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Implementation of the Montreal Protocol

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Montreal, 26-28 July 1995

PROJECT PROPOSALS: BRAZIL

This document includes the following project proposals which have been grouped by sector. The agency responsible for the implementation of the project is also indicated. The project proposals are presented in the order indicated below.

Foam

• Conversion to CFC-free Technology in the Manufacture of Polyurethane Foam at Macform	UNDP
• Conversion to CFC-free Technology in the Manufacture of Polyurethane Foam at Nacra	UNDP
• Conversion to CFC-free Technology in the manufacture of Polyurethane Foam at MBR	UNDP
• Conversion to CFC-free Technology in the Manufacture of Integral Skin Polyurethane Foam for Steering Wheels at Plascar	UNDP
• Investment Project for Phasing Out of ODS at Frisokar Equipamentos Plasticos Ltda.	UNIDO

Refrigeration

• Elimination of CFCs in the manufacture of domestic chest freezers at Multibras S.A. Eletrodomesticos	UNDP
• Conversion of the assembly of refrigeration compressors to phase out CFC-12 and CFC/HCFC-502 by using HFC-134a and R-404a at Elgin Maquinas	UNIDO

PROJECT COVER SHEET

COUNTRY:	**BRAZIL**
PROJECT TITLE:	**MACFORM**-Conversion to CFC-free Technology in the Manufacture of Polyurethane Foam
SECTOR COVERED:	Foam Blowing
ODS USE IN SECTOR:	900 t (1993)
PROJECT IMPACT:	25 t (1994)
PROJECT DURATION:	1.5 year
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	USD 225,000 Incremental Capital Cost USD 29,000 Incremental Operating Cost
PROPOSED MLF GRANT:	USD 254,000
COST EFFECTIVENESS:	Grant Effectiveness : USD 10.16/kg/y Unit Abatement Cost : USD 2.14/kg/y
IMPLEMENTING AGENCY:	UNDP
COORDINATING MINISTRY:	Brazilian Industry and Trade Ministry
APPRAISAL DATE:	February/March, 1995

PROJECT SUMMARY

In this project, Macform Injecao De Polyuretanos Ind. E Com. LTDA ("MACFORM") will phaseout the use of CFCs in the manufacture of molded PUR foam cushions and integral skin foam parts. Ultimately all production will be converted to full water blown foams, but in the production of integral skin products, HCFC-141b may be used for a limited period, to allow the development and commercial introduction of final formulations by the chemical supplier. The project includes replacement of two foam dispensers, trials, training, technology transfer as well as incremental operating costs for two years.

Prepared by: Bert Veenendaal
Reviewed by: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF BRAZIL

MACFORM-CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF POLYURETHANE FOAM

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of PUR foams (rigid, integral skin and flexible molded) at Macform Injecao De Poliuretanos Ind. E Com. LTDA ("MACFORM").

2. SECTOR BACKGROUND

The Brazilian foam industry, excluded the use of foams in domestic refrigeration, consumed in 1993 about 900 t CFC-11. This usage is concentrated in the manufacture of rigid and semi-rigid foams. CFC-use in the manufacture of flexible PUR slabstock/molded and thermoplastic foams was already substantially phased out, with the residual use mainly concentrated in the production of flexible molded foams. The following table shows the breakdown of CFC-use per foam category:

CATEGORY	CFC-USE (t)	%	FOAM TYPE
Commercial refrigeration	160	18	R-PUR
Furniture Industry	55	6	F/ISF-PUR
Automotive Industry	370	41	F/ISF-PUR
Building Construction	170	19	R-PUR
Others	145	16	F/ISF/R-PUR
TOTAL	**900**	**100**	

CFC-Consumption in the Brazilian Foam Industry (1993)

Foam in the commercial refrigeration sector is used for cold storage rooms, industrial refrigerators/freezers and refrigerated trucks. The furniture industry used molded seat cushions, armrests and chair bases, mainly in office applications. The automotive industry likewise for seat cushions and armrests but also for steering wheels. In the building industry, foam is used for thermal as well as acoustical insulation and ornamental use (imitation wood). Other applications include thermoware (coolers, bottles, casseroles) bicycle saddles, imitation wood etc.

3. ENTERPRISE BACKGROUND

MACFORM was founded 1986. The enterprise in completely brazilian owned. Facilities are located in Osasco/SP (3,600 m^2). About 110 employees produce low density packaging foam ("pour-in-place"), flexible PUR foam cushions for motor cycles and rigid integral skin foam for electrical/electronical cabinets. sales are around USD 2.4 mio/y. Main market is the electronical industry, requiring prompt delivery and outstanding quality. The company is currently upgrading its quality control system to comply with ISO 9000 under a support program financed by UNIDO. The enterprise operates the following foaming equipment:

DISPENSER TYPE	APPLICATION	PRODUCTION	STATUS
Spray Foam Type Applicator with Pour Gun	Packaging Foam	10 t	Already Converted to CFC-free Technology
Sintenar LP-15	Semi-rigid ISF	50 t	Under Reconstruction
Sintenar LP-20	Flexible Foam	20 t	Uses CFCs
Sintenar LP- 8 Sintenar LP-30	Rigid ISF	100 t	Uses CFCs

4. PROJECT DESCRIPTION

Under this project, MACFORM will phaseout the use of CFCs in its manufacturing operations. The technology chosen is water blown foams in all operations. Such systems are readily available in the Brazilian market for flexible molded, but will need special adaption for the low density of the cushions produced. All water blown integral skin foam is also commercially available, but currently not offered in Brazil. In addition, individual fine tuning will have to implemented to guarantee continuation of the high quality level required. Therefore the interim use of HCFC-141b as an partial replacement, a drop-in technology, may be needed. All water blown technology of sufficient quality requires high pressure equipment. By consolidation of production and excluding semi-rigid ISF from the program, as currently no production is in place, the amount of foam dispensers to be replaced can be reduced to two. The project also includes technology transfer, trials and training of equipment operators (18). The company will induce slightly higher costs based on the higher use of MDI it its new formulations.

5. TECHNOLOGY

ODS phaseout technologies for flexible PUR molded foams are for all practical purposes restricted to water based technologies, sometimes complemented with (premixed) additives.

ODS phaseout technologies for integral skin foams are as under:

Low ODS Technologies ("Interim")	> HCFC-22
	> HCFC-141b
ODS free technologies ("Permanent")	> Pentane
	> HFC-134a
	> Water Based

The company has selected water based technologies as replacement in both applications, but may need some interim use of HCFC-141b during the adjustment process of its integral skin formulations.

The higher viscosities induced and resulting mixing deficiencies can be coped with through the use of high pressure dispensing equipment.

6. PROJECT COSTS

6.1. CAPITAL COSTS

The following are the incremental capital cost expected:

2 High Pressure 30 l/min Foam Dispensers complete, installed		USD 170,000
Trials for flexible foam	USD 5,000	
for ISF foam	USD 10,000	USD 15,000
Technology Transfer, Training		USD 20,000
Contingency		USD 20,000
Total		**USD 225,000**

6.2. OPERATING COSTS

The use of all waterblown foams requires higher MDI levels to react with the water and to generate the required carbondioxide that acts as the actual blowing agent:

BEFORE:	25,000 kg CFC-11 @ 360	USD 90,000
AFTER:	37,500 kg MDI @ 2.85	USD 106,875
INCREMENTAL OPERATING COSTS/Y		**USD 16,875**
NPV (10% discount, 2 years)		**USD 29,000**

6.3. COST EFFECTIVENESS

a) Incremental Capital Costs........................USD 225,000
b) Capital Recovery Factor (10y/10%)....................0.16275
c) Annual Incremental Operating Costs..............USD 16,875
d) ODP Reduction/Y..................................kg 25,000

UNIT ABATEMENT COSTS [{a(b)+ c}/d].................USD/kg/y 2,14

GRANT EFFECTIVENESS (a + c/d).......................USD/kg/y 10.16

The latter is well within the threshold of USD 16.86/kg/y that has been established for projects in this category, presented to the 17th Executive Committee.

7. FINANCIAL PLAN

The enterprise requests a grant covering the entire incremental costs as calculated under 6.1 and 6.2:

USD 254,000

8. PROJECT IMPLEMENTATION

UNDP will oversee the implementation of this project and provide technical support. Implementation is expected as follows:

TASK	TIME FOR COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
Document preparation	xx					
Procurement preparation	xx	x				
2. Installation						
Arrival			x			
Machine Installation				x		
3. Start-up,						
Machine Start-up				x		
Trials, Training, Phase-in				x	xxx	
Certification						x

9. REQUIRED REGULATORY ACTION

The project requires no regulatory action.

10. PROJECT IMPACT

This project will eliminate the use of at least 25 t CFC-11 in the first year after implementation. The project employs commercially developed and environmentally acceptable technology.

11. ANNEXES

Annex-A: technical Review

TECHNICAL REVIEW.

1.Country:

Brazil

2.Project Title:

MACFORM-Conversion to CFC-free Technology in the Manufacture of Polyurethane Foam.

3.(Sub)Sector:

Foamed Plastics.

4.CP-Relationship:

CFC use was substantially phased out in the production of flexible slabstock foams.

Some CFCs are still used in the molding sector.

The national coordinating Ministery is the Brazil Industry and Trade Ministery.

The implementing body is the UNDP.

5.Technology:

It is proposed to change to only-water blown formulation in both technologies (flexible molding and integral skin foam production).

This technology can be accepted .

It is understood and accepted that, in an interim period, for ISF production, some HCFC 141b will be used until water blown formulations are fully mature.

6.Environmental Impact:

Fully water blown technologies are entirely acceptable from an environmental viewpoint.

The interim solution for ISF production, to use HCFC 141b, is also fully acceptable.

7.Project Costs:

The project document does not give many details about the CFC11 use in the molding area. All what is known is that 20 t of molded foam is made, and 100 T of ISF. The CFC use of each technology is not mentioned, so that it cannot be verified whether the operating costs are correctly presented . It is also questioned whether two years (instead of one) of incremented cost must be offered.

The incremental capital costs as presented, do not reveal many details.

Based upon the data given, the cost for elimination of 1 kg of ODS is

USD 225,000 / 25,000 or 9.0 USD.

8. Implementation:

Acceptable as presented.

9. Recommendation:

The project can be accepted when more details about the justfication of capital and operating costs are given.

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date: 060495 H Creyf

After discussion with Mr B. Veenendaal, Foam Sector Expert, the raised technical questions were solved, and project costs were agreed upon.
It is hence recommended to accept the project.

