC FREE TECHNOLOGY PROJECTS .
- WE ALSO APPRECIATE YOUR CONFIDENCE IN OUR TECHNICAL ABILITIES AND WE ARE ALWAYS PLEASED TO HELP IN ANY WAY WE CAN IF YOU HAVE ANY OTHER QUERIES .
- AS FOR YOUR QUERIES REGARDING THE FOAM MACHINES AT THE PLANT IN MEXICO PLS FIND BELOW OUR COMMENTS AND PROPOSALS :

- ACCORDING TO THE ANSWER GIVEN BY THE COMPANY CONCERNED WE TEND TO AGREE WITH THEIR ASSESEMENT OF THE SITUATION FOR THE FOLLOWING REASONS :

A) WE AGREE THAT THE "HEAD CARRYING BOOM" SHOULD BE FULLY AUTOMATIC AND NOT MANUAL FOR SUCH A LARGE CAPACITY OF PRODUCTION I.E. 780.000 REF./YR .

B) ACCORDING TO YR FAX THE COMPANY WISHES TO CONVERT TO HCFC-141b AND NOT TO CYCLOPENTANE. WE ALSO UNDERSTOOD THAT THEY WOULD BE USING THEIR OLD FOAMING WORKSTATIONS AND THAT THEY WOULD ONLY CHANGE THE FOAM MACHINE AND THE 15 MIXING HEADS TO USE HCFC-141b .

C) GIVEN THE SITUATION AT THAT FACTORY WE CAN NOT JUDGE FROM OUR SIDE THE PROBLEMS THAT ARE PRESENT AT THAT PARTICULAR SITE FOR MANY REASONS .
FOR EXAMPLE : POSITION AND DISTANCES OF FOAM MACHINE AND THE FOAM WORKSTATIONS ; THE DETAILED LAYOUT WHETHER THERE ARE ANY OBTACLES WHICH WOULD BE ENCOUNTERED; THE DESIGN CONSTRUCTION OF THE CABINET AND INJECTION ZONE.

D) BY USING HCFC-141b THEY PROBABLY DO NOT SEE ANY NEED FOR MODIFICATION OF THE WORKSTATIONS DESPITE THE FACT THAT HCFC-141b HAS LOWER THERMAL INSULATION RESULT THAN CYCLO-PENTANE .

THE MODIFICATION OF THE WORKSTATIONS , LAYOUT AND CABINET DESIGN CONSTRUCTION MIGHT BE MORE EXPENSIVE THAN THE SAVINGS IN USING ONE OR TWO MOVING HEADS INSTEAD OF 15 FIXED HEADS .

- IN MANY CASES THE COST OF THE NEW WORKSTATIONS OR ANY MAJOR MODIFICATION TO EXISTING WORKSTATIONS IS USUALLY QUITE EXPENSIVE .

E) IN OUR FAXED PROPOSAL (FAX 3509 DD NOV.10.94) WE HAVE PROPOSED A COMPLETE SIMPLE LINE BASED ON THE REQUIREMENT YOU HAVE REQUESTED FOR A FOAM MACHINE WITH MULTIPLE - MIXING HEADS. HOWEVER YOU ALSO HAVE TO TAKE INTO CONSIDERATION THE WORKSTATIONS USED FOR SUCH A LINE . AS DESCRIBED EARLIER THE LOCATION , PRODUCTIVITY , CABINET CONSTRUCTION ARE ALSO IMPORTANT FACTORS WHICH WILL HAVE TO BE CONSIDERED. ESPECIALLY THE FOAM WORK STATIONS (JIGS) SO EITHER YOU INCREASE COST OF PU M/C AND HEADS OR COST OF JIGS.

F) AS FAR AS THE PROPOSED BUDGET IS CONCERD WE BELIEVE THAT THE PRICE OF A FOAM MACHINE FOR 125.000 USD PLUS 15 MIXING HEADS FOR 25.000 USD EACH IS A GOOD APPROXIMATE LEVEL FOR SUCH A LINE TAKING INTO CONSIDERATION THAT YOU WOULD PROBABLY SAVE THE EXTRA COST OF MODIFICATION OF THE WORKSTATION ACCORDING TO WHAT WE UNDERSTOOD FROM YR FAX AND HAVING FULLY AUTOMATIC SYSTEM LAYOUT (NOT MANUAL).

- WE HOPE THAT WE HAVE ANSWERED YOUR QUESTION TO OUR BEST KNOWLEDGE AND WE ARE READY TO ASSIST YOU FURTHER IF YOU NEED ANYTHING MORE .

- WE THANK YOU AGAIN IN ADVANCE FOR YOUR HELP .

BEST REGARDS
LEMATIC/LEBANON

PROJECT COVER SHEET

COUNTRY: MEXICO

PROJECT TITLE: Elimination of CFCs in the Manufacture of Domestic Refrigerators by the VITRO Group of Companies.

SECTOR COVERED: DOMESTIC REFRIGERATION

ODS USE IN SECTOR: 883 tons ODS (July '93 - June '94)
PROJECT IMPACT (ODP): 415 ODP tons

	TOTAL	SUPERMATIC Ref. Mfr.	ERNA Ref. Mfr.	FACOSA Comp. Mfr
TOTAL PROJECT COST (US$)	3,405,230	1,782,921	1,038,309	584,000
INCREMENTAL CAPITAL COST	1,592,960	414,960	594,000	584,000
INCREMENTAL OPERATING COST	1,812,270	1,367,961	444,309	-
PROPOSED MLF GRANT (US$)	3,405,230	1,782,921	1,038,309	584,000
PROJECT IMPACT (ODP tons)	415.0	366.0	49.0	0
UNIT ABATEMENT COST US$/Kg	5.00	3.93	11.04	n/a

Note: The above figures take the 24% export to non-article-5 countries by Supermatic into account.

PROJECT DURATION: 1.5 years
ECONOMIC LIFE: 10 years

NATIONAL COORDINATING BODY: SEDESOL - Ozone Protection Unit, National Institute of Ecology (INE)

IMPLEMENTING AGENCY: UNDP

APPRAISAL DATE: July 1994

PROJECT SUMMARY:

This project will eliminate CFC consumption in the manufacture of domestic refrigerators by the VITRO Group of companies. The project encompasses three enterprises within the VITRO Group, Supermatic and Erna, who manufacture refrigerators, and Facosa, a compressor manufacturer, all 100% Mexican owned. The two refrigerator manufacturers currently use CFC 11 as a blowing agent in the production of rigid PU insulation foam for cabinets and doors, and CFC 12 as refrigerant. Compressors are sourced from Facosa (56%), and from Embraco, Brazil. This project will result in conversion from CFC 11 to HCFC 141b, and CFC 12 to HFC 134a respectively, and will eliminate 415 ODP tons per year based on July '93 to June '94 consumption. Facosa will convert to HFC 134a compressor production. Funds requested will be used to change the existing production lines, and for re-design, testing, pre-production trials, and training. Incremental Operating Costs resulting from the change to the new technology are requested for the refrigerator manufacturers for a period of SIX months.

Prepared by: Stuart Kelly (Refrigeration), Bert Veenendaal (Foam), in collaboration with SEDESOL/INE

Reviewed by: Martien Jannsen (Refrigeration), ...(Foam) Their comments are attached

PROJECT OF THE GOVERNMENT OF MEXICO

ELIMINATION OF CFCs IN THE MANUFACTURE OF DOMESTIC REFRIGERATORS FOR THE VITRO HOLDING

1. PROJECT OBJECTIVE.

The objective of this project is to eliminate CFCs used by **Supermatic S.A.** and **Estufas y Refrigeradores Nacionales S.A. (Erna)**, two existing manufacturers of domestic refrigerators belonging to the **Vitro Enseres Domesticos** Group of companies **(VITRO)**. The CFC's which will be eliminated include CFC 11, used as a blowing agent for producing thermal insulating foams, and CFC 12, used as a refrigerant in the production of domestic refrigerators.

2. SECTOR BACKGROUND.

Mexico's Country Programme (CP) for the reduction of Ozone Depleting Substances (ODS) was approved in February 1992.

It is estimated that for the period July 93 - June 94, total CFC 11 consumption for the manufacture of thermal insulation foams was approximately 1,500 tons. Of this, about 702 tons were used in the manufacture of domestic refrigerators.

During that same 12-month period, total CFC 12 consumption for refrigeration and airconditioning applications was estimated to be 4,410 tons, out of which approximately 180 tons were used for the manufacture of domestic refrigerators.

Uninhibited growth in the manufacture of domestic refrigerators would lead to a total estimated CFC consumption of 1,200 tons in the year 2000. SEDESOL is seeking a reduction in the use of CFCs in the manufacture of domestic refrigerators beginning in 1995. Approval of this project by the Multilateral Fund in December 1994 will result in the elimination of 456 tons of CFCs used in the manufacture of domestic refrigerators during 1996.