Hubert Creyf, Foam Sector Technical Reviewer.
Date, 061195. H Creyf

PROJECT COVER SHEET

COUNTRY:	Brazil
PROJECT TITLE:	**NACRA**-Conversion to CFC-free Technology in the Manufacture of Polyurethane Foam
SECTOR COVERED:	Foam Blowing
ODS USE IN SECTOR:	900 t (1993)
PROJECT IMPACT:	20 t (1994)
PROJECT DURATION:	1.5 year
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	USD 263,000 Incremental Capital Cost USD 23,500 Incremental Operating Cost
PROPOSED MLF GRANT:	USD 286,500
COST EFFECTIVENESS:	Grant Effectiveness : USD 14.33/kg/y Unit Abatement Cost : USD 2.82/kg/y
IMPLEMENTING AGENCY:	UNDP
COORDINATING MINISTRY:	Brazilian Industry and Trade Ministry
APPRAISAL DATE:	February/March, 1995

PROJECT SUMMARY

In this project, Nacra Injecao De Polyuretanos Ind. E Com. LTDA ("NACRA") will phaseout the use of CFCs in the manufacture of molded PUR foam cushions and integral skin foam parts. Ultimately all production will be converted to full water blown foams, but in the production of integral skin products, HCFC-141b will be used for a limited period, to allow the development and commercial introduction of final formulations by the chemical supplier. The project includes replacement of two foam dispensers, trials, training, technology transfer as well as incremental operating costs for two years.

Prepared by: Bert Veenendaal
Reviewed by: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF BRAZIL

MACFORM-CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF POLYURETHANE FOAM

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of PUR foams (integral skin and flexible molded) at Nacra Injecao De Poliuretanos Ind. E Com. LTDA ("NACRA").

2. SECTOR BACKGROUND

The Brazilian foam industry, excluded the use of foams in domestic refrigeration, consumed in 1993 about 900 t CFC-11. This usage is concentrated in the manufacture of rigid and semi-rigid foams. CFC-use in the manufacture of flexible PUR slabstock/molded and thermoplastic foams was already substantially phased out, with the residual use mainly concentrated in the production of flexible molded foams. The following table shows the breakdown of CFC-use per foam category:

CATEGORY	CFC-USE (t)	%	FOAM TYPE
Commercial refrigeration	160	18	R-PUR
Furniture Industry	55	6	F/ISF-PUR
Automotive Industry	370	41	F/ISF-PUR
Building Construction	170	19	R-PUR
Others	145	16	F/ISF/R-PUR
TOTAL	**900**	**100**	

CFC-Consumption in the Brazilian Foam Industry (1993)

Foam in the commercial refrigeration sector is used for cold storage rooms, industrial refrigerators/freezers and refrigerated trucks. The furniture industry used molded seat cushions, armrests and chair bases, mainly in office applications. The automotive industry likewise for seat cushions and armrests but also for steering wheels. In the building industry, foam is used for thermal as well as for acoustical insulation and for ornamental use (imitation wood). Other applications include thermoware (coolers, bottles, casseroles) bicycle saddles, imitation wood etc.

3. ENTERPRISE BACKGROUND

NACRA is a 100% Brazilian owned, employing about 40 employees in the production of flexible PUR foam cushions and semi-rigid integral skin foam, mainly for furniture applications. Sales are around USD 1.2 mio/y. The enterprise operates a facility in Diadema/Sao Paulo (1,450 m^2). CFCs (20 t; 1994) is used in all foams produced. The following foam producing equipment--all low pressure--is on site:

DISPENSER TYPE				APPLICATION	STATUS
MAKE	L/MIN	YEAR	TIMERS		
Wotan	8	1987	no	IS-PUR	) All in use, with
Salpol	15	1993	30	IS-PUR	) different
Salpol	7	1993	30	IS-PUR	) formulations
Sintenal	8	1986	4	IS-PUR	Under revision
Cannon	50	1983	8	IS-PUR	Under revision
Sintenal	30	1986	8	F-PUR	In use

The relatively large amount of foam dispensers is related to the fact that different formulations are used. The current equipment is not capable to formulation changes "on the fly".

4. PROJECT DESCRIPTION

Under this project, NACRA will phaseout the use of CFCs in its manufacturing operations. The technology chosen is water blown foams in all operations. Such systems are readily available in the Brazilian market for flexible molded, but will need special adaption for the low density of the cushions produced. All water blown integral skin foam is also commercially available, but currently not offered in Brazil. In addition, individual fine tuning will have to implemented for the different formulations. Therefore the interim use of HCFC-141b as a partial replacement, a drop-in technology, will be needed. All water blown technology of sufficient quality requires high pressure equipment. By consolidation of the IS-PUR production on a dispenser capable to run different formulations simultaneously and excluding the capacity that is currently under retrofit--and obviously constitutes production expansion--the amount of foam dispensers to be replaced can be reduced to two.

The project also includes technology transfer, trials and training of equipment operators.

The company will induce higher costs based on the use of MDI.

5. TECHNOLOGY

ODS phaseout technologies for flexible PUR molded foams are for all practical purposes restricted to water based technologies, sometimes complemented with (premixed) additives.

ODS phaseout technologies for integral skin foams are as under:

Low ODS Technologies ("Interim")	> HCFC-22
	> HCFC-141b
ODS free technologies ("Permanent")	> Pentane
	> HFC-134a
	> Water Based

The company has selected water based technologies as replacement in both applications, but will need interim use of HCFC-141b during the adjustment process of its integral skin formulations. The higher viscosities induced and resulting mixing deficiencies can be coped with through the use of high pressure dispensing equipment.

6. PROJECT COSTS

6.1. CAPITAL COSTS

The following are the incremental capital cost expected:

1 High Pressure 30 l/min Foam Dispenser for IS-PUF multiple programs, complete, installed.............	USD 120,000
1 High Pressure 30 l/min Foam Dispenser for F-PUF 8 timers, complete, installed......................	USD 85,000
Trials for flexible foam.....USD 5,000 for ISF foam..........USD 10,000...............	USD 15,000
Technology Transfer, Training.........................	USD 20,000
Contingency..	USD 23,000
Total..	**USD 263,000**

6.2. OPERATING COSTS

The use of all waterblown foams requires higher MDI levels to react with the water and to generate the required carbondioxide that acts as the actual blowing agent:

BEFORE:	20,000 kg CFC-11 @ 3.60....................	USD 72,000
AFTER:	30,000 kg MDI @ 2.85......................	USD 85,500

INCREMENTAL OPERATING COSTS/Y......................	**USD 13,500**
NPV (10% discount, 2 years).........................	**USD 23,500**

6.3. COST EFFECTIVENESS

a) Incremental Capital Costs........................USD 263,000
b) Capital Recovery Factor (10y/10%)....................0.16275
c) Annual Incremental Operating Costs..............USD 13,500
d) ODP Reduction/Y...................................kg 20,000

UNIT ABATEMENT COSTS [{a(b)+ c}/d].................USD/kg/y 2,82

GRANT EFFECTIVENESS (a + c/d).......................USD/kg/y 14.33

The latter is within the threshold of USD 16.86/kg/y that has been established for projects in this category, presented to the 17th Executive Committee Meeting.

7. FINANCIAL PLAN

The enterprise requests a grant covering the entire incremental costs as calculated under 6.1 and 6.2:

USD 286,500

8. PROJECT IMPLEMENTATION

UNDP will oversee the implementation of this project and provide technical support. Implementation is expected as follows:

TASK	TIME FOR COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
Document preparation	xx					
Procurement preparation	xx	x				
2. Installation						
Arrival			x			
Machine Installation				x		
3. Start-up,						
Machine Start-up				x		
Trials, Training, Phase-in				x	xxx	
Certification						x

9. REQUIRED REGULATORY ACTION

The project requires no regulatory action.

10. PROJECT IMPACT

This project will eliminate the use of at least 25 t CFC-11 in the first year after implementation. The project employs commercially developed and environmentally acceptable technology.

11. ANNEXES

Annex-A: Technical Review

(30)

TECHNICAL REVIEW.

1.Country:

Brazil

2.Project Title:

NACRA-Conversion to CFC-free Technology in the Manufacture of Polyurethane Foam.

3.(Sub)Sector:

Foamed Plastics.

4.CP-Relationship:

CFC use was substantially phased out in the production of flexible slabstock foams.

Some CFCs are still used in the molding sector.

The national coordinating Ministry is the Brazil Industry and Trade Ministery.

The implementing body is the UNDP.

5.Technology:

It is proposed to change to only-water blown formulations in both technologies (flexible molding and integral skin foam production).

This technology can be accepted .

It is understood and accepted that, in an interim period, for ISF production, some HCFC 141b will be used until water blown formulations are fully mature.

6.Environmental Impact:

Fully water blown technologies are entirely acceptable from an environmental viewpoint.

The interim solution for ISF production, to use HCFC 141b, is also fully acceptable.

The ODP of HCFC 141b is 0.11; the ODP of CFC11 being 1.0. The GWP of HCFC 141b is 10% of the GWP of CFC11.

(31)

7.Project Costs:

The project is unclear about the actual machines used, in both technologies. It must be assumed that one HP-foam dispensor is needed in the IS area and one for molding. If this is correct, the presented capital costs can be accepted.

There is also no justification for the elements of the operating costs, so that also this element cannot be verified.

Based upon the elements given, but not necessesarely accepted, the cost to eliminate one kg of ODS is:

USD (263,000 + 23,500 / 20,000) or USD 14.33.

Note that the value of 20,000 kg of CFC 11 is only mentioned in the cost effectiveness of the chapter of the project.

8.Implementation:

Acceptable as presented.

9.Recommendation:

The project can be accepted, provided that the data in chapter 7 of the project (PROJECT COSTS) are justified more extensivily.

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date:060495

After discussion with mr [illegible]
technical questions were solved, and project costs were agreed upon.
It is hence recommended to accept the project.

Hubert Creyf, Foam Sector Technical Reviewer.
Date, 061195.

PROJECT COVER SHEET

COUNTRY:	Brazil
PROJECT TITLE:	MBR-Conversion to CFC-free Technology in the Manufacture of Polyurethane Foam
SECTOR COVERED:	Foam Blowing
ODS USE IN SECTOR:	900 t (1993)
PROJECT IMPACT:	40 t (1994)
PROJECT DURATION:	1.5 year
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	USD 320,000 Incremental Capital Cost USD 47,000 Incremental Operating Cost
PROPOSED MLF GRANT:	USD 367,000
COST EFFECTIVENESS:	Grant Effectiveness : USD 9.18/kg/y Unit Abatement Cost : USD 1.98/kg/y
IMPLEMENTING AGENCY:	UNDP
COORDINATING MINISTRY:	Brazilian Industry and Trade Ministry
APPRAISAL DATE:	February/March, 1995

PROJECT SUMMARY

In this project, MBR - Ind. Com. LTDA ("MBR") will phaseout the use of CFCs in the manufacture of molded and integral skin PUR foam for the production of bicycle saddles. Ultimately all production will be converted to full water blown foams, but in the production of integral skin products, HCFC-141b may be used for a limited period, to allow the development and commercial introduction of final formulations by the chemical supplier. The project includes replacement of three foam dispensers, trials, training, technology transfer as well as incremental operating costs for two years.

Prepared by: Bert Veenendaal
Reviewed by: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF BRAZIL

MBR-CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF POLYURETHANE FOAM

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of PUR foams (integral skin and flexible molded) at MBR - Ind. Com. LTDA ("MBR").