It is estimated that about 1,380,000 domestic refrigerators were manufactured in Mexico during the 12 month period July 93 - June 94. Production is shared between two company holdings, each of which has two enterprises involved in the manufacture of domestic refrigerators. They are the **Organizacion Mabe** Group encompassing **Industrias Astral S.A. (Astral)** and **Ensambladora de Refrigeradores S.A. (Enresa)**, and the **Vitro Enseres Domesticos** Group which includes **Supermatic S.A. (Supermatic)** and **Estufas y Refrigeradores Nacionales S.A. (Erna)**. Growth of 5 to 7% is anticipated in the sector by both Groups. Data on production volume and ODS consumption for these enterprises during the period July 1993 to June 1994 is provided in the following table:

Enterprise	Production Volume	CFC 11 Consumption (tons)	CFC 12 Consumption (tons)
Mabe Group			
Astral	732,413	287.0	88.0
Enresa	112,409	40.0	12.0
Vitro Group			
Supermatic	433,715	334.0	69.0
Erna	102,000	41.0	12.0
Totals	1,380,537	702.0	181.0

In addition to the two refrigerator manufacturers, each Group includes a hermetic refrigeration compressor manufacturer, and a domestic refrigeration service organisation. This project proposal includes the compressor manufacturer, **Fabricacion de Compresores S.A. (Facosa)**, belonging to the VITRO Group as the availability of HFC 134a compressors from this enterprise is critical to the successful implementation of the project.

A separate project proposal has been prepared to address the elimination of CFCs in the manufacture of domestic refrigerators in the MABE Group.

Approval and implementation of both projects will eliminate the use of CFCs in the manufacture of domestic refrigerators in Mexico in 1996.

There is additional consumption of CFCs for the servicing of domestic refrigerators and both the VITRO Group and the MABE Group have extensive service networks throughout Mexico. Separate project proposals are being developed to reduce CFC consumption in the service sector.

3. ENTERPRISE BACKGROUND

The combined total production of domestic refrigerators at **Supermatic** and **Erna** in the 12 month period July 1993 to June 1994 inclusive amounted to 535,715 units. This represents approximately 40% of domestic refrigerator production in Mexico in this time period.

More details on the individual enterprises are provided below:

3.1 Supermatic S.A.

CFC use in last 12 months: (July '93 - June '94)	334.0 tons of CFC 11 69.0 tons of CFC 12
Plant Location:	Ant. Carr. a Roma Km 9, Apodaca, Nueva Leon, Mexico.
Number of Models:	7 (Refrigerators)
Production Volume: (July '93 - June '94)	433,715 units
No. of Production Lines:	2
Compressor Suppliers:	Facosa, Mexico (46%) Embraco, Brazil (54%)
Contact persons:	Ing. Guillermo Barcena Mastretta - Project Engineer
Tel/Fax:	Tel: (52 83) 86 0444 (Ext. 326) Fax: (52 83) 86 2347

Supermatic manufactures a range of domestic appliances including washing machines, cookers, refrigerators etc. and they have around 1,500 emplyees. Supermatic's first domestic refrigerator production line was commissioned in 1985, the second in 1990. 75% of production is sold in Mexico, with the remainder exported to the USA, Canada, and some South American markets.

Product brand names include Whirlpool, Philips, Kenmore, Acros, and Supermatic. There is a commercial trading agreement between the VITRO Group and Whirlpool, USA, which includes the provision of technology and technical assistance for product development, as well as for problem solving and quality control in normal production. This technical interchange between Whirpool and Supermatic is vigorously pursued and it also involves personnel exchange and training activities. There is good reason for this on both sides, including the wish by Whirlpool to protect their international product and brand name reputation.

Because of their relationship with Whirlpool and their export sales to the USA, Supermatic are well aware of the importance of energy efficiency considerations in both the existing CFC technology, and CFC replacement, based refrigeration systems. This is already demonstrated in their existing PU insulation foam use.

The VITRO Group also comprises **Imec A.C. - Centro de Tecnologia Avanzada.** This technology centre, with facilities in both San Luis

Potosi and Apodaca, is devoted to product development and process improvement for the whole VITRO Group. Imec also benefits from a close working relationship with Whirlpool, USA, under the technical exchange arrangements included in the commercial trading agreement.

It should be noted that the very close involvement with Whirpool is only in the form of a commercial trading agreement and the present legal corporate ownership of the Vitro Group, including both Supermatic and Erna, is 100% Mexican. A copy of a letter from the VITRO Group legal depratment confirming this is attached annexed to this project proposal. Supermatic are then eligible for 100% funding from the MLF of the incremental costs in this CFC elimination project proposal.

The existing CFC technology was initially developed "in-house" by Supermatic with assistance from compressor and refrigerant suppliers and then improved following the establishment of the association with Whirlpool Corporation in the 1980's. The CFC replacement technology will be provided to Supermatic by Whirlpool, USA, under the terms of the commercial trading agreement referred to above, and thus successful implementation of this project can be anticipated.

The following tables provide a summary of domestic refrigerator production by Supermatic during the 12 month period July 1993 to June 1994 inclusive, as well as other relevant project data.

Model No.	Descriptio n	Production Volume Jul'93-Jun'94	CFC 12 Charge Kgs	CFC 12 Consumption Kgs	PU Foam per Unit Kgs
08S3DBN	SDM Ref	66,915	0.118	7,896.0	3.067
09S3DBN	SDM Ref	61,768	0.118	7,289.0	3.452
10S3DBN	SDM Ref	92,651	0.118	10,933.0	3.710
12S3DBN	SDM Ref	36,030	0.183	6,594.0	4.073
12090-4	DD Ref NF	27,511	0.197	5,420.0	5.482
RT-12DK	DD Ref NF	41,266	0.197	8,129.0	5.482
14090-4	DD Ref NF	33,859	0.227	7,686.0	6.446
RT-14VK	DD Ref NF	50,789	0.227	11,529.0	6.446
EV15ONX	SD Ref NF	22,926	0.227	5,204.0	7.343
Total or Weighted Average		433,715	0.163	70,680	4.611

Key: SD = Single Door
Ref = Refrigerator
NF = No Frost
DD = Double Door
M = Manual Defrost

Model No.	R12 Compressor HP, Source & Cost in US$			R134a Compressor HP, Source & Cost in US$			Capacity Cubic Feet
08S3DBN	1/8	F	35.76	1/8	F	36.82	8.0
09S3DBN	1/8	F	35.76	1/8	F	36.82	9.0
10S3DBN	1/8	F	35.76	1/8	F	36.82	10.0
12S3DBN	1/6	F	36.82	1/6	F	37.92	12.0
12090-4	1/6	E	33.45	1/6	E	35.02	12.0
RT-12DK	1/6	E	33.45	1/6	E	35.02	12.0
14090-4	1/5	E	33.82	1/5	E	35.64	14.0
RT-14VK	1/5	E	33.82	1/5	E	35.64	14.0
EV150NX	1/5	E	35.08	1/5	E	37.02	15.0
Weighted Average	35.07			36.41			

Key: F = Facosa E = Embraco

3.2 Estufas y Refrigeradores Nacionales S.A. (Erna)

CFC use in last 12 months: (July '93 - June '94)	41.0 tons of CFC 11 12.0 tons of CFC 12
Plant Location:	Carr. Panamericana Km 280, Celaya, Gto, Mexico.
Number of Models:	10 (Refrigerators)
Production Volume: (July '93 - June '94)	102,000 units
No. of Production Lines:	2
Compressor Suppliers:	Facosa, Mexico (100%)
Contact persons:	Ing. Javier Garcia Cantu - Project Engineer

Contact is via Ing. Guillermo Barcena Mastretta, Supermatic, as overall project co-ordinator.

Erna was established by the Mexican Government to manufacture a range of basic stoves and domestic refrigerators at affordable prices for the population at large. The first domestic refrigerator production line, sourced from Italy, was commissioned in 1981. A second production line was added in 1986 when the enterprise was privatised and became part of the VITRO Group. All production is sold in Mexico under the Acros, Whirlpool, and Philips brand names. The enterprise currently has approximately 230 employees.

The original CFC technology was developed "in-house" with assistance from the original equipment and component suppliers. Since then Erna, like Supermatic, have benefited from the technical support from Whirlpool, USA. The CFC replacement technology will similarly be provided by Whirlpool, with the same implications for successful implementation of the Erna part of this project.

The legal interpretation on corporate ownership is that Erna is also 100% Mexican-owned and thus entitled to funding from the MLF of 100% of the incremental costs in this CFC elimination project proposal.

The following tables provide a summary of domestic refrigerator production by Erna during the 12 month period July 1993 to June 1994 inclusive, as well as other relevant project data.