2. SECTOR BACKGROUND

The Brazilian foam industry, excluded the use of foams in domestic refrigeration, consumed in 1993 about 900 t CFC-11. This usage is concentrated in the manufacture of rigid and semi-rigid foams. CFC-use in the manufacture of flexible PUR slabstock/molded and thermoplastic foams was already substantially phased out, with the residual use mainly concentrated in the production of flexible molded foams. The following table shows the breakdown of CFC-use per foam category:

CATEGORY	CFC-USE (t)	%	FOAM TYPE
Commercial refrigeration	160	18	R-PUR
Furniture Industry	55	6	F/ISF-PUR
Automotive Industry	370	41	F/ISF-PUR
Building Construction	170	19	R-PUR
Others	145	16	F/ISF/R-PUR
TOTAL	**900**	**100**	

CFC-Consumption in the Brazilian Foam Industry (1993)

Foam in the commercial refrigeration sector is used for cold storage rooms, industrial refrigerators/freezers and refrigerated trucks. The furniture industry used molded seat cushions, armrests and chair bases, mainly in office applications. The automotive industry likewise for seat cushions and armrests but also for steering wheels. In the building industry, foam is used for thermal as well as for acoustical insulation and for ornamental use (imitation wood). Other applications include thermoware (coolers, bottles, casseroles) bicycle saddles, imitation wood etc.

3. ENTERPRISE BACKGROUND

MBR is a 100% Brazilian, family owned enterprise, employing about 160 employees in the production of bicycle parts, such as saddles, pedals, star wheels, breaks etc. Bicycle saddles, the company's main product, are made from IS-PUR foam or a polypropylene skin backfoamed with F-PUR foam. MBR is in this field the leading manufacturer in Brazil. Annual sales are around USD 6,000,000. The enterprise operates a facility in Diadema/Sao Paulo (3,500 m^2). CFCs (40 t; 1994) is used in all foams produced. The following foam producing equipment--all low pressure--is on site:

DISPENSER TYPE				APPLICATION	PRODUCTION	
MAKE	L/MIN	YEAR	TIMERS		FOAM (t/y)	CFCs
Thermomechanic	20	1990	no	F-PUF	100	10
Sintenal	8	1986	2	IS-PUR	) 300	30
Transtecnica	20	1994	20	IS-PUR	)	

4. PROJECT DESCRIPTION

Under this project, MBR will phaseout the use of CFCs in its manufacturing operations. The technology chosen is water blown foams in all operations. Such systems are readily available in the Brazilian market for flexible molded, but will need special adaption for the low density of the cushions produced. All water blown integral skin foam is also commercially available, but currently not offered in Brazil. In addition, some fine tuning will have to implemented to assure a perfect product surface. Therefore the interim use of HCFC-141b as a partial replacement, a drop-in technology, may be needed. All water blown technology of sufficient quality requires the replacement of the current low pressure equipment by high pressure ones.

The project also includes technology transfer, trials and training of equipment operators. The company will induce higher costs based on the use of MDI.

5. TECHNOLOGY

ODS phaseout technologies for flexible PUR molded foams are for all practical purposes restricted to water based technologies, sometimes complemented with (premixed) additives.

ODS phaseout technologies for integral skin foams are as under:

Low ODS Technologies ("Interim")	> HCFC-22
	> HCFC-141b
ODS free technologies ("Permanent")	> Pentane
	> HFC-134a
	> Water Based

The company has selected water based technologies as replacement in both applications, but may need interim use of HCFC-141b during the adjustment process of its integral skin formulations. The higher viscosities induced and resulting mixing deficiencies can be coped with through the use of high pressure dispensing equipment.

6. PROJECT COSTS

6.1 CAPITAL COSTS

The following are the incremental capital cost expected:

2 High Pressure 8/20 l/min Foam Dispenser for IS-PUF multiple programs, complete, installed	USD 170,000
1 High Pressure 20 l/min Foam Dispenser for F-PUF complete, installed	USD 85,000
Trials for flexible foam.....USD 5,000 for ISF foam..........USD 10,000	USD 15,000
Technology Transfer, Training	USD 20,000
Contingency	USD 30,000
Total	**USD 320,000**

6.2 OPERATING COSTS

The use of all waterblown foams requires higher MDI levels to react with the water and to generate the required carbondioxide that acts as the actual blowing agent:

BEFORE:	40,000 kg CFC-11 @ 3.60	USD 144,000
AFTER:	60,000 kg MDI @ 2.85	USD 171,000
INCREMENTAL OPERATING COSTS/Y		**USD 27,000**
NPV (10% discount, 2 years)		**USD 47,000**

6.3 COST EFFECTIVENESS

a)	Incremental Capital Costs........................USD	320,000
b)	Capital Recovery Factor (10y/10%).....................0.16275	
c)	Incremental Operating Costs: Annually...........USD	27,000
d)	NPV................USD	47,000
e)	ODP Reduction/Y.................................kg	40,000

UNIT ABATEMENT COSTS [{a(b)+ c}/e].................USD/kg/y 1,98

GRANT EFFECTIVENESS (a + d/e)......................USD/kg/y 9.18

The latter is well within the threshold of USD 16.86/kg/y that has been established for projects in this category, presented to the 17th Executive Committee.

7. FINANCIAL PLAN

The enterprise requests a grant covering the entire incremental costs as calculated under 6.1 and 6.2:

USD 367,500

8. PROJECT IMPLEMENTATION

UNDP will oversee the implementation of this project and provide technical support. Implementation is expected as follows:

TASK	TIME FOR COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
Document preparation	xx					
Procurement preparation	xx	x				
2. Installation						
Arrival			x			
Machine Installation				x		
3. Start-up,						
Machine Start-up				x		
Trials, Training, Phase-in				x	xxx	
Certification						x

9. REQUIRED REGULATORY ACTION

The project requires no regulatory action.

10. PROJECT IMPACT

This project will eliminate the use of at least 25 t CFC-11 in the first year after implementation. The project employs commercially developed and environmentally acceptable technology.

ANNEX: Technical Review

TECHNICAL REVIEW -

1.Country:

Brazil

2.Project Title:

MBR-Conversion to CFC-free lechnology in the Manufacture of Polyurethane Foam.

3.(Sub)Sector:

Foamed Plastics.

4.CP-Relationship:

CFC use was substantially phased out in the production of flexible slabstock foams.

Some CFCs are still used in the molding sector.

The national coordinating Ministery is the Brazil Ministery of Industry and Trade.

The implementing body is the UNDP.

5.Technology:

It is proposed to change to only-water blown formulations in both technologies (flexible molding and integral skin foam production). This technology can be accepted .

It is understood and accepted that, in an interim period, for ISF production, some HCFC 141b will be used until water blown formulations are fully mature.

6.Environmental Impact:

Fully water blown technologies are entirely acceptable from an environmental viewpoint.

The interim solution for ISF production, to use HCFC 141b, is also fully acceptable.

The ODP of HCFC 141b is 0.11; the ODP of CFC11 being 1.0. The GWP of HCFC 141b is 10% of the GWP of CFC11.

7.Project Costs:

The project is unclear about the actual machines used, in both technologies. It must be assumed that two HP-foam dispensors are needed in the IS area and one for molding. If this is correct, the presented capital costs can be accepted.

There is also no justification for the elements of the operating costs, so that also this element cannot be verified.

Based upon the elements given, but not necessesarely accepted, the cost to eliminate one kg of ODS is:

USD (320,000 + 47,000 / 40,000) or USD 9.18.

8.Implementation:

Acceptable as presented.

9.Recommendation:

The project can be accepted, provided that the data in chapter 7 of the project (PROJECT COSTS) are justified more extensivily.

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date:060495

After discussion with Mr B. Veenendaal, Foam Sector Expert, the raised technical questions were solved, and project costs were agreed upon.
It is hence recommended to accept the project.

Hubert Creyf, Foam Sector Technical Reviewer.
Date, 061195.

PROJECT COVER SHEET

COUNTRY:	Brazil
PROJECT TITLE:	PLASCAR Conversion to CFC-free Technology in the Manufacture of Integral Skin Polyurethane Foam for Steering Wheels
SECTOR COVERED:	Foam Blowing
ODS USE IN SECTOR:	900 t (1993)
PROJECT IMPACT:	15 t (1994)
PROJECT DURATION:	1 year
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	USD 85,000 Incremental Capital Cost USD 42,400 Incremental Operating Cost
PROPOSED MLF GRANT:	USD 127,400
COST EFFECTIVENESS:	Grant Effectiveness : USD 8.49/kg/y Unit Abatement Cost : USD 2.55/kg/y
IMPLEMENTING AGENCY:	UNDP
COORDINATING MINISTRY:	Brazilian Industry and Trade Ministry
APPRAISAL DATE:	February/March, 1995

PROJECT SUMMARY

In this project, Plascar S/A Ind. E Com ("PLASCAR") will phaseout the use of CFCs in the manufacture of integral skin PUR foam for the production of automotive steering wheels. HCFC-141b will be used as an interim solution. Ultimately, the use of all water blown formulations is expected. Such formulations are already in use in furniture and truck applications. The project includes retrofit of gaskets,seals and hoses of the three high pressure foam dispensers, trials, training, technology transfer as well as incremental operating costs for two years.

Prepared by: Bert Veenendaal
Reviewed by: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF BRAZIL

PLASCAR-CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF INTEGRAL SKIN POLYURETHANE FOAM FOR STEERING WHEELS

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of automotive steering wheels at Plascar S/A Ind. E Com. ("PLASCAR").

2. SECTOR BACKGROUND

The Brazilian foam industry, excluded the use of foams in domestic refrigeration, consumed in 1993 about 900 t CFC-11. This usage is concentrated in the manufacture of rigid and semi-rigid foams. CFC-use in the manufacture of flexible PUR slabstock/molded and thermoplastic foams was already substantially phased out, with the residual use mainly concentrated in the production of flexible molded foams. The following table shows the breakdown of CFC-use per foam category:

CATEGORY	CFC-USE (t)	%	FOAM TYPE
Commercial refrigeration	160	18	R-PUR
Furniture Industry	55	6	F/ISF-PUR
Automotive Industry	370	41	F/ISF-PUR
Building Construction	170	19	R-PUR
Others	145	16	F/ISF/R-PUR
TOTAL	**900**	**100**	

CFC-Consumption in the Brazilian Foam Industry (1993)

Foam in the commercial refrigeration sector is used for cold storage rooms, industrial refrigerators/freezers and refrigerated trucks. The furniture industry used molded seat cushions, armrests and chair bases, mainly in office applications. The automotive industry likewise for seat cushions and armrests but also for steering wheels. In the building industry, foam is used for thermal as well as for acoustical insulation and for ornamental use (imitation wood). Other applications include thermoware (coolers, bottles, casseroles) bicycle saddles, imitation wood etc.

3. ENTERPRISE BACKGROUND

PLASCAR, founded in 1963 is a major supplier of automotive trim parts in Brazil. The enterprise is a privately owned company with stocks open to public negotiations in the Stock Market, employing about 1,400 individuals. It operates six factories, strategically located around the brazilian automotive manufacturers (Fiat, Volkswagen, GM, Ford, Mercedes). Total constructed area is almost 60,000 sq meters. Consolidated sales in 1994 were 166 mio USD. Polyurethane foam is produced for head rests, dashboards and steering wheels. Only the steering wheel operation uses auxiliary blowing agents (ABAs). All foam dispensing equipment is high pressure.

4. PROJECT DESCRIPTION

Under this project, PLASCAR will complete the phaseout of the use of CFCs in its steering wheel manufacturing operations (2). The technology chosen is HCFC-141b in both operations, after evaluations by the enterprise of about any other possible technology. The company is aware that HCFC-141b has an ODP and as such may constitute an interim solution. However, the current non-ODP alternatives are not (yet) acceptable for its customers and an acceptable interim system is therefore required. The existing high pressure foam equipment will need some retrofitting to adapt to the strong solvent characteristics of HCFC-141b. The project also includes technology transfer, trials and training of equipment operators. The company will induce higher costs based on the price of HCFC-141b.

5. TECHNOLOGY

ODS phaseout technologies for integral skin foams are as under:

Low ODS Technologies ("Interim")	> HCFC-22
	> HCFC-141b
ODS free technologies ("Permanent")	> Pentane
	> HFC-134a
	> Water Based

The company has evaluated HCFC-22, water and methylene chloride (!) with unsatisfactory results. The use of pentane is rejected by some of its customers based on flammability concerns. It also would increase the project cost threefold. The use of HFC-134a would likewise lead to unacceptable high (operating) costs. The interim use of HCFC-141b, a "drop-in solution--remains the only viable option until such time that one of the permanent solutions develops to an acceptable quality level. From those, water based systems seem most promising.

6. PROJECT COSTS

6.1. CAPITAL COSTS

The following are the incremental capital cost expected:

Equipment Modifications: 3 dispensers @USD 15,000	USD	45,000
Trials: 3 dispensers @ USD 5,000	USD	15,000
Technology Transfer, Training	USD	20,000
Contingency	USD	5,000
INCREMENTAL CAPITAL COSTS	**USD**	**85,000**

6.2. OPERATING COSTS

BEFORE:	15,000 kg CFC-11 @ 3.60	USD	54,000
AFTER:	27,500 kg MDI @ 5.30	USD	78,375
INCREMENTAL OPERATING COSTS/Y		**USD**	**24,375**
NPV (10% discount, 2 years)		**USD**	**42,400**

6.3. COST EFFECTIVENESS

a)	Incremental Capital Costs	USD	85,000
b)	Capital Recovery Factor (10y/10%)		0.16275
c)	Incremental Operating Costs: Annually	USD	24,375
d)	NPV	USD	42,400
e)	ODP Reduction/Y	kg	15,000
UNIT ABATEMENT COSTS [{a(b)+ c}/e]		**USD/kg/y**	**2.55**
GRANT EFFECTIVENESS (a + d/e)		**USD/kg/y**	**8.49**

The latter is well within the threshold of USD 16.86/kg/y that has been established for projects in this category, as established by the Executive Committee at its 16th Meeting held in March 1995.

7. FINANCIAL PLAN

The enterprise requests a grant covering the entire incremental costs as calculated under 6.1 and 6.2:

USD 127,400

8. PROJECT IMPLEMENTATION

UNDP will oversee the implementation of this project and provide technical support. Implementation is expected as follows:

TASK	TIME FOR COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
Document preparation	xx					
Procurement preparation	xx					
2. Installation						
Arrival		x				
Machine Retrofit		x				
3. Start-up,						
Machine Start-up		x				
Trials, Training, Phase-in		x	xxx	xxx		
Certification				x		

9. REQUIRED REGULATORY ACTION

The project requires no regulatory action.

10. PROJECT IMPACT

This project will eliminate the use of at least 15 t CFC-11 in the first year after implementation. The project employs commercially developed and environmentally acceptable technology.

ANNEX: Technical Review

TECHNICAL REVIEW.

1.Country:

Brazil

2.Project Title:

PLASCAR Conversion to CFC-free Technology in the Manufacture of Integral Skin Polyurethane Foam for Steering Wheels.

3.(Sub)Sector:

Foamed Plastics.

4.CP-Relationship:

CFC use was substantially phased out in the production of flexible slabstock foams.

Some CFCs are still used in the molding sector.

The national coordinating Ministery is the Brazil Industry and Trade Ministery. The implementing body is the UNDP.

5.Technology:

The presented interim solution to use HCFC 141b until an acceptable ODP zero solution is available for the production of integral skin automotive parts, can be fully accepted.

The rejecting of other possible solutions is well funded in the project and acceptable.

6.Environmental Impact:

The interim solution for ISF production, to use HCFC 141b, is also fully acceptable.

The ODP of HCFC 141b is 0.11; the ODP of CFC11 being 1.0. The GWP of HCFC 141b is 10% of the GWP of CFC11.

7.Project Costs:

Although the capital cost items in the project are not very well detailed , they can be accepted.

Concerning the operating costs, the MDI price seems unacceptably high. The accepted kg price for MDI is USD 2.85 and not USD 5.30.
This change would lead to a situation where a benefit is made of USD (54,000 - 36,338) or USD 17,662, and would reduce the cost to USD 85,000.
Under those circumstances the unit abatement price would become:
USD (85,000 / 15,000) or USD 5.67.

8. Implementation:

Acceptable as presented.

9. Recommendation:

It is recommended to check the MDI price, and make the necessary corrections in the cost items.
The project can than be accepted.

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date:060495 H Creyf

After discussion with Mr B. Veenendaal, Foam Sector Expert, the raised technical questions were solved, and project costs were agreed upon.
It is hence recommended to accept the project.

Hubert Creyf, Foam Sector Technical Reviewer.
Date, 061195. H Creyf

PROJECT DOCUMENT

COUNTRY:	BRAZIL
PROJECT TITLE:	Investment Project for Phasing Out of ODS at FRISOKAR Equipamentos Plasticos Ltda.
SECTOR COVERED:	Integral Skin Semi-flexible Foam (ISSF)
ODS USE BY SECTOR:	878 MT of CFC-11, 20 MT of HCFC 22 and 2 MT of HCFC 134a in 1993, in all rigid and semirigid foam applications
PROJECT IMPACT:	Phase-out of annual consumption of 42 tons of CFC-11 (total ODS = 42 tons/year)
PROJECT DURATION:	18 months
ECONOMIC LIFE OF PROJECT:	10 years
TOTAL PROJECT COSTS:	US $596,949
OVERHEADS OF IMPLEMENTING COSTS:	US $ 77,603 (13%)
PROPOSED FINANCING BY MULTILATERAL FUND:	US $674,552
COST EFFECTIVENESS:	16.06 US $/kg
COUNTERPART ENTERPRISE:	FRISOKAR Equipamentos Plasticos Ltda.
IMPLEMENTING AGENCY:	UNIDO
COORDINATING MINISTRY:	Brazilian Ministry of Industry, Trade and Tourism

PROJECT IMPACT: The project has been designed to phase out 100% of CFC-11 used when producing Integral Skin Semi-Flexible Foam (ISSF) at FRISOKAR Equipamentos Plasticos Ltda., Sao Paulo, Brazil. The chosen alternative is N-pentane as foam blowing agent. The project will be implemented through modification of existing production facilities and installation of supplementary safety equipment and instruments.

INDEX

1. BACKGROUND

1.1 Sector Background

Rigid and semi-rigid PU foam sector (excluding domestic refrigeration).

There are about 200 companies in the country, 12% of which consume the equivalent of 68% of the output of CFCs used by the sector. They are considered medium sized companies. The remaining ones are small and spread all over the country.

Foam Sector	Number of companies	CFC Tons/year
Automotive	7	324
	(several)	50
Civil	8	104
	(several)	64
Industrial Refrigeration	4	110
	(several)	54
Furniture	2	52
Others	3	18
Subtotal medium size companies	24	608
Subtotal small companies	176	292
GRAND TOTAL	**200**	**900**

ODS Consumption

According to the country programme of 1993 the total consumption by sectors was estimated as follows:

- Domestic refrigeration	461 tons
- Industrial/commercial refrigeration	5,287 tons
- Foams (rigid & semi-rigid excl. refrigeration)	900 tons
- Others	1,050 tons
- Fire extinguisher	68 tons
- Solvents	897 tons
- Aerosols	255 tons
TOTAL	**8,918 tons**

The split consumption of CFC's in 1993 in all sectors was:

CFC 11	2,726 tons
CFC 12	5,333 tons
Other CFC's	139 tons
Others	720 tons
TOTAL	**8,918 tons**

Production of CFC in Brazil

The production of CFC in Brazil is shared by two multinational companies (Hoechst 36% and Du Pont 64%) which are able to supply the full domestic demand. About 10% have been imported directly by users or supplied by local distributors.

Conversion strategy

The production facilities of the PU foams manufacturers for ISSF will be converted in order to phase out the use of ODS. Preparatory assistance has been given to some companies to establish their needs during the complete conversion of the factories and the total elimination of CFC products from their operation.

A study of the available options for alternative blowing agents has been prepared and the effect on the operation and production process has been determined for the use of normal pentane which is preferred.

Used technologies

The company FRISOKAR is using CFC 11 in foam production. Most of the equipment is "home made" and some is from a well known international supplier (HENNECKE). FRISOKAR is producing goods of standard quality meeting the demands of the Brazilian market, which takes up 90% of production.

1.2 Background Information on FRISOKAR Equipamentos Plasticos Ltda.

FRISOKAR is an all Brazilian owned company. There are five directors. The site consists of two old warehouses side by side, 1,800 m^2, and the total land available is 5,000 m^2. There are 140 employees. Most of the equipment is home made.

FRISOKAR produce Integral Skin Semi Flexible Foam (ISSF) for the automobile industry, mainly door protection strips, and also arm rests for office furniture. The ISSF foam is 65-70% of production. High resilience moulded foam (HR) for office chair seats and backs makes up the majority of the remainder of production; There is a very small and infrequent production (<3%) of integral skin rigid foam spoilers on the rear of the car.

FRISOKAR consume about 40 tons of CFC- II per year all for ISSF. The HR production is now "all water blown", and neither this nor the production of rigid integral skin foam is the subject of this project.

The total number of mouldings of all types produced per day is ca.6,500. Approximately 650 tons of polyol are used per annum. The isocyanate for ISSF is crude MDI. (TDI/MDI used in the case if the low density HR moulding).

The ISSF moulding process consists of:

Raw materials

Base polyol is purchased in bulk ($20m^3$ storage tank). All other materials are purchased in 200 litre drums. The complete polyol blend (base polyol/polymer polyol/cross linkers/catalyst/CFC-11) is blended in a 0.5t tank. The blended polyol is then transferred to 200 litre drums and from these to the machine day tanks. (One machine is fed directly from the blending tank).

The isocyanate is added directly to the machine day tanks from 200 litre drums.

Foam process

FRISOKAR have a total of five low pressure machines, only three of which work with ISSF. There are two carousels for ISSF and a third is under construction. Some ISSF production is also carried out with the moulds on trolleys which are wheeled to and from the heating/mould conditioning oven. All machines are two stream, (polyol blend/isocyanate), and have high shear mixing. The dispense position of the machine head is controlled by hand.

Moulds are conditioned to about 45°C by passing through electrically heated ovens on the carousel. Foam liquid dispense times vary from 1 to 16 seconds (piece weights 20g to 3,000g). The mouldings are removed from the mould after 4 to 5 minutes.

Ventilation

There is one extraction hood over the waxing station of the larger of the two carousels. This is adequate for this carousel as it operates at present, but ventilation is generally inadequate and the whole building ventilation/extraction needs to be installed.