Model No.	Description	Production Volume Jul'93-Jun'94	CFC 12 Charge Kgs	CFC 12 Consumption Kgs	PU Foam per Unit Kgs
140-A RL-70 5020	SDM Ref SDM Ref DD Ref NF	38,367 43,942 19,691	0.100 0.110 0.170	3,836.7 4,833.6 3,347.5	1.95 2.82 3.66
		102,000	0.118	12,017.8	2.655

Key: SD = Single Door; DD = Double Door; Ref = Refrigerator; M = Manual Defrost; NF = No Frost

Model No.	R12 Compressor HP, Source & Cost in US$	R134a Compressor HP, Source & Cost in US$	Capacity Cubic Feet
140-A RL-70 5020	1/8 F 35.76 1/8 F 35.76 1/8 F 35.76	1/8 F 36.82 1/8 F 36.82 1/8 F 36.82	5.0 7.0 7.0
Weighted Average	35.76	36.82	

Key: F = Facosa; E = Embraco

Model No.	R12 Condenser Price US$	R134a Condenser Price US$
140-A RL-70 5020	3.75 6.55 8.62	4.50 7.88 10.34
Weighted Average	5.89	7.07

New energy regulations will be introduced in Mexico in 1995 which will require refrigerator manufacturers to meet energy efficiency Standards for domestic appliances. The technology changes to CFC 11 and HFC 134a will have an adverse effect on the energy performance of the Erna refrigerators to the extent that they will not be bale to meet the new energy efficiency Standards. Erna see see changes to the system condenser and capillary tube as the two most important elements that will enable them to recover the loss in performance resulting from the technology change. The increases in condenser surface area and capillary tube length, together with the need for a cleaner and contaminant-free product, result in incremental costs which are reflected in the incremental operating costs claimed by Erna in this project proposal.

3.3 Fabricacion de Compresores S.A. (Facosa)

CFC use in last 12 months: (July '93 - June '94)	41.0 tons of CFC 11 12.0 tons of CFC 12
Plant Location:	Carr. Miguel Aleman Km 16.695 #4, Apodaca, Nueva Leon, Mexico.
Number of Models:	2 (Compressors)
Production Capacity (1994):	600,000 units
Production Volume: (July '93 - June '94)	421,425 units
Sales (July '93 - June '94):	303,245 units to Supermatic/Erna 62,036 units for Dom. Ref. Service 56,144 units for Commercial Ref.
Contact persons:	Ing. Juan Antonio Villareal Ing. Jose Luis Ovalle Alba
Tel/Fax:	Tel: (52 83) 29 2005 Fax: (52 83) 29 2037

Facosa was founded in 1991 as a result of re-structuring a previous MABE/VITRO Group 50:50 joint venture compressor manufacturing operation based in San Luis Potosi. The enterprise operates two compressor manufacturing facilities, the main one at Apodaca produces compressors principally for the domestic refrigeration sector, although a small number of compressors from this facility are sold to the commercial refrigeration sector (13%). The other facility, in Mexico City, produced an additional 420,000 hermetic compresssors in the same period <u>solely</u> for use in the commercial refrigeration sector.

This project to eliminate CFCs in the manufacture of domestic refrigerators, therefore, only addresses the Facosa facility at Apodaca. Future project proposals to eliminate ODS consumption in the commercial refrigeration sector may include a request from Facosa for incremental costs relating to technology change at the Mexico City compressor manufacturing plant.

Facosa's present compressor technolgy was obtained from Mitsubishi and they comply with JIS, ASTM, and NEMA Standards throughout all stages of their compressor manufacturing operations.

HFC 134a compressor technology has been developed "in-house" by Imec, the VITRO Group's own Advanced Technology Centre, and Facosa will commence production of HFC 134a compressors during H2 1995.

Again, the legal interpretation on corporate ownership is that Facosa is also 100% Mexican-owned and thus entitled to funding from the MLF of 100% of the incremental costs in this CFC elimination project proposal.

3.4 Vitro Group/Whirpool Corporation Technology Relationship

The following information is provided as additional information on the relationship between the Vitro Enseres Domesticos Group and the Whirlpool Corporation:

The association with Whirlpool dating from 1987 expanded the technology and products acessible to the Vitro Group. In exchange for technical assistance fees, the rights to both current and future technical information and patents can be granted to Vitro. Some specific examples include:

- product development, marketing, and sales support actvities for new products in the Mexican market.
- use of Whirlpool brandnames and trademarks in Mexico.
- full service suppport on all products.
- automatic provision of information on materials specifications, engineering standards, and all engineering material supporting product design and manufacture.
- full access to to Whirlpool product design data for product development activities.
- assistance to Vitro in complying with all relevant Mexican <u>and</u> USA safety, energy, and environmental Standards.
- A formal technlogy transfer agreement whereby the local

capability of Vitro's own Technolgy Centre (Imec A.C.) becomes fully accredited. The centre already has 120 technical staff.

- Personnel exchange with assignments ranging from 6 months to 5 years, and covering all disciplines.

- The CFC elimination programme at Vitro is following strict project planning disciplines already proven within the Whirlpool organisation. Technical exchange with Whirpool's European operations is also ongoing, as is exchange with EMBRACO, Vitro Groups external compressor supplier.

- There exists alraedy in Vitro Group a CFC elimination project team which comprises all functional disciplines and which is supported by staff from Whirlpool experienced in the non-CFC tecnology.

4. PROJECT DESCRIPTION

Supermatic and Erna presently use CFC 11 for the production of rigid insulation foam needed for the refrigerator cabinets and doors, and they use CFC 12 as refrigerant. The total consumption in the 12 month period July 1993 to June 1994, and the ODP tons that will be eliminated by this project, are shown in the following table:

Enterprise	CFC 11 (tons)	ODP tons eliminated (see Note*)	CFC 12 (tons)	Total ODP tons eliminated
Supermatic	334	297	69	366
Erna	41	37	12	49
Totals	375	334	81	415

Note *: The second column of figures for CFC 11 takes the ODP of HCFC 141b into account (ODP = 0.11).

4.1. Replacement of CFC 11 with HCFC 141b.

Both Supermatic and Erna will transfer to HCFC 141b as an interim step to an ODS-free system. The injection machines for the rigid insulation foam should be high pressure machines that will be able to process the higher viscosities and mixing requirements of the low ODS systems and also any of the developing ODS-free systems.

This will require equipment replacement and training at Supermatic and Erna. A more detailed description of the existing foam injection equipment is given in para 5.1.3.

The two companies will also require test-runs before being able to start industrial production with the new technology. These activities will include training of staff in the safe handling of HCFC 141b.

Incremental Operational Costs associated with the technology change from CFC 11 to HCFC 141b are requested for a period of <u>SIX months</u>.

4.2. Replacement of CFC 12 with HFC 134a.

The conversion to HFC 134a requires the use of HFC 134a compressors and the associated new synthetic lubricants, re-design of the refrigeration systems to cater for the difference in thermodynamic performance of HFC 134a versus CFC 12, prototyping, testing and optimization of each refrigerator model, and pilot scale manufacture and testing before full scale conversion of production to HFC 134a for each model. The conversion will result in changes in manufacturing procedures for which production line supervisor and operator training will be required.

The different properties of HFC 134a, the need to avoid cross-contamination with CFC 12, and the phased nature of the conversion of refrigerator production from CFC 12 to HFC 134a at both Supermatic and Erna, means that new system evacuation, refrigerant charging, and leak detection equipment will be required. A more detailed description of the existing equipment on which the technology change will impact is provided in para 5.2.3.

Key to the success of CFC 12 elimination is the local availability of HFC 134a compressors. The VITRO Group's main compressor manufacturer, Facosa has committed to the conversion of their compressor manufacturing operations to be able to provide the necessary volume of HFC 134a compressors in accordance with technology change programmes for both Supermatic and Erna.

Significant changes to Facosa's present compressor manufacturing operations are required in order to produce HFC 134a compressors which will be clean, dry, and free from all trace contaminants likely to have an adverse effect on HFC 134a/synthetic ester lubricant chemistry in a domestic refrigerator system. The changes that are necessary include retrofitting of two arc welding machines, retrofit of the existing cleaning and chemical treatment system plus some additional new cleaning equipment, new ester lubricant deydration and testing equipment, and equipment for leak testing of the completed compressors. A more detailed description of the existing equipment which requires replacement is provided in para 5.2.3.

While incremental Capital Costs are requested for FACOSA, incremental operating costs are passed on to the refrigerator manufacturers.

Incremental Operational Costs associated with the technology change from CFC 12 to HFC 134a are requested by Supermatic and Erna for a period of SIX months.

5. TECHNOLOGY

5.1. Replacement of CFC 11 with HCFC 141b.

5.1.1. OVERVIEW

There are currently three main directions in the development of CFC free systems for thermoset insulation foams:

CFC 11 > partial water/HCFC 141b > ?
CFC 11 > partial water/HCFC 22, 142b > HFC 134a, 152a
CFC 11 > n-, iso-, and cyclo-, pentane

In addition, compounds such as perfluoroalkanes, HCFC 123, fluorinated ethers and 2-chloropropane have been suggested, but the technology is not mature. Furthermore, the products are either only available in limited quantities, or toxicological testing is not complete and, therefore, safety in use cannot be evaluated.

The first option, the liquid solution is the one which will be applied in this project, and it employs technology that is closely related to the existing one. The final step in this process is not yet decided. One potential solution may be HFC 356, but full water blown foam with improved cell structure remains an option in systems where dimensional changes, although costly, are possible.