Finishing and storage

After demould the articles are placed manually on a series of tables down the centre of the production hall. Here they are trimmed prior to transfer to an another warehouse -across the street-, where they are stored prior to sale.

2. PROJECT OBJECTIVE

The objective of this project is to eliminate the use of CFC-11 in the production of ISSF at FRISOKAR, through the purchase of new equipment and conversion of production facilities thus allowing n-pentane to be used as the blowing agent.

3. PROJECT DESCRIPTION

Frisokar is prepared to phase out ODS as soon as the new technology has been acquired, the equipment installed, and staff training completed.

3.1 Project modifications

The main modifications to be introduced in the existing production facilities at Frisokar will lead to improvements and changes in the following areas:

- Storage and handling of n-pentane:
  A new external storage tank at a specified distance from the factory is needed. New loading equipment, safety devices and sprinkler system will be required.

- Production area:
  New equipment for the blending of polyol and pentane is required. These facilities to be fitted with all necessary safety features and ventilation.

  New high pressure dispense machines will replace the low pressure models now in use.These will be specifically designed to work with pentane (or similar products), having reduced volume mixing head, impingement not mechanical mixing, and no solvent flush.

  Mould conditioning will be by water circulation not electric oven as now.

  The ventilation over and around the dispense machines and carousels will be designed to include both the dispense position and the waxing station, as well as general improvements to eliminate areas of low air flow.

  The ventilation in the factory will be improved and safety measures updated. Detection systems for n-pentane will be installed.

  All machinery and equipment in the foaming area will be grounded.

- Final goods storage:
  The ventilation in the ware-house will be improved. Detection systems for n-pentane will be installed.

A complete project evaluation is given in Annex A.

3.2 Evaluation of alternative blowing agents

The possible alternative blowing agents to CFC-11 for the production of ISSF are detailed in Table 1 below. These can be generally classified as;

(a) HCFC
(b) HFC
(c) Hydrocarbons
(d) Inert gases
(e) Chlorinated solvents-methylene chloride

Table 1.

Alternatives to CFC-11 as blowing agents for Integral Skin Semi Flexible Foams

Type	Cost	ODS	Technical Suitability	Flammability
1. HCFC 141b	High	0.11	OK	Slight
2. HCFC 22	High	0.06	OK	Nil
3. HCFC 134a	V.High	Nil	OK	Nil
4. n-Pentane	Low	Nil	OK	High
5. Carbon Dioxide	Low	Nil	Not proven as yet.	Nil
6. Methylene chloride	Low	Nil	Unsuitable	Nil

There are three HCFC/HFC's which could be used satisfactorily in ISSF production. These are HCFC 14 lb, HCFC 22,and HCFC 134a. The alternatives 2 and 3 being gases at NTP require special handling, and are expensive compared to CFC-11. However, this could be offset against a lower use level, < < 50% that of CFC-11. The relative ODP's are 0.06 and zero. HCFC 14 lb is a virtual 'drop in replacement' for CFC-11. Slightly less is needed (85%) but price is significantly higher. ODP is 0.11. As there are moves to ban HCFC's in several countries and indeed Brazil has opted for a 'final solution', non of these options has been pursued.

The hydrocarbon n-pentane is used in ISSF production. With a zero ODP, a use rate 50% that of CFC-11 and being considerably cheaper, it is considered to be the most viable alternative. This is despite a high fire/explosion risk. Technology is available and in use to overcome the problems safely.

N-Pentane is cheaper than Cyclo-Pentane and the quality (hardness) of foam produced for this particular application is better than if C-Pentane is used.

Carbon dioxide is the only inert gas considered as an alternative blowing agent for polyurethane foams at present. It is now well established in low density foam production (slabstock), and its use will soon be extended to low density moulding. There are different ways of using CO_2 for ISSF foam blowing. Carbon dioxide can be injected as liquid CO_2 in the mixing head, but this process has not been yet proven for ISSF. A possible date for its introduction in this area is 1996/7.

The most common way of using CO_2 is "water blowing", whereby the added water reacts with the Isocyanate producing CO_2, which expands the reacting PU forming mixture. A densification of the microcellular foam is obtained when it expands and is compressed against the mould internal surface kept at around 40°C but this does not constitute a thick and dense skin as is obtained when blowing with CFC-11, HCFC's or n-pentane.

It is possible to use methylene chloride ($MeCl_2$) in the production of ISSF foams, but only in blends with CFC-11. Typically a wt/wt ratio of CFC-11 to $MeCl_2$ of 3:1 would be used to improve skin quality. Increases in the amount of $MeCl_2$ tend to be detrimental to the skin and at 100% $MeCl_2$ the skin is very thin and weak. $MeCl_2$ is also retained in the polymer to a greater degree than CFC-11. Foam properties particularly on ageing are thus reduced.

The low MAC value of $MeCl_2$ (500 ppm or less, depending on local regulations) leads to more problems regarding workplace exposure. This should be coupled to arguments over toxicity which are still unresolved. The ODP of $MeCl_2$ is zero.

The preferred alternative technology is thus the use of n-pentane. Storage, handling and use of this hydrocarbon in polyurethane foam production is now well established. Satisfactory safety measures have been developed.

The use of n-pentane in ISSF manufacture is therefore the recommended technology to be installed at FRISOKAR.

3.3 Conversion costs

To convert the production facilities to n-pentane FRISOKAR is eligible for financing from the Multilateral Fund as follows:

I. Incremental investment costs- used for replacement of capital goods, training, facility (re)construction,installation,, start up etc.

II. Incremental operating costs for four years, to be used for electricity, maintenance, insurance.

III. Contingency fund

4. OUTPUTS

4.1 Capital goods replacement

Foam system

The use of n-pentane as an auxiliary blowing agent in the polyurethane foam industry is well known, and used in several countries. The equipment to be installed at FRISOKAR falls into two categories.

1. Installation of bulk storage facilities for n-pentane and the purchase of new foam dispense machines and blending facilities to convert to pentane.

2. Safety in handling and the use of raw materials.

   The items to be installed are:

   - Pentane tank storage system.

   - Sprinkler system, fire extinguisher, gas detectors, fire alarm system, high pressure metering system

   - Two high pressure dispense machines complete with metering, mixing and control facilities.

   - Two polyol/pentane blending units,nitrogen blanketed (one per machine).

   - Modifications to ventilation system above and around each machine at the foam dispense point and mould waxing station; installation of fans, ductwork etc.

   - Fans, ductwork for improved ventilation in the total production factory. All areas need to be involved, not just that for ISSF production.

   - Comprehensive gas detection system in the factory and foam storage facilities, particularly where pentane is blended with polyol, at and around the foam dispense point, and all areas of potential low air flow.

4.2 Training

Within this project, personnel of FRISOKAR will be trained in the following;

Risk prevention when using pentane
Maintenance of new equipment;
Technology and working sequences/functions of the machines;
Electrical installation and fault diagnosis,
Safety rules and safety equipment

4.3 Project implementation

The project will be coordinated by PROZON. The implementation will be carried out by, UNIDO in close cooperation with FRISOKAR.

For the implementation of major components of the project (gas tank, pumping system'. fire safety, new machinery etc.) subcontracts will be concluded on the basis of competitive bidding. The sub contracts will include the supply of equipment, installation, commissioning and on-the-job training of FRISOKAR personnel. The terms of reference for the sub contracts will be detailed after approval of the project.

The final equipment specification and workplan can only be drawn up after approval of the basic approach for the project implementation by PROZON of and FRISOKAR EQUIPAMENTOS PLASTICOS LTDA.

UNIDO as Implementing Agency has the necessary experience and capabilities for a successful implementation of projects on the enterprise level. Upon approval by the Multilateral Fund for the implementation of the Montreal Protocol (MFMP), the project budget will be transferred to UNIDO. The respective project allotment document will then be issued by UNIDO's finance section. Any substantive or financial deviation is subject to approval by the Executive Committee of the Multilateral Fund for the implementation of the Montreal protocol.

The milestones for the project implementation are below.

4.4. Milestones

		Duration	Months 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1.	Sign project Rec.funding	1	x																	
2.	Appoint contractor site inspection	1	x																	
3.	Prepn. of Workplan	1	x																	
4.	Specification of equipment	1		x																
5.	Bids	1			x															
6.	Purchase of equipment	3				x	x	x												
7.	Supply/installation of equipment	6					x	x	x	x	x	x	x	x	x	x				
8.	Training	2					x	x												
9.	Start-up tests	1													x					
10.	On site training	1															x			
11.	Operational																			x

5. PROJECT COSTS

5.1 Incremental investment costs

Incremental costs will-be the purchase of new machinery, modification of manufacturing facilities, safety equipment (see Annex A: Equipment Specification and Cost Breakdown), training, installation and consultancy services for modifications'. (see Annex B: Project Budget for FRISOKAR).

5.2 Incremental operating costs

The incremental operating costs are based on the price difference between the ODS to be phased out and its replacement, as well as several other factors incurred in the production costs which are higher because of the requirements of the new process.

FRISOKAR S.A. Table 2.
INCREMENTAL OPERATING COSTS

	YEAR			
	One	Two	Three	Four
Tonnes of PU foam	700	700	700	700
%of CFC-11	6	6	6	6
Tonnes of CFC-11	42	42	42	42
% of Pentane	3	3	3	3
Tonnes of pentane	21	21	21	21
Price of CFC-11 (US$/kg)	3.69	3.69	3.69	3.69
Cost per year US$	154,980	154,980	154,980	154,980
Price of Pentane (US$/kg)	1.31	1.31	1.31	1.31
Cost per year US$	27,510	27,510	27,510	27,510
Savings with Pentane (A)	-127,470	-127,470	-127,470	-127,470
Insurance	20,000	20,000	20,000	20,000
Electricity	20,000	20,000	20,000	20,000
Maintenance	35,251	35,251	35,251	35,251
Training	30,000	0	0	0
Trial production	45,000			
Extra production cost (B)	150,251	75,251	75,251	75,251
INCR.COST/YEAR (A)+(B)	22,781	-52,219	-52,219	-52,219
TOTAL INCREMENTAL COSTS	-133,876			

ANALYSIS OF TABLE 2.

a) Incremental savings

Present situation:	At present 6% of CFC-11 is employed in foam production
Future situation:	3% of pentane will be needed when substitution takes place. (lower molecular weight of pentane)
Market prices are:	3.69 US$/kg for CFC-11 1.31 US$/kg for pentane

Based on the above the incremental savings per year of operation are US$ 127,470

b) Incremental costs

INSURANCE: The additional cost of insurance to cover the risk of working with pentane is US$ 20,000 per year.

ELECTRICITY: New equipment (ventilation, pumps etc.) is required to operate the plant. The electricity, needed for this is estimated to cost US$ 20,000 per year. (54KwH x 400 H/month x 12 month/year x 0.078 $/KwH = US$20,000)

MAINTENANCE: A preventative maintenance system will have to replace the existing maintenance system as soon as the switch to pentane is made. There will be an increased level of instrumentation, and maintenance staff will have to upgrade their knowledge. The purchase of new equipment will result in an increase in incremental costs of about 5% of the investment. Only the maintenance of this equipment has been considered for incremental cost purposes (see Annex A).

Total cost of new equipment for maintenance purposes (US$ 705,000). Maintenance for new equipment (5%) US$ 35,250.

TRAINING COSTS: It is considered that US$ 30,000 will be needed to train FRISOKAR staff in the security and safety procedures related to the operation with pentane (four operators and foremen for two weeks in Europe or USA).

TRIAL PRODUCTION: At least five days will be needed to start up the two new machines. During this period some production will be lost. This has been estimated at US$ 45,000.

Contingency fund

A contingency fund of 15% of the total project budget has been included.

Total costs

The investment cost of US$ 1,202,325 will include capital investment cost for new equipment and machinery,the modification of manufacturing facilities, ventilation and safety devices, training and consultancy services of which US $471,500 must be borne by FRISOKAR.

The incremental operating costs in this project are:

a) Negative because of the price difference between CFC-11 and n-pentane , and the lower use rate of pentane.

b) Positive because of the extra cost of insurance, electricity, maintenance and process disruption.

The total incremental cost over a four years period is US$ (-133,876).

Other cost: A 15% contingency fund has been included to ensure an adequate funding of the project.

The total project cost is US$ 596,949
The overhead cost of the implementing agency is 13% (US$ 77,603)

Requested funding by the Multilateral Fund of the Montreal Protocol is US$ 674,552 (See Annex B).

6. PREREQUISITES

In accordance with the rules and regulations of the Executive Committee of the Multilateral Fund for implementation of the Montreal Protocol, the project funds will cover only incremental capital costs related to the plant conversion. All the other expenses dealing in particular with civil and construction works, provision of additional equipment, machinery, utilities, instrumentation, raw materials, etc., have to be covered by the counterpart.

Therefore, prior to start the project implementation, a Memorandum of Understanding has to be prepared and approved by the Project/Government authorities concerned and UNIDO. The Memorandum will specify all responsibilities of the counterpart and will be considered as an integral part of the project document.

ANNEX A: EQUIPMENT SPECIFICATION AND COST BREAKDOWN FOR FRISOKAR EQUIPAMENTOS PLASTICOS LTDA.

Item	Description	Qty	Unit cost US$	Total cost US$
1.	Complete pentane storage tank system ($20m^3$ capacity), instruments and sprinkler system. Valves, fillings etc. to supply at 5 bar above vapour pressure.	1	50,000	50,000(*)
2.1	Pipework from pentane tank to premix stations.	2	10,000	20,000(*)
2.2	Polyol/pentane blending stations	2	60,000	120,000(*)
3.	High pressure foam machines	2	150,000	300,000(*)
4.1	Ventilation at machine	2	45,000	90,000
4.2	Factory survey by Ventilation consultant	1	20,000	20,000
4.3	Fans/ductwork for improved factory ventilation	1	80,000	80,000
4.4	Fans/ductwork for improved finished goods store	1	80,000	80,000
5.1	Gas detector system, production hall and store	2	70,000	140,000(*)
5.2	Gas feelers	50	1,500	75,000(*)
6.	Fire protection system	2	9,000	18,000
TOTAL			US $	993,000

NOTE. Items marked (*) were used to calculate 'maintenance'

ANNEX B: PROJECT BUDGET FOR FRISOKAR EQUIPAMENTOS PLASTICOS

		m/m	EXCOM US$	FRISOKAR US$	TOTAL US$
BL 11-51	Expert in ODS phase out in foam sector	1.0	15,000		15,000
BL 11-52	Consultant in safety and security operating with C-5	1.0	15,000		15,000
BL 11-53	Consultant in production layout	0.5	7,500		7,500
BL 21-00	Subcontract for:				
	1. Provision of pentane storage tank 20m^3, valves, fittings for connection of nitrogen pre-pressure.		50,000		50,000
	2. Polyol/pentane premix stations allowing continuous automatic transfer to the machine day tanks. Pipework from pentane storage tank to premix stations.		140,000		140,000
	3. High pressure dispense machines.		300,000		300,000
	4. Ventilation survey. Improvements at machines, in the production hall and finished goods store.			270,000	270,000
	5. Gas detector system for pentane storage, foam production and store.		75,000	140,000	215,000
	6. Fire protection and system for PU chemicals and pentane according to local regulations.		18,000		18,000
BL 32-01	Training of technicians		15,000	15,000	
	Subtotal		**635,500**	**410,000**	**1,045,500**
BL 51-00	Miscellaneous 15%		95,325	61,500	156,825
	INVESTMENT COST		730,825	471,500	1,202,325
	Incremental operating costs (negative)		(-133,876)		
	TOTAL PROJECT COSTS		**596,949**		
	13% overhead cost		**77,603**		
	TOTAL BUDGET FOR THE PROJECT US $		**674,552**		
	Cost Effectiveness	**$/kg**	**16.06**		

MGA
Southern Africa Pty Ltd
of the USA
P.O. Box 1133
Gloucester, MA
Project #950518-UNIDO-FR-01

D. MADINABEITIA
2522 Blackwood Road
Wilmington, DE. 19810
Ph./FAX:302-475-2059

MGA Inc.
42 Rogers Street
Box 591
Gloucester MA. 01931-0591
Fax: 1-508-281-3315

Attn: Mr. Michael Gigliotti:

Date: May 31, 1995

Subject: Final Appraisal of FRISOKAR (Brasil) Project Document transmitted to you on 29/5/95 by UNIDO.

Reference my previous comment dated 25/5/95.

The latest (final) appraisal document is being faxed to you along with this memo. While I am not clear how some of our earlier suggestions were actually handled (Specifically the use of Annexes C and D and the documentation issue) I assume that the comment by M. Yousseff that the "rest of the comments were OK" would indicate that they were comfortable with the Document up to that point.

I feel that the Project is well conceived and should deserve all consideration possible for approval.

Regards,

Dan Madinabeitia

TECHNICAL REVIEW

1. Country of Origin: **Brasil**

2. Project Title: **Investment for Phasing Out of ODS at FRISOKAR Equipamentos Plasticos Ltda., Sao Paulo, Brasil**

3. Sector Covered: **Integral Skin Semi-flexible Foam (ISSF)**

4. Relationship to Country Program: **Not known**

5. Technology:

a) Justification for Selection of Alternative Technology:

The chosen alternative of n-pentane to replace CFC-11 for producing ISSF is logical and acceptable, providing that proper safety and ventilation are in place. This choice is a long term solution since it meets most criteria, especially those related to environmental acceptability , technical feasibility and economic practicality.

b) Agreements:

Not known

c) Facilities: Ref: para. 3.2

Storage and handling, production equipment, ventilation, leak detection and finished product storage in the general description are appropriate for this type of production.

We are informed that the foaming plant includes metering unit and alarm, and all equipment will be properly grounded.

Additional (incremental) ventilation in the finished storage area is recommended since some low level diffusion of foaming agent may occur with finished products.

The technology selected will enable factory conversion without reduction of product quality and at the same time remaining cost-effective.

6. Environmental Impact

a) Alternative Foaming Agent

N-pentane has a zero ODP.... a negligible Global Warming Potential (GWP)..... and a has a use rate of 50-60% of CFC-11.

It is a viable alternative.

b)New Plant Facilities
The facilities proposed in this Project will assure safety and protection for the plant surroundings.

7. Project Costs:

Cost of Equipment
a) Prices have been discussed with potential suppliers and all equipment and costs are in line with those for plants world-wide for plants utilizing hydrocarbons for the production of polyurethane foams. Quotations in support of the high-cost items should be available for examination by the MPBC.

b) Some of the Cost Items in Annex B are difficult to correlate with Cost Elements listed in Annex A. Note: These corrections have been made.

Referring to Annex A the note stating certain items marked + were used to calculate "maintenance" is not clear. Perhaps this concern will be eliminated when the Annex D details are available. In any case its relevency should be explained or it should be deleted.

c) **FRISOKAR** is assuming the full cost of ventilation improvements at the machines--a valuabble plus for the project.

d) Baseline cost and scrap value of existing equipment have not been determined. How much of the existing equipment will remain in place? How much will be replaced.? What will be the fate of the scrapped equipment? This is being addressed and should be OK.

e) Net cost of the chemical formulation (ex foaming agent) --to produce foam (i.e. Higher usage of polyol or urethane may result in a higher net cost despite savings in foaming agent. This could be a legitimate incremental cost if it can be documented. Since it is not mentioned in the text, one must assume that no incremental cost difference exists.

f) Start-up Costs --The level of costs associated with training of technicians is reasonable and in line with similar costs world-wide. We are informed that no duplication exists in the use of the Safety and Security consultant.

g) Operating Costs

Back-up information on the Operating Cost items should be detailed in Annex D under a subsection entitled Operating Cost Detail (Refer to Table 2, p. 11 of Project.):

Cost per year :	$154,980
Insurance:	20,000
Electricity	20,000
Maintenance	35,251
Training	30,000
Trial Production	45,000

These figures seem reasonable, but supplying the data base used for each item will reduce uncertainty of the Project Approval.

h) Other Costs

Consultancy costs and implementing agency overhead costs are reasonable.

If any finished product is exported this must be stated and the appropriate Export Deduction must apply. A statement describing export activity or lack therof needs to be added to Section 1.2 of Background Information.

The statement that FRISOKAR is 100% Brasilian owned is appropriate. If it were otherwise, deductions would apply in a similar manner.

i) Cost Effectiveness

This is determined from incremental operational and investment expenses for one full year period divided by the Kg. of ODS removed from the environment. The $16.06 / Kg. is an acceptable cost.

j) Implementation Time

The overall time frame is reasonable. A better fix on this could be required by MPBC. With specific delivery times substantiated by supplier estimates referrable to Annex D, then this could be a non-issue.

PROJECT OF THE GOVERNMENT OF BRAZIL

ELIMINATION OF CFC's IN THE MANUFACTURE OF CHEST FREEZERS AT MULTIBRAS S.A. ELETRODOMESTICOS.

1 PROJECT OBJECTIVE.

The object of this project is to eliminate CFC's used by Multibras in the manufacture of domestic chest freezers. The CFC's which will be eliminated include CFC 11 used as a blowing agent for producing thermal insulation foam and CFC 12 used as a refrigerant in the production of domestic freezers.

2. SECTOR BACKGROUND.

Brazil's country programme for the phaseout of ozone depleting substances was presented at the 13th Executive Committee Meeting in July 1994. Brazil is a producer of CFC's and production of CFC 11 and 12 was estimated to be 11,493 MT in 1993. The estimated consumption of all ODS for 1993 was 8,918 ODP tonnes which comprised 8,064 tonnes of CFC 11 and CFC 12 combined. For the refrigeration sector, the situation is as reflected in the following table:

	ODP tonnes
Foams used in the Refrigeration Sector	1,210
Domestic Refrigeration excluding Foams	461
Industrial/Commercial Refrigeration and A/C	498
Mobile Air conditioning (A/C)	254
Service	4,535
Total Refrigeration & A/C Sector	6,958

For the domestic refrigeration sector, Brazil has two main compressor manufacturing industries and six major companies involved in the manufacture or assembly of domestic refrigerators and freezers. The 3 major domestic refrigeration manufacturers companies share some 70% of the total ODS consumption of CFC 11 and CFC 12 in Brazil. The current refrigerator manufacturing capacity is about 4 million units. The refrigerator and A/C sector is expecting a rapid growth of 10% per year as the economy recovers.