The second one, the "gas" solution, utilizes a gaseous mixture of physical blowing agents, and always requires new equipment, and extensive adjustments. The final step in this process is seen as the introduction of gaseous HFC's.

The third option, pentane technology, has recently been introduced in Europe. Pentanes are flammable and this means a careful review of manufacturing operations with respect to the safe handling of a flammable foam blowing agent. Their use may not be a practical option in the existing work environments of some enterprises. Several companies currently offer pentane packages, including equipment. UNDP requires, however, independent process safety review prior to, and after, installation.

5.1.2 SELECTION

Based on economic and environmental considerations, cyclopentane appears to be the best choice for domestic refrigerator applications. It combines an attractive price with zero ODP properties. However, the reduced K-factor of cyclopentane blown foam, coupled with the strict energy efficiency performance requirements now being applied in Mexico, virtually excludes the use of cyclopentane without major refrigerator cabinet dimensional changes. Similar standards exist in the USA and Supermatic has important exports to that market.

HCFC 22/142b were also considered but were also rejected on energy performance considerations.

The use of HCFC 141b is recognised by both Supermatic and Erna as a CFC 11 replacement that represents:

- proven technology in both processing and product performance.
- an environmentally acceptable blowing agent (as a transitional replacement for CFC 11).
- readily available technology in the Mexican market.

The choice of high pressure foam dispensing equipment will facilitate the subsequent step to a final ODP-free system without major additional capital costs.

5.1.3 IMPACT ON PRODUCTION PROCESS

The use of reduced ABA/141b technology, with higher related viscosity of the polyol blend, will be facilitated through the employment of high pressure foam production equipment.

HCFC 141b is moderately flammable in the gaseous state, but the liquid is not flammable. In the intended application, HCFC 141b/polyol blends should not pose any risk, but a monitoring check at commissioning will be performed to ensure safe worker exposure levels. Ventillation is to be installed where needed to ensure that exposure levels are maintained below the recommended occupational exposure limit.

Foam densities may have to be adjusted to obtain proper insulation values.

The liner material must be resistant to HCFC 141b and both enterprises will change to the use of high impact polystyrene (HIPS) in combination with an ethylene vinyl alcohol (EVOH) protective layer.

The relevant existing equipment on which the technology change to HCFC 141b will impact is as follows:

SUPERMATIC

In production line 1 there is one Cannon HC100 high pressure machine for the cabinets (capacity 28 gpm), and two high pressure machines (a HC100 and a H100) for the doors, each with one mixing head, and each with a capacity of 28 gpm.

Two new (1994) Hennecke HK120 machines designed for HCFC 141b use have been purchased for refrigerator door foam insulation duties for production lines 1 and 2. These will feed three mixing chambers and their respective carousels.

In production line 2 there are two Wirlpool-Mobay high pressure dispensing machines based on Hennecke equipment that feed twelve heads for filling cabinets. Each machine has a capacity of 55 gpm. Presently, doors are filled in line 1 only.

There are no mixing stations because Supermatic buys a pre-mix of polyol and CFC 11 blowing agent.

Notes:

Supermatic already has high pressure foam dispensing equipment in all their lines and it was therefore explained that according to current practices in the assessment of incremental capital costs, they would not be eligible to receive funds for replacement or retrofitting of their current equipment which should be able to use HCFC-141b without any problems. This is why only ventilation equipment is requested for the CFC-11 component at Supermatic.

ERNA

ERNA has two low-pressure CANNON machines for cabinets and one low-pressure CANNON machine for doors. They also have recently acquired a second-hand low pressure Elastogram machine which has replaced one of the two above-mentioned CANNON machines used for the cabinets, although the latter presently remains in stand-by duty. The details of these machines are as follows:

Elastogram PU50P. Serial No. 010 40788 600. Vintage 1979.

Cannon H40 RF2. Serial No. 270177. Vintage 1981. Stand-by.

Cannon H40 RF2. Serial No. 270176. Vintage 1981.

Cannon H100 RF2. Serial No. 390036. Vintage 1981

ERNA uses one pre-mixing station to feed the Elastogram machine.

5.2. Replacement of CFC 12 with HFC 134a.

5.2.1. OVERVIEW

HFC 134a is universally accepted as a cost effective replacement for CFC 12 in the manufacture of domestic refrigerators. HFC 134a is widely available and the technology is mature, having already been introduced commercially in many of the Developed Countries.

Whilst hydrocarbon refrigerants are being used on a limited basis in at least one Developed Country, the technology is not considered as sufficiently developed to consider transfer to Mexico at the present time. Safety issues associated with the use of flammable hydrocarbon refrigerants, and the absence of suitable compressors on a commercial scale further mitigate against the adoption of this technology at the present time.

HFC 152a might be considered as another candidate for CFC 12 replacement in domestic refrigerators. However, HFC 152a is also flammable, the technology has not been developed commercially, and there are some questions around it's stability in refrigerator systems. Furthermore, compressors for use with HFC 152a are not commercially available.

5.2.2. SELECTION

The selected technology is HFC 134a. The CFC 12 based refrigerator technology used by Supermatic and Erna was obtained under a technology agreement with Whirlpool, USA. There is an ongoing technology and technical assistance arrangement with Whirlpool which is part of a commercial trading agreement between VITRO Group and Whirlpool. The new HFC 134a based technology has also been developed with assistance from Whirlpool. The VITRO Group commenced their HFC 134a technology development activities in early 1993, and they have already produced CFC-free versions of several models of both the Supermatic and Erna product range for test purposes.

For the manufacture of CFC 12 compressors, FACOSA currently uses technology originally supplied by Mitsubishi. The technology for the new HFC 134a compressors has been developed in-house at the VITRO Group's own Advanced Technolgy Centre, again with technical cooperation from Whirlpool.

Both the refrigerator manufacturers, and Facosa, are thus considered very capable of successfully implementing all aspects of this project relating to HFC 134a technology.

5.2.3. IMPACT ON PRODUCTION PROCESS

HFC 134a, like CFC 12, is non flammable. HFC 134a has also been the subject of extensive toxicological testing and is considered safe in use in industrial applications provided the suppliers recommended occupational exposure levels are not exceeded. At the present time this means ensuring that exposure levels do not exceed 1000 parts per million on an 8-hour time-weighted average basis. This is the same as the Occupational Exposure Limit (OEL) / Threshold Limit Value (TLV) for CFC 12 and thus no changes from current practices are required.

There will be an approximately 10% reduction in the mass charge of HFC 134a compared with CFC 12 for a refrigerator system of the same capacity. This is taken into account in the calculation of the incremental operational cost (see annex A, Part 2.).

It is well understood that the chemical stability of HFC 134a and synthetic lubricants in domestic refrigerator systems, and hence the long term performance of the appliances, are sensitive to moisture content and certain chlorinated impurities. This requires that CFC 12 and HFC 134a handling equipment be carefully segregated, and it also calls for better evacuation of the system prior to refrigerant charging.

In order to ensure both thorough evacuation and complete system dehydration prior to refrigerant charging with the HFC 134a, many refrigerator manufacturers have opted to source their HFC 134a compressors "dry", simply pressurised with nitrogen, and without lubricant. In many cases this is a major change from current practice and requires that the refrigerator manufacturer installs the necessary lubricant storage, handling, drying, testing, and charging equipment. In the case of Supermatic, they are already using this approach to domestic refrigerator manufacture and they will continue with the same process. Erna, however, will continue with their existing process operations, they will purchase HFC 134a compressors from Facosa already charged with lubricant. In view of this, Facosa will require new lubricant handling and charging equipment as well as dry nitrogen charging equipment.

Because system cleanliness and moisture content are paramount to the successful manufacture of hermetic compressor based HFC 134a refrigeration systems, both Supermatic and Erna will need to carefully re-assess production procedures and retrain production personnel as appropriate. Provision for this is made within the project proposal.

The conversion from CFC 12 to HFC 134a will take place on a model by model, production line by production line, basis so that both enterprises will be producing CFC 12 and HFC 134a refrigerators during the implementation phase of this project. This is feasible given the configuration of the production facilities at both

Supermatic and Erna.

As a consequence of the substantial changes to current practice, and the defined need for system cleanliness and low moisture content, there will be the need for a careful re-assessment of production procedures and personnel re-training as appropriate. Provision for this is also made in the project.

Leak detection of the refrigeration system is an integral part of the manufacturing process. The use of HFC 134a requires that new leak detection equipment, suitable for use with HFC 134a, be employed. Helium mass spec detectors are proposed.

The above considerations mean that within this project there is a requirement for new system evacuation equipment, new refrigerant charging equipment, and new leak detection at both Supermatic and Erna. Furthermore, the changes to be introduced at Supermatic will also require lubricant storage, handling, drying, testing, and charging equipment.