Multibras consumed 1,192 tons of CFCs in 1994 for the manufacturing of all their refrigeration products, of which 166 tonnes was used for the production of chest freezers. In 1994, Multibras in their

PROJECT COVER SHEET.

PROJECT TITLE:	Elimination of CFC's in the manufacture of domestic chest freezers at Multibras S.A. Eletrodomesticos.
SECTOR COVERED:	Refrigeration and A/C Sector
ODS USE IN SECTOR:	6,958 tonnes/year ODP
ODP-TONS ELIMINATED:	166 tonnes/year ODP
SUBSECTOR COVERED:	Domestic Chest Freezers
TOTAL PROJECT COST:	US$ 1,389,173
CAPITAL COST REQUESTED:	US$ 257,213
OPERATING COST REQUESTED:	US$ 609,631
TOTAL COST REQUESTED:	US$ **866,844** --> figure takes 37.6% non-article-5 ownership into account
UNIT ABATEMENT COST:	3.93 US$/kg/year ODP
PROJECT DURATION:	1.5 years
ECONOMIC LIFE:	10 years
NATIONAL COORDINATING BODY:	Grupo Tecnico de Ozonio (GTO)
IMPLEMENTING AGENCY:	United Nations Development Programme (UNDP)
APPRAISAL DATE:	January 1995

PROJECT DESCRIPTION:

This project is part of an overall programme to eliminate the use of CFC's at Multibras S.A. Eletrodomesticos. This project will eliminate the use of CFC's in the production of chest freezers. CFC 11 used as a blowing agent for producing thermal insulating foams will be replaced by HCFC 141b. The company is 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 line for CFC 12 chest freezers into a line producing HFC 134a equipment. The project will eliminate 165.9 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).

PREPARED BY: Mr. Roger Hodson / Mr. Jacques Van Engel
REVIEWED BY: Dr. L.J.M. Kuijpers/Dr. J.M.P. Janssen (Refrigeration) and Dr. H. Creyf (Foam). Comments are attached.

plant in Joinville produced about 2,080,000 freezer, refrigeration and air conditioning units and their plants in San Bernardo and Manuas produced about 573,000 units.

While there are no regulations specifying a maximum energy consumption for refrigerators and freezers at this time in Brazil, it is anticipated that an agreement between the industry and the Government will be reached in 1995 in this regard, based on the DOE (USA) standard.

For chest freezers, the estimated market share for one year as of October 1994 looked as follows:

Company	No of Units	%
Multibras	112,483	32.5
Refripar	108,998	31.5
Metalfrio	82,981	24.0
Reubli	22,696	6.6
Esmaltec	11,642	3.4
Geltec	7,527	2.2
Total	346,327	100

It should be noted that from 1 January 94 through 31 December 1994, the production figure of chest freezers at Multibras was 149,567 units. The reason for the difference with the figure for Multibras in the above table (112,483) is due to the fact that Multibras only started to produce chest freezers since 1 January 1994, so that 112,483 in fact corresponds to a production during a 10-month period (1 January - 31 October 1994).

3. ENTERPRISE INFORMATION.

3.1. General Background.

Multibras S.A. Eletrodomesticos was established on May 1st 1994 as a result of the merger of Brastemp, Consul and Semer all of them reporting to the Brasmotor group. the new company is the major home appliance manufacturer in the Brazilian market having an annual invoice value of US$ 800 million and approximately 11,000 employees, including 8,000 in the refrigeration sector.

Brastemp started to operate in 1951 when Brasmotor Co started to assemble imported refrigerators. Consul was started in 1950 at Joinville (SC) starting to manufacture absorption refrigerators and later electrical refrigerators (1956) air conditioners (1972) and upright/chest freezers (1983). It was integrated to Brasmotor group in 1977. Semer was founded in 1946 and incorporated by Brasmotor group in 1985.

Multibras refrigeration and airconditioning production has the following market share:-

- refrigerators 67%
- air conditioners 50%
- upright freezers 49%
- chest freezers 33%

Total daily production in 1994 is 9,300 refrigerators and freezers out of this total 700 are chest and upright freezers which is the topic of this project.

Multibras is also a market leader in the production of microwave ovens, automatic dryers, washing machines, dishwashers, airconditioning, stoves, etc.

Multibras has produced around 430,000 products per month and the refrigeration plant located in Joinville is responsible for 200,000. Its export markets include USA, Canada, Spain, Australia, France, South Africa and countries of Latin America. However, their export share to non-article-5 country is about 8%, so that no deductions have to be made according to a decision taken by the Executive Committee Meeting of December 1994 on this issue.

<u>3.2. Company Data.</u>

CONSUMPTION (1/1 - 31/12/94) (all models incl. Chest freezers)	798 tons R11 for manufacturing 394 tons R12 for manufacturing
FULL NAME	Multibras S A Eletrodomesticos
PLANT LOCATION	Rua Dona Francisca 6920 Caixa Postal 267/269 89219-900, Joinville, Brazil.
NAME OF CONTACT	Mr. Paulo Vodianitskaia Mr. Paulo Ricardo Feil Mr. Rogerio Augusto Martins
TEL/FAX	Tel 55-474-41-4514 / Fax 41-4700
NON-ARTICLE-5 OWNERSHIP	37.6 %
NUMBER OF MODELS	4 models (see note)
No OF PRODUCTION LINES.	1 line (see note)
PRODUCTION FOR 1994 (1/1-31/12)	149,567 (see note)
COMPRESSOR SUPPLIER	EMBRACO, Joinville Brazil

<u>Note:</u> While this project will only phaseout CFCs in one line producing chest freezers, Multibras has in fact a total of nine product lines related to refrigeration, as described in the following table.

Joinville:	1 product line for Compact Refrigerators 1 product line for Chest freezers (*) 2 product lines for Standard Refrigerators 1 product line for Upright Freezers 1 product line for Airconditioners
Sao Bernardo do Campo:	1 product line for Upright Freezers 1 product line for 2-door Refrigerators
Manaus:	1 product line for airconditioners

(*) : Subject of this project

3.3. Information on Ownership.

Its stock composition based on a detailed printout dated 31 December 1994 is as follow:

Brasmotor	50.10 %
Whirlpool Brazil	28.88 %
Whirlpool USA	1.75 %
Other Foreign Companies	2.55 %
Other Local Companies	16.72 %
	100.00 %

However, it should be noted that parts of Brasmotor (8.86 %) and Whirlpool-Brazil (100 %) are also owned by non-article-5 countries so that the non-article-5 ownership is calculated as 4.44 + 28.88 + 1.75 + 2.55 = 37.62 % This percentage is deducted from the project capital and operational cost calculations (see para 6).

3.4. Company Strategy.

Multibras has chosen for a phaseout strategy in several steps. The first one is the modification of the chest freezer production line in 1995 (present project). Thereafter, other production lines will be converted on line-by-line basis, based on the experience gained from this project.

The above strategy has the approval of the Government Departments visited by UNDP in Brasilia in December 1994. It explains why this project only addresses one of the production lines at Multibras. The project also respects the interagency agreement signed between UNDP, UNIDO and the World Bank.

3.5. Research Capabilities and Technology Agreements.

Multibras has a general technology agreement with Whirlpool, but not a specific agreement for CFC substitution technology. Therefore, for implementation of this technology, Multibras counts with a team of 150 engineers and technicians in its Refrigeration Technology Center in Joinville. This Center counts exchanges information with Whirlpool Technology Centers in the USA and Europe and has been supported by suppliers such as Embraco, Leybold, A'Gramkow, Bayer, Dow, Du Pont, Hoechst, etc.

3.6. Description of the chest freezer models.

The following tables provide a summary of the chest freezer production by Multibras during the 12 month period from 1 January to 31 December 1994.

Model No	Description	Capacity Cu ft	Production Vol	R12 charge kgs	R12 use kgs
HA 22	SD Frz	7.8	59,749	0.100	5,975
HA 31	SD Frz	10.9	46,093	0.100	4,609
HB 41	DD Frz	14.7	26,331	0.300	7,899
HB 53	DD Frz	18.7	17,394	0.300	5,218
Total or Weighted Avg:		11.24	149,567	0.158	23,702

Key: SD=Single Door, DD=Double Door, Frz=Freezer
Note: From the above table, one concludes that CFC-12 consumption equals 23.7 Tons per Year.

Model No	Weight of PU Foam per unit in kgs	Type/Weight of Plastic Liner in kgs		Compressor Capacity in HP		Compressor Price in US$	
				R-12	R-134a	R-12	R-134a
HA 22	6.598	HIPS	0.726	1/6	1/6	35.9	41.7
HA 31	8.014	HIPS	0.937	1/4	1/4	40.5	48.7
HB 41	9.656	HIPS	1.452	1/4	1/4	42.4	50.2
HB 53	11.530	HIPS	1.452	1/3	1/3	44.6	55.7
Weighted Avg:	8.146		1.003			39.5	47.0

Model No	Condenser Price US$ R-12	Condenser Price US$ R-134a	Capill.Tube Price US$ R-12	Capill.Tube Price US$ R-134a	Filter/Dryer Price US$ R-12	Filter/Dryer Price US$ R-134a	PU Foam Formulation per kg Foam	
HA 22	N/A (no change)		0.494	0.682	0.03	0.05	Polyol	0.3649
HA 31			0.494	0.682	0.05	0.07	MDI	0.5040
HB 41			0.494	0.682	0.05	0.07	Blow.Ag.	0.1311
HB 53			0.494	0.682	0.05	0.07		------
								1.0000
Weighted Avg:			0.494	0.682	0.042	0.062		

<u>Note:</u> The Filter/Dryer cost are for the active ingredient only and do not contain the assembly.
<u>Note:</u> From the above tables one concludes that CFC-11 consumption equals 0.1311 x 8.146 x 149,567 = 159.8 Tonnes per Year.

4 . PROJECT DESCRIPTION

Multibras uses CFC 11 to produce PU foam and CFC 12 as the refrigerant for the chest freezers produced in their factory in Joinville Brazil. Successful completion of the project will see Multibras using HCFC 141b as the blowing agent and HFC 134a as the refrigerant. The following table shows the original consumption of CFC's and the ODP tons which are eliminated by the project.

	CFC 11 in tons	ODP tons eliminated (see note *)	CFC 12 in tons	Total ODP tons eliminated
MULTIBRAS CHEST FRZRS	159.8	142.2	23.7	165.9

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 company will transfer to HCFC 141b as an interim step to an ODS free system. The injection machine for the rigid insulation foam is a high pressure machine that is able to process the higher viscosities and mixing requirements of the low ODS systems and also any of the of the developing ODS free systems.

The transition to HCFC 141b will require some equipment replacement, training and test runs before industrial production can be started with the new technology. These activities will include training of staff in worker -safety related matters related to the use of HCFC 141b.

Operational costs for six months are requested, which are determined during the formulation of the project.