The technology change from CFC 12 to HFC 134a, and the way that the change will be implemented at Supermatic and Erna, has obvious implications for the compressor manufacturing operations at Facosa. In addition to redesign of the compressor to meet performance requirements which take account of the different thermodymanic properties of HFC 134a, and the issue of materials compatability, the manufacturing operations must be capable of producing a HFC 134a compressor which is free from trace contaminants likely to produce undesirable chemical reactions involving the HFC 134a, the synthetic ester lubricant, or both.

To guarantee a "clean and dry" HFC 134a compressor a number of changes are required to the existing compressor production process. The main elements where changes are required are:

- Retrofitting two arc welding machines to achieve a cleaning welding process with no residues.

- Retrofit of the existing compressor shell chemical treatment, cleaning, and drying equipment, plus additional ultrasonic immersion cleaning equipment.

- Ester lubricant dehydration and testing equipment to ensure only "dry" lubricant is charged into the "dry" compressor.

- Compressor leak detection equipment to ensure the integrity of the compressor and it's capability of maintaining a dry nitrogen charge during distribution and storage prior to use.

The relevant existing equipment on which the technology change to HFC 134a will impact is as follows:

SUPERMATIC

4 x Production Control Unit (PCU) Model 40101 refrigerant and lubricant charging units complete with vacuum pumps. Equipment Serial Nos. are 2830, 5512-1, 5512-2, and 7327/240. Items Nos. 2830 and 7327/240 will retrofitted, the other two items will be replaced.

63 Stokes vacuum pumps, 15 M3/hr capacity.

2 Leybold Inficon HLD 3000 electronic R12 refrigerant leak detectors.

Notes:

The existing Supermatic production line 1. is dedicated to the assembly of refrigerators for sale in the Mexican market. It has two PCU refrigerant and lube combined charging units, one in use, one on stand-by, with the necessary associated lube dryibg equipment.

This production line has a vacuum pump carousel with 27 vacuum pumps in service at the time of the existing equipment verification.

Helium pressure test/leak detection equipment is used for system integrity testing.

A different assembly process is employed on line 2. at Supermatic where currently most of the production is for export. The evaporation/compression/condensing/expansion circuit system is first assembled, and then subsequently tested before incorporation into the final refrigerator unit. A nitrogen pressurisation/water bath immersion process followed by dark room/fluorescent light is used for initial system integrity leak detection.

This line also is also equipped with two PCU refrigerant and lube charging units, one in use, one on stand-by.

Production line 2. at Supermatic employs two vacuum carousels, each equipped with 18 vacuum pumps, as witnessed at the time of existing equipment verifcation.

Post charging leak detection is by Leybold Inficon HLD 3000 R12 electronic leak detectors.

As mentioned above, there are a total of four charging units, two of which are in standby. The project will only provide for the replacement of the two machines that are in full-time use. It was suggested that the two standby units could be retrofitted for use with HFC 134a, instead of having to purchase two new charging units. This however is <u>not</u> possible because the standby units are not designed to work on a continuous basis and would not be able to cope with the production volume required.

ERNA

2 x Galileo automatic refrigerant charging units model V210F.

30 Galileo KC15 vacuum pumps, 15 M3/hr capacity.

10 Leybold D16/B/DS vacuum pumps, 16 M3/hr capacity.

3 X Leybold Inficon HLD 3000 electronic R12 leak detectors

1 X Galileo hand-held Electronic R-12 leak detector

Notes:

With the new HFC technolgy, Erna will continue with their current manufacturing process which is based on using compressors already charged with lubricant. Only refrigerant charging equipment will, therefore, require replacement.

Production line 1. at Erna has a vacuum pump carousel with capacity for 32 vacuum pumps. At the time of existing equipment verification, Erna had 25 Galileo, and 3 Leybold, vacuum pumps in service on line 1.

Production line 2. at Erna involves a fixed vacuum pump system for evacuation. At the time of existing equipment verification there were 7 Leybold vacuum pumps installed and in operation.

5 Galileo vacuum pumps were being repaired for stand-by duty, this being a regular feature of vacuum pump operation at Erna.

FACOSA

A process diagram illustrating the changes that will be necessary as a result of the conversion to the production of HFC 134a compressors at Facosa, together with the enterprises own description of the reasons for the changes are appended to this project as **Annex D.**

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS (US$)

CAPITAL COST FOR CONVERSION OF COMPRESSOR MANUFACTURING OPERATIONS FROM CFC 12 TO HFC 134a TECHNOLOGY - FACOSA

Replacement Upper & Lower Shell Dies (2 units)	36,000
Retrofitting two arc Welding Machines (2 units)	100,000
Metal Press Modifications (9 Presses)	5,000
Retrofit of Five Cleaning, Chemical Treatment and Drying Units	15,000
New Ultrasonic Immersion Cleaner (1 unit)	160,000
Ester Lube Dehydration and Testing System (1 unit)	73,000
Compressor Leak Detection Equipment (1 unit)	110,000
Training	15,000
Test Trials	17,000
Contingencies (10%)	53,000
Subtotal	**584,000**

CAPITAL COST FOR CFC 11 PHASE-OUT - SUPERMATIC

	US$
Ventilation systems for cabinets (2 units)	60,000
Ventilation systems for doors (1 units)	30,000
Test/Trials Training	15,000
Contingencies (10%)	10,000
Subtotal	115,000
Amount requested taking 24% export to USA into account	87,400

CAPITAL COST FOR CFC 11 PHASE-OUT - ERNA

High Pressure Machines for Cabinets (2 units)	250,000
High Pressure Machines for Doors (2 units)	110,000
Ventilation System for HCFC 141b	30,000
Test Trials, Training	10,000
Contingencies (10%)	40,000
Subtotal	**440,000**
(ERNA does not export to non-article-5 countries)	

CAPITAL COST FOR CFC 12 PHASE-OUT - SUPERMATIC

Refrigerant & Lube Charging Equipment (2 units, see note)	180,000
New Vacuum Pumps (10 units)	25,000
Retrofitting of Vacuum Pumps (53 units)	21,500
HFC 134a Leak Detection Equipment (2 units)	8,000
Lube storage & Deydration System (1 unit)	120,000
Training	15,000
Test Trials	22,500
Contingencies (10%)	39,000
Subtotal	**431,000**
Amount requested taking 24% export to USA into account	**327,560**

Note: As explained above, the two standby pumps, eventhough retrofitted, could not be used for full production volumes, and this is why two new units are needed.

CAPITAL COST FOR CFC 12 PHASE-OUT - ERNA

Refrigerant Charging Equipment: 2 units to be replaced	80,000
New Vacuum Pumps (5 units)	12,500
Retrofit of Existing Vacuum Pumps (35 units)	14,000
HFC 134a Leak Detection Equipment (4 units)	16,000
Training	10,000
Test Trials	7,500
Contingencies (10%)	14,000
Subtotal	**154,000**
TOTAL INCREMENTAL CAPITAL COST (US$) (ERNA does not export to non-article-5 countries)	**1,592,960**

6.2 INCREMENTAL OPERATIONING COSTS & BENEFITS (US$)

The calculation of the incremental operating costs for both Supermatic and Erna is based on a six month period using 50% of their actual production for the period July 93 to June 94 inclusive and ignoring growth. Annex A provides detailed explanations on how the incremental operating costs were obtained, the costs are summarised below. The amounts take the 24% export production by Supermatic to non-article 5 countries into account.

PHASE-OUT OF CFC 11	
Cost for Materials (see Annex A, Part 1.):	
Supermatic	**848,671**
Erna	**317,642**
PHASE-OUT OF CFC 12	
Cost for Materials (see Annex A, Part 2.):	
Supermatic	**519,290**
Erna	**126,667**
TOTAL INCREMENTAL OPERATING COST (US$)	**1,812,270**

6.3 TOTAL PROJECT INCREMENTAL COSTS (US$)

TOTAL COST (Capital + Operating)	**3,405,230**
Article 5.1 Country Ownership	**100%**
FUNDING REQUESTED FROM THE MLF (US$)	**3,405,230**

6.4 UNIT ABATEMENT COST (US$/Kg)

a. Total Capital Investment Cost (US$)	**1,592,960**
b. Capital Recovery Factor (10% p.a.)	**0.16275**
c. Total Incremental Operating Costs/Benefits	**1,812,270**
d. ODS Reduction (ODP Kgs July '93 - June '94)	**414,000**
e. Unit Abatement Cost (US$/Kg) [(a x b) + c] /d	**5.0**

THE PROJECT UNIT ABATEMENT COST IS 5.0 US$/Kg

7. FINANCING PLAN

The VITRO Group requests reimbursement to the amount of the total project costs of US$ 3,405,230 in line with the 100% Article 5.1 country ownership of the enterprise. This amount takes the 24% export production by Supermatic to non-article 5 countries into account.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP will versee the successful implementation of this project and will provide technical assistance during project execution.

8.2 SCHEDULE

TASK	TIME TO COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
MLF Approval	x					
Procurement Preparation	xx	x				
Vendor Selection		xx				
2. Installation						
Arrival of Equipment		xx				
Customs Clearance		x				
Machine Installation		x	x			
3. Commissioning						
Machine Start-up			x			
Trials & Training			xxx	xxx	xx	
Mass Production Change					x	xx
Certification						x

9. PROJECT IMPACT

This project will eliminate the use of 456 tons of CFC's (415 ODP tons) per year. This data is based on figures for the 12 MONTH period July 94 - June 93.

10. ANNEXES

ANNEX A: CALCULATION OF INCREMENTAL OPERATING COSTS
ANNEX B: PROJECT TECHNICAL REVIEWS
ANNEX C: INFORMATION ON CORPORATE OWNWERSHIP
ANNEX D: FACOSA - PROCESS DIAGRAM & DETAILS OF EQUIPMENT CHANGES

ANNEX A: SUMMARY BUDGET TABLE

Amounts below take export figures by Supermatic to non-Article 5 Countries (24%) into account. All companies are 100% Mexican owned.

		Total	FACOSA Compr.Manuf.	SUPERMATIC Refr.Manuf.	ERNA Refr.Manuf.
a. CFC Consumption (ODP Tons)	CFC-11	334	0	297	37
	CFC-12	80	0	68	12
	Both	414	0	365	49
b. Incremental Capital Cost	CFC-11	527,400	0	87,400	440,000
	CFC-12	1,065,560	584,000	327,560	154,000
	Both	1,592,960	584,000	414,960	594,000
c. Incremental Operational Cost	CFC-11	1,166,313	0	848,671	317,642
	CFC-12	645,957	0	519,290	126,667
	Both	1,812,270	0	1,367,961	444,309
d. Total Incremental Cost (d = b + c)	CFC-11	1,693,713	0	936,071	757,642
	CFC-12	1,711,517	584,000	846,850	280,667
	Both	3,405,230	584,000	1,782,921	1,038,309
f. Capital Conv. Factor (10 yrs)		0.16275	0.16275	0.16275	0.16275
g. Unit Abatement Cost g=(b*f+c)/(a*1000)	CFC-11	3.75	N/A	2.91	10.52
	CFC-12	10.24	N/A	8.42	12.64
	Both	5.00	N/A	3.93	11.04
h. Cost Effectiveness h = g / a	CFC-11	5.07	N/A	3.15	20.48
	CFC-12	21.39	N/A	12.45	23.39
	Both	8.23	N/A	4.88	21.19

Annex A.1.1 -- Calculation of the Incremental Operating Cost for SUPERMATIC

1. The Elimination of CFC-11 as Blowing Agent for Thermal Insulatin Foams.

SUPERMATIC === SUPERMATIC === SUPERMATIC ===	CFC-11	HCFC-141b	Difference
Use per kg of Foam produced.			
a. kg Polyol	0.3430	0.3430	0.0000
b. kg MDI	0.4900	0.4900	0.0000
c. kg Blowing Agent	0.1670	0.1670	0.0000
Prices in US$			
d. Polyol with Blowing Agent (US$/kg)	2.3600	2.8000	0.4400
e. MDI (US$/kg)	2.1000	2.2200	0.1200
g. Polystyrene for Liner (US$/kg)	1.7670	2.3100	0.5430
Cost per kg of foam produced			
h. = (a + c) x d. Polyol with Blowing Agent	1.2036	1.4280	0.2244
i. = b x e. MDI	1.0290	1.0878	0.0588
k. = h+i+j, Total per kg foam	2.2326	2.5158	0.2832
Material used per Refrigerator			
l. kg of foams per unit (average)	4.6113	5.0724	0.4611
m. kg of polystyrene per unit (average)	3.8910	4.1380	0.2470
Cost per Refrigeration Unit			
n. = l x k. for foams	10.2952	12.7611	2.4660
o. = m x g. for polystyrene	6.8754	9.5588	2.6834
p. = n + o. Total per unit	17.1706	22.3199	5.1493
q. Nr of Refrigerator Units/6-months			216,858
r. Total Incremental Cost for 6 months (US$)			1,116,673
s. Amount requested taking 24% USA exports into account			848,671

167

Note: Production data is based on July 93 - June 94 figures.

Annex A.1.2 -- Calculation of the Incremental Operating Cost for SUPERMATIC

2. The Elimination of CFC-12 as Refrigerant.

SUPERMATIC === SUPERMATIC === SUPERMATIC ===	CFC-12	HFC-134a	Difference
1. Refrigerant			
a. Price per kg Refrigerant	2.130	7.500	
b. Kg per Refrigerator (average)	0.163	0.147	
c. Number of Refrigerators for 6 months (see note)	216,858		
d. Cost for Refrigerant d= a x b x c	75,291	239,085	163,795
2. Compressors			
a. Cost per Compressor (see note)	35.07	36.41	
b. Number of Compressors for 6 months (see note)	216,858		
c. Cost for Compressors c = a x b	7,605,193	7,895,782	290,589
3. Condensors			
a. Cost per Condensor	N/C	N/C	
b. Number of Condensors for 6 months	N/C		
c. Cost for Condensor c = a x b			0
4. Filter/Dryer			
a. Cost per Filter/Dryer	0.42	0.53	
b. Number of Filter/Dryers for 6 months	216,858		
c. Cost for Filter/Dryer c = a x b	91,080	114,934	23,854
5. Capillary Tubes			
a. Cost per Capillary Tube	N/C	N/C	
b. Number of Capillary Tubes for 6 months	216,858		
c. Cost for Capillary Tube c = a x b			0
6. Compressor Lubricant			
a. Price per litre of Lubricant	1.84	4.89	
b. Litres of Lubricants/compressor (average)	0.31	0.31	
c. Number of compressors	216,858		
d. Cost for Lubricant d = a x b x c	123,696	328,734	205,039
e. Total for six months			683,277
f. Amount requested taking 24% USA exports into account			519,290

Note: All figures in this table are based on a weighted average of the refrigerator models produced. For averages for compressors, see annex C. Production data are based on July 93 - June 94 figures.

Annex A.2.1 -- Calculation of the Incremental Operating Cost for ERNA

1. The Elimination of CFC-11 as Blowing Agent for Thermal Insulatin Foams.

ERNA === ERNA === ERNA === ERNA === ERNA	CFC-11	HCFC-141b	Difference	
Use per kg of Foam produced.				
a. kg Polyol	0.4250	0.4300	0.0050	
b. kg MDI	0.4250	0.4300	0.0050	
c. kg Blowing Agent	0.1500	0.1400	(0.0100)	
Prices in US$				
d. Polyol plus Blowing Agent (US$/kg)	2.3600	2.8000	0.4400	
e. MDI (US$/kg)	2.1000	2.1000	0.0000	
g. Polystyrene for Liner (US$/kg)	1.7670	2.3100	0.5430	
Cost per kg of foam produced				
h. = (a + c) x d. Polyol and Blowing Agent	1.3570	1.5960	0.2390	
i. = b x e. MDI	0.8925	0.9030	0.0105	
k. = h+i+j, Total per kg foam	2.2495	2.4990	0.2495	
Material used per Refrigerator				
l. kg of foams per unit (average)	2.6550	2.9205	0.2655	20.3
m. kg of polystyrene per unit (average)	4.8720	5.8490	0.9770	
Cost per Refrigeration Unit				
n. = l x k. for foams	5.9724	7.2983	1.3259	
o. = m x g. for polystyrene	8.6088	13.5112	4.9024	
p. = n + o. Total per unit	14.5812	20.8095	6.2283	
q. Nr of Refrigeration Units for 6 months			51,000	
r. Total Incremental Cost per year (US$)			317,642	

Annex A.2.2 -- Calculation of the Incremental Operating Cost for ERNA

2. The Elimination of CFC-12 as Refrigerant.

ERNA === ERNA === ERNA === ERNA === ERNA	CFC-12	HFC-134a	Difference
1. Refrigerant			
a. Price per kg Refrigerant	2.13	7.50	
b. Kg per Refrigerator (average, see note)	0.118	0.106	
c. Number of Refrigerators per 6 months (see note)	51,000		
d. Cost for Refrigerant d= a x b x c	12,818	40,545	27,727
2. Compressors			
a. Cost per Compressor (see note)	35.76	36.82	
b. Number of Compressors per 6 months (see note)	51,000		
c. Cost for Compressors c = a x b	1,823,760	1,877,820	54,060
3. Condensors			
a. Cost per Condensor	5.89	6.48	
b. Number of Condensors per 6 months	51,000		
c. Cost for Condensor c = a x b	300,390	330,480	30,090
4. Filter/Dryer			
a. Cost per Filter/Dryer	0.63	0.75	
b. Number of Filter/Dryers per 6 months	51,000		
c. Cost for Filter/Dryer c = a x b	32,130	38,250	6,120
5. Capillary Tubes			
a. Cost per Capillary Tube	0.81	0.98	
b. Number of Capillary Tubes per 6 months	51,000		
c. Cost for Capillary Tube c = a x b	41,310	49,980	8,670
e. Total for 6-months period			126,667

Note: Numbers such as charge in kg, compressor prices etc, are based on a weighted average of the refrigerators per model. See annex C for a clarification on this point. Production data are based on July 93 - June 94 figures.

Annex B

TECHNICAL REVIEW

1. COUNTRY.

Mexico.

2. PROJECT TITLE.

Elimination of CFCs in the manufacture of Domestic Refrigerators by the VITRO Group of Compagnies.

3. (SUB)SECTOR.

DOMESTIC REFRIGERATION - FOAMED PLASTICS.

4. CP-RELATIONSHIP.

Mexico's CP for reduction of ozone was approved in February 1992. This project is part of it. The National Coordination body (SEDESOL) seeks reduction of CFC use in the refrigeration industry as from 1995.
Note: this Technical Review deals only with the foam part of the project.

5. TECHNOLOGY.

The proposed technology includes the replacement of CFC 11 in the insulating foams of the cabinet and doors by HCFC 141b. This technology is quite acceptable since in this way only 10% of the insulating value is lost. This is important in view of the future Mexican energy requirements for domestic appliances. In view hereof, the environmental impact of HCFC 141b (see further) is acceptable. The technology proposed is proven, and is applied in other countries where high insulating standards are wanted.
The use of HCFC 141b however, implies extra ventilation, since usually a recommended TLV of 500 ppm is required (1000 ppm for CFC11).

6. ENVIRONMENTAL IMPACT.

The environmental effect of HCFC 141b is acceptable; the ODP is 0.1 and the GWP is around 10% of the GWP of CFC11. The smog formation potential is 1, the same value as methane.

Annex B

7. PROJECT COSTS.

The project incremental capital costs are well explained and minimum investments are proposed. Retrofitting was considered but was either too expensive or impossible. Consideration could be made as to whether the old low pressure machines can be sold on the Mexican market (if they are worth it).
The proposed incremental operation cost for Supermatic seem to wrongly calculated, since the value i for HCFC 141b is not 1.0878, but 1.0290 (the values of b and e being equal in both cases). This results in total incremental operational costs of 931,730 USD (instead of 996,433 USD). The difference being 64,703 USD.
The cost to reduce 1t of CFC11 is 8,331 USD (proposed correction taken into account).

8. IMPLEMENTATION.

The proposed 1.5 years project duration is realistic.

9. RECOMMENDATION.

It is recommended to approve the project, with the small correction in the incremental operation cost.

Prepared by Dr. Hubert Creyf
UNDP Foam Sector Reviewer
Date 25 October 1994

H Creyf

Annex B

TECHNICAL REVIEW

Country of origin:	MEXICO
Project title	Elimination of CFCs in the Manufacture of Domestic Refrigerators by the VITRO Group of companies
Sector/subsector:	Domestic Refrigeration
Relationship to the country programme:	The project forms part of the country programme as approved by the Executive Committee. This review addresses only the refrigerant conversion part of the project and does not address the part related to the foam blowing agent conversion.
Technology:	The technology selected for the refrigerant conversion is HFC-134a which is a proven and acceptable (non-transitional) technology to reduce CFC-12 consumption. Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of lack of commercially available compressors and safety aspects. The VITRO Group strongly cooperates with Whirlpool USA and related companies (Whirlpool Europe and Embraco, Brazil). This cooperation includes technology transfer -- for both the appliance manufacturers SUPERMATIC and ERNA, as well as the compressor manufacturer FACOSA -- that covers new HFC-134a applications. Besides this, all three companies in the VITRO Group have already done development work for the new technology. All together, a successful project implementation can be anticipated.
Environmental impact:	HFC-134a has an ODP of zero and a GWP of 0.27. For domestic refrigeration, a GWP of this magnitude is negligible.

Annex B

Project costs:	a) Incremental capital costs for all three companies: o The requested equipment is essential for the conversion process. Associated costs are reasonable. (Only the compressor leak detection equipment seems relatively expensive). o Costs of training, testing and trials are reasonable. b) Incremental operational costs for SUPERMATIC and ERNA: o Compressor incremental operational costs are correctly passed on to the appliance manufacturer. o Operational costa are claimed for 6 months. o Items claimed in the calculation of the operational costs are correct and the costs are reasonable. o The correct number of appliances is used in the calculations. c) General: o The UAC-value for the refrigeration part of SUPERMATIC amounts to US $12.1 and for ENRA to US $18.2 which are respectively low and moderate as compared to similar projects. o The overall UAC value of the project is relatively low.
Implementation timeframe:	Reasonable
Relevance and adequacy of information provided:	Sufficient
Recommendations:	Approval as proposed.

Martien Janssen
Washington, D.C.
25 October 1994

Annex C

VITRO JURIDICA, RELACIONES PUBLICAS Y BANCARIAS

Monterrey, N.L., a 23 de Septiembre de 1994, para los efectos legales a que haya lugar, se hace constar que Supermatic, S.A. de C.V., Fabricación de Compresores, S.A. de C.V. y Fabricantes de Aparatos Domésticos, S.A. de C.V., son empresas mexicanas con el siguiente Capital Social:

SUPERMATIC, S.A. DE C.V.

REP. ACTUAL ACCIONES

ACCIONISTAS	CAPITAL FIJO	
	SERIE "A"	SERIE "B"
VITROMATIC, S.A. DE C.V.	7'889,699	7'580,300
VITRO CORPORATIVO, S.A. DE C.V.	1	
	7'889,700	7'580,300

	CAPITAL VARIABLE	
VITROMATIC, S.A. DE C.V.	SERIE "C"	SERIE "D"
	8'058,000	7'742,000
	SERIE "C-1"	SERIE"D-1
	5,610	5,390
	SERIE "C-2"	SERIE "D-2"
	5'967,000	5'733,000
	SERIE "C-3"	SERIE "D-3"
	2'101,200	2'018,800
	SERIE "C-4"	SERIE "D-4"
	4'182,000	4'018,000
	SERIE "C-5"	SERIE "D-5"
	9'435,000	9'065,000

TOTAL 73'801,000

Apartado Postal 104 Suc. "B", 66250 Garza Garcia, N.L. México. Teléfonos (83) 29-1200 y 29-1300 Fax (83) 35721(

Annex C

VITRO JURIDICA, RELACIONES PUBLICAS Y BANCARIAS

FABRICACION DE COMPRESORES, S.A. DE C.V.

REP. ACTUAL ACCIONES

ACCIONISTAS	CAPITAL FIJO SERIE "A"	SERIE "B"
VITROMATIC, S.A. DE C.V.	509	490
VITRO CORPORATIVO, S.A. DE C.V.	1	
	510	490

CAPITAL VARIABLE

VITROMATIC, S.A. DE C.V.	SERIE "C"	SERIE "D"
	17'437,359	16'753,541
	SERIE "C-1"	SERIE"D-1
	2'845,800	2'734,200
	SERIE "C-2"	SERIE"D-2
	3'570,000	3'430,000

TOTAL 46'771,900

Apartado Postal 104 Suc. "B", 66250 Garza García, N.L. México, Teléfonos (83) 29-1200 y 29-1300 Fax (83) 357210

Annex C

VITRO JURIDICA, RELACIONES PUBLICAS Y BANCARIAS

FABRICANTES DE APARATOS DOMESTICOS, S.A. DE C.V.

REP. ACTUAL ACCIONES

ACCIONISTAS	CAPITAL FIJO SERIE "A"	SERIE "B"
VITROMATIC, S.A. DE C.V.	510	490
VITRO CORPORATIVO, S.A. DE C.V.	1	
	510	490

CAPITAL VARIABLE

VITROMATIC, S.A. DE C.V.

SERIE "C"	SERIE "D"
1'733,490	1'665,510
SERIE "C-1"	SERIE"D-1
11'862,600	11'397,400
SERIE "C-2"	SERIE "D-2"
2'856,000	2'744,000
SERIE "C-3"	SERIE "D-3"
6'885,000	6'615,000
SERIE "C-4"	SERIE "D-4"
852,822	819,378
SERIE "C-5"	SERIE "D-5"
17'391,000	16'709,000
SERIE "C-6"	SERIE "D-6"
6'120,000	5'880,000
SERIE "C-7"	SERIE "D-7"
12'779,531	12'278,373

TOTAL 118'590,104

Monterrey, N.L., 29 de Septiembre de 1994.

ATENTAMENTE,

LIC. ANDRES GONZALEZ GONZALEZ.
GERENTE LEGAL

Annex D

- **NEW ULTRASONIC INMERSION CLEANER**

THIS WASHER MACHINE WORKS IN THREE STEPS TO ASSURE THE CLEANING MACHINERY PARTS, IN ALL THE CASES PERCLOROETHILENE IS REQUIRED.

IN FIRST STATION WITH HEATERS, THE DEGREASER IS EVAPORATED AND WITH TERMICAL SHUCK BY MEANS OF ASPERTION OF PERCLOROETHILENE. THE SECOND STATION CONTINUES CLEANING THE PIECES. AND FINALLLY BY INMERTION AND ULTRASONIC SYSTEM THE MACHINING PARTS ARE ALL CLEANED-

CHLORINES FLUIDS HAVE HEAVY REACTION WITH FREON R-134a FORMING SALTS IN CAPILLAR TUBES OF REFRIGERATION SYSTEMS.

DUE TO THE CHEMMICAL REACTIONS WITH PARTS THAT BRINGING CHLORINES IS NECESSARY THE CHANGE FOR ANOTHER FLUID THAT ACCEPT ULTRASONIC SYSTEM. THEREFORE, ANOTHER DESIGN OF AN ULTRASONIC WASHING MACHINE IS REQUIRED.

- **OIL DEHYDRATATION AND TESTING SYSTEM**

ACTUALLY WE ARE CHARGEING OIL FROM THE ORIGINAL OIL DRUMS, WE ARE NOT USING ANY SPECIAL EQUIPMENT.

POLYOLESTER LUBRICANTS LIKE ALTERNATIVE FOR USE IN COMPRESSORS IN PRECECENCE OF R-134a ARE HYGROSCOPIC AND MUST BE KEPT SEALED AND DRY AT $<$ 100 PPM.

- **COMPRESSOR LEAK DETECTION EQUIPMENT**

OUR SYSTEM FOR LEAK DETECTION IS IN TWO INMERSION WATTER STATION THE COMPRESSOR IS CHARGING WITH 11 KG/CM2 OF INTERNAL PRESSION OF DRY AIR.

THE COMPRESSOR IS HANGING IN A CONVEIOR AND CONTINUES TO A WATER TANK BY INMERTION OF THE COMPRESSOR AND THE LEAKAGE ARE VISUALLY DETECTED.

THE NEW REQUIREMENT OF LEAKAGE IS 0.05 OZ PER YEAR. WITH THE CONVENTIONAL HALOGEN DETECTOR IS NOT POSSIBLE TO DETECT R-134a LEAKS.

ANNEX D

FABRICACION DE COMPRESORES, S.A. DE C.V.

• UPPER AND LOWER SHELL DIES

ACTUAL UPPER AND LOWER SHELL DIES ARE TEN YEARS OLD, AND IT IS IMPERATIVE TO CHANGE ACTUAL DESIGN FOR A BAYONET TYPE. DUE TO LEAKAGE WITH R-134a ARE SEVIEREST THAN R-12, THIS IS BECAUSE R-134a HAS LOWEST INTERNAL MOLECULAS THAN R-12 IN CONSECUENCE LESS DENSITY.

• SPOT WELDING MACHINES

ACTUAL ARC WELDERS ARE HORIZONTAL MACHINES.

THE OPERATOR MANUALLY LOAD THE TWO COMPRESSOR HALVIES INTO A ROTATING SPINDLE TOOLING AND IT WOULD BE PRESSED IN PLACE BY A TAIL STOCK CILINDER WITH LINE CENTER, THEY HAVE AN ARC WELDING TORCH THAT MOVES INTO POSICION TO PERFORM THE WELDING OPERATION.

THEY ARE 15 YEARS OLD AND THEIR CAPACITY ARE 60 SECONDS PER PIECE. DUE TO CHANGE UPPER AND LOWER SHELL DESIGN, WE MUST CHANGE ACTUAL ARC WELDERS (HORIZONTAL WELDERS) FOR ANOTHER VERTICAL TYPE.

• METAL PRESS SYSTEM MODIFICATION

THE ACTUAL SYSTEM CONSIST IN A DROPPING MINERAL OIL LUBE BY GRAVITY EXCEPT IN TWO PRESSES THAT THEY HAVE AN AUTOMATIC PRESSURE FREE LUBE SYSTEM, IN ALL CASES IT IS NECESSARY TO CHANGE FOR AN AUTOMATIC PRESSURE FEED LUBE SYSTEM BECAUSE THE NON OIL FLUID THAT WE ARE TO USE LIKE METAL STAMPING, LUBRICANT NEEDS A SYSTEM BY ASPERTION TO ASSURE BEST RESULTS.

CHANGE FOR A NON OIL FLUID BECAUSE IN ORDER TO AVOID PARAPHINES AND GELS DUE TO REACTIONS IN COMPRESSOR IN PRESENCE OF R-134a.

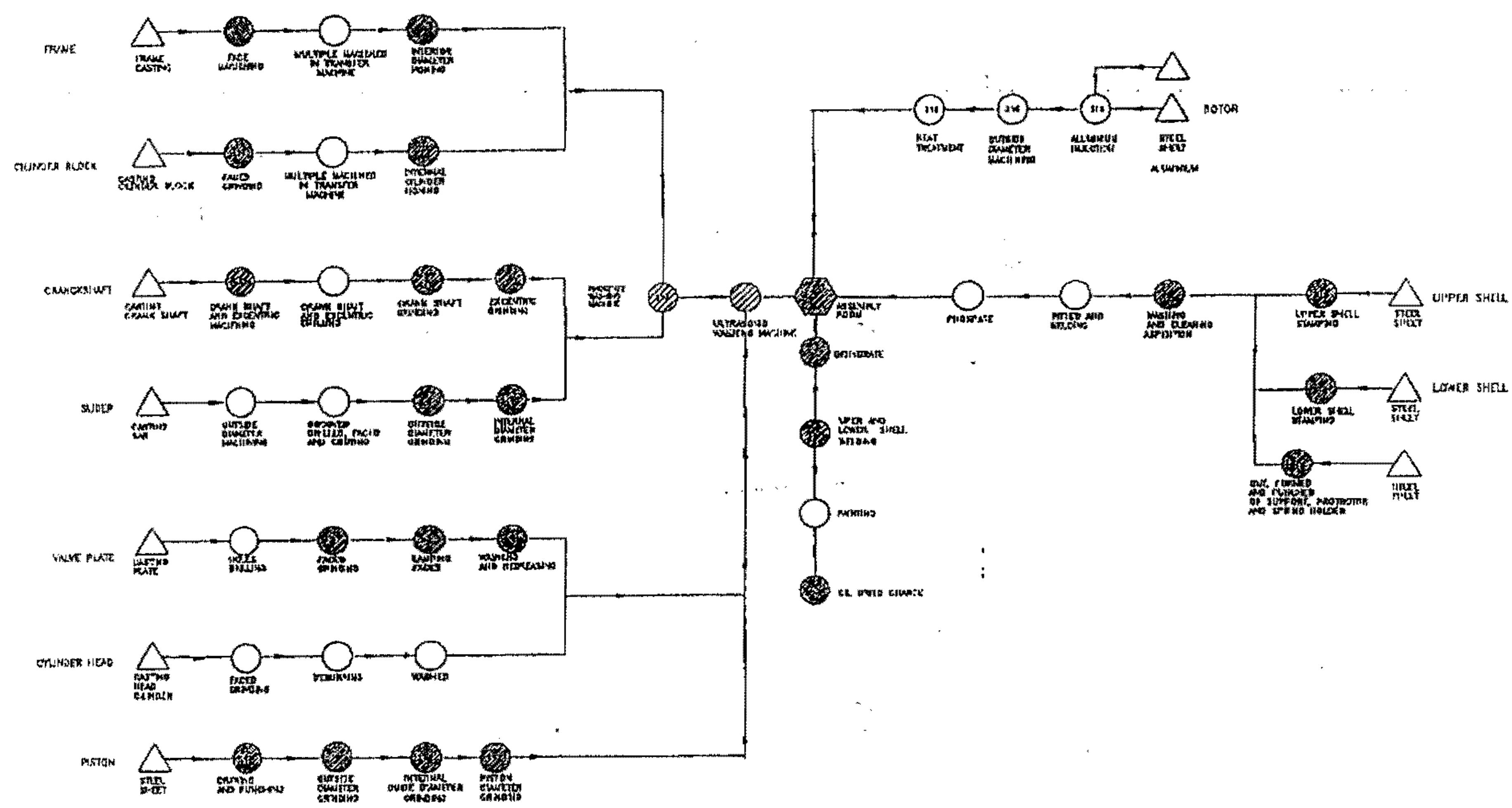
• RETROFIT OF FIVE CLEANING/CHEMICAL TREATMENT UNITS

ACTUALLY EXIST IN MACHINERY AREA THREE LATHES AND TEN GRINDING MACHINES USING MINERAL CUTTING OIL. THIS EQUIPMENT HAVE 15 YEARS OLD.

THE CENTER LESS GRINDING MACHINES CONSIST IN A GRINDING WHEEL, REGULATING WHEELTRUING UNIT, AN HIDRAULIC UNIT, A CUTTING FUID TANK AND AN ELECTRICAL CONTROL CAGINET. THE LATHES ARE A MULTIPLE SPINDLE AUTOMATIC MACHINES.

IN ALL CASES SUBSTITUTION OF ACTUAL CUTTING FLUID SYSTEMS FOR A UNIQUE SEALED SYSTEM IS NECESSARY TO AVOID CONTAMINATION BETWEEN NON OIL CUTTING FLUID (NEW ONE) AND HIDRAULIC FLUIDS THAT ARE USED FOR THE OPERATION OF THE MACHINERY MECHANISMS.

ANNEX D



• NEW ONES

VITRO ENSERES DOMESTICOS

PROCESS FLOW CHART