4.2. Replacement of CFC 12 with HFC 134a.

The conversion to HFC 134a requires the use of 134a compressors and the associated new synthetic lubricants, re-design of the refrigeration system to cater for the difference in the thermodynamic performance of HFC 134a versus CFC 12, prototyping, testing and optimization of each freezer model, and pilot scale manufacture and testing before full scale conversion of production to HFC 134a. 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. The technology change on which this project will impact is given later.

Operational costs for six months are requested , and are determined during the time that the project is prepared.

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 > 356?, 365?, 245ca? etc.
CFC 11 > partial water/HCFC 22/142b > HFC 134a, HFC 152a.
CFC 11 > n-, iso- and cyclopentane

In addition compounds such as perfluoroalkanes, fluorinated ethers and 2-chloropropane have been suggested but the technology is not mature. Furthermore the products are 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 which is closely related to the existing one The final step to non ODS technology in this process is not decided. One potential solution is HFC 356, but full water blown systems 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 into Europe. Pentanes are flammable and this means a careful review of manufacturing operations with respect to the safe handling of a flammable blowing agent. Their use may not be a practical option in the existing work environment of some enterprises. Several companies currently offer pentane technology packages including equipment. UNDP requires however independent process safety review prior to and after installation.

5.1.2. Selection.

Based on environmental considerations, cyclopentane appears to be the best choice for domestic refrigerator and freezer applications. It combines an attractive price with zero ODP properties. However, the adoption of cyclopentane technology was not selected by Multibras considering their tight technological relationship with Whirlpool USA, and in view of product liability and energy efficiency reasons. It should be noted that Multibras exports some of their production to the USA. Furthermore, and as already mentioned above, it is anticipated that an agreement between the industry and the Government of Brazil will be reached in 1995 based on the DOE (USA) standard for energy efficiency. This as well as safety considerations further precludes the easy introduction of cyclopentane.

22/142b was considered but rejected for energy performance considerations.

The use of 141b is recognized as a CFC 11 replacement that is

- proven technology in both processing and product performance.
- environmentally acceptable
- readily available

Multibras already has high-pressure foam machines for the production of chest freezers which will facilitate the subsequent step to a final zero ODP insulating foam system without additional major capital costs for dispensing equipment.

5.1.3. Impact on Production Processes

The use of 141b technology with higher related viscosity of the polyol blend will be facilitated through the employment of high pressure foam production equipment which Multibras already has.

HCFC 141b is moderately flammable in the gaseous state, but the liquid is not flammable. In the intended application the use of HCFC 141b/ polyol blends should not pose any risk, but a monitoring check at commissioning will be performed to ensure safe worker exposure levels. Ventilation is to be installed where needed to ensure exposure levels are maintained below the recommended occupational exposure limit. Foam density may have to be adjusted to obtain proper insulation values. The liner material needs to be resistant to 141b possibly by using (HIPS) high impact polystyrene in combination with a protective layer.

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

1. One Cannon High Pressure Machine for doors. Output 30 kgs/min, Year 1994, Model No A50.
2. One Cannon High Pressure Machine for cabinets. Output 80 kgs/min, Year 1992, Model No A200.
3. One high-pressure mixing station for doors (see note 1 in para 6.1).
4. One bulk storage tank, plus associated pumps and piping
5. A day tank
6. Jigs and 4 moulds.

<u>NOTE:</u> Items 3 through 6 cannot be used for HCFC 141b, since they also serve other production lines at Multibras which will remain on CFC 11 for at least a couple of years. Therefore, some funding is requested to provide for these items to be included in this project. The storage tank for CFC 11 belongs to the gas supplier.

5.2. REPLACEMENT OF CFC 12 WITH HFC 134a.

5.2.1. Overview.

HFC 134a is universally accepted as a 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 developed countries.

While hydrocarbon refrigerants are being used on a limited basis in at least one developed country, the technology is not considered as sufficiently developed to permit transfer to article 5 countries 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 about its 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 and has been developed with the help of their overseas partner and the help of compressor and refrigerant suppliers, this should ensure satisfactory completion of the project.

5.2.3. Impact on production processes.

HFC 134a like CFC 12 is non flammable. HFC 134a has also been the subject of extensive toxicological testing and is considered safe in industrial applications provided the suppliers recommended 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 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)

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.

Because system cleanliness and moisture content is paramount to the successful manufacture of HFC 134a refrigerators the enterprise will carefully need to re-assess production procedures and re-train production personnel as appropriate. Provision is made for this within the proposal.

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

1. One Charging Machine A'Gramkow UNIMAX Type 01285 designed for use with CFC 12 only.
2. Seventeen Vacuum Pumps from Edwards Model EM 18, Capacity of 21 CFM
3. One Helium Leak Detector, ECOTEC 500

6. PROJECT COSTS.

6.1. Capital Costs.

6.1.1. Capital Cost for the CFC-11 Conversion.

	US$
HCFC 141b Bulk Storage and Distribution System (Note 1)	74,000
Four new Moulds for door-lids (Note 2)	51,000
Polyol Storage and Distribution System (Note 3)	45,000
Premix Station/Door Foaming Line Conversion/Connection (Note 4)	30,000
Additional Ventilation for 6 foam stations and two mixing units	24,000
Training (250 US$ per person, 10 people)	2,500
Test Trials (100 US$ per trial, 3 trials per model, 4 models)	1,200
Contingencies (10% of capital cost)	23,000
Subtotal Incr. Capital Cost for CFC 11;	250,700
Taking 37.6% non-article-5 ownership into account	156,437

Note 1: The company will progressively change production lines from CFC 11 to HCFC 141b. The investment is for 33% of the cost of a new HCFC 141b storage tank, distribution lines and process pumps. This is the true incremental cost for one out of three production line. The CFC 11 storage tank cannot be used for HCFC 141b because it will be required to service the other production lines which will remain on CFC 11. The present storage facility for CFC 11 belongs to the supplier and is loaned as a free service. This arrangement will be discontinued by suppliers who will not supply a loan-tank for HCFC 141b.

Note 2: The doors and lids for chest freezers are currently made on two moulding machines. The machines are from different manufacturers, and the moulds are not interchangeable between the machines. Therefore, new moulds are needed so that one moulding machine can operate on CFC 11 and another one on HCFC 141b -- CANNON drum dosing unit.

Note 3: This is a consequence of the need to use different polyols for CFC 11 and HCFC 141b formulations. Previously one system served several production lines; changing to HCFC 141b means additional equipment for the new polyol.

Note 4: For the same reason as explained in note 1, a new premixing station is required.

6.1.2. Capital Cost for the CFC-12 Conversion.

	US$
One Refrigerant Charging Machine (Note 1)	62,000
Four new Vacuum Pumps (Note 2)	12,000
Retrofitting of 13 Vacuum Pumps (Note 2)	6,500
One Leak Detection Systems (Note 3)	36,000
Training	15,000
Reliability Test Trials, etc.	15,000
Contingencies (10% of capital cost)	15,000
Subtotal Capital Cost for CFC 12;	161,500
Taking 37.6 % non-article-5 ownership into account	100,776

Note 1: During plant visit, it was verified that the current A'Gramkow charging unit cannot be retrofitted to HFC 134a. A unit of equivalent technology level will cost 62,000 US$ (quote received and verified).

Note 2: Standard prices for vacuum pumps which are used in similar projects in other countries are being applied. The current practice of retrofitting of vacuum pumps proposed in similar projects are applied in this project. The company is of course free to apply these two amounts to buying better equipment and/or chose not to retrofit its vacuum pumps.

Note 3: The existing ECOTEC detection unit will not sense R-134a and a new unit is required at a cost of US$ 36,000. Quotes for this, as well as the technological soundness of this request, were verified by UNDP's consultant during plant visit (quote received and verified).

Conclusion: The total capital cost requested for this project (CFC 11 and CFC 12 combined) amounts to US$ 257,213.

6.2. Operational Costs.

The calculation is based on a six month period using production data based on Jan 94 - Dec 94 figures. This was done further to a decision at the 13th Executive Committee Meeting held in Montreal in July 1994.

Annex A provides detailed explanations on how the incremental operational costs were obtained. The figures below already takes the foreign ownership of Multibras (37.6 %) into account.

Operational Cost for Replacement of CFC-11 :	US$ 361,368
Operational Cost for Replacement of CFC-12 :	US$ 248,263
Total Operational Cost :	US$ 609,631

6.3. Unit Abatement Cost.

	US$/kg
a. Capital Investment Costs	257,213
b. Capital Recovery Factor (10% p.a.)	0.16275
d. Incremental Operating Costs	609,631
e. ODS Reduction (ODP Kgs)	165,900
f. Unit Abatement Cost (US$/Kg) [(a*b + d)] / e	3.93

7. FINANCING PLAN

MULTIBRAS is requesting reimbursement to the amount of the project costs of US$ 866,844.

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,			x			
Machine installation			xx			
3. Start-Up						
Machine start-up			x	x		
Trials, training				xxx	x	
Certification					xx	

9. PROJECT IMPACT

This project will eliminate the use of 165.9 ODP tons per year. This data is based on figures for the period Jan 94 - Dec 94.

10. ANNEXES.

Annex A: Calculation of Operational Costs
Annex B: Technical Reviews

ANNEX A. INCREMENTAL OPERATIONAL COST CALCULATIONS

Incremental cost calculations resulting from replacing CFC 11 with HCFC 141b

Multibras	CFC 11	HCFC 141b	Diff.
Use/kg of foam produced			
a kg Polyol	0.3649	0.3690	0.041
b MDI	0.5040	0.5280	0.024
c kg Blowing agent	0.1311	0.1030	(0.0281)
Prices in US $/kg			
d polyol	2.21	3.18	0.97
e MDI	2.51	2.51	0.00
f Blowing agent	2.58	4.12	1.54
g Liner type HIPS	1.30	1.50	0.20
Cost /kg of foam produced			
h = a x d Polyol	0.8064	1.1734	0.3670
i = b x e MDI	1.2650	1.3253	0.0602
j = c x f Blowing agent	0.3382	0.4244	0.0861
k = h + i + j Total cost/kg of foam	2.4097	2.9231	0.5134
Materials used per refrigerator			
l kg of foam per refrigerator average	8.146	9.296	1.1500
m kg of liner material	1.003	1.003	0.0000
COST PER REFRIGERATOR			
n = l x k for foam	19.6295	27.1728	7.5433
o = m x g for liner	1.3030	1.5045	0.2006
p = n + o total per refrigerator	20.9334	28.6773	7.7439
q = No of refrigerators See note 1 below.		149,567	
INCREMENTAL OPERATIONAL COST PER YEAR (US$)		1,158,231	
INCREMENTAL OPERATIONAL COST FOR SIX MONTHS (US$)		579,115	
TAKING 37.6% NON-ARTICLE-FIVE OWNERSHIP INTO ACCOUNT		361,368	

(Annex A continued)

Incremental Costs resulting from replacing the CFC 12 with HFC 134a (US$)

Multibras	CFC 12	HFC 134a	Diff
1. Refrigerant			
a Price/kg of refrigerant (see note 2)	3.329	9.410	
b Kg of refrigerant/ refrigerator avg	0.158	0.142	
c No of refrigerators produced.(See note 1)	149,567	149,567	
1. Cost per refrigerator = a x b x c	78,670	200,136	121,466
2. Compressors			
a Cost per compressor	39.5	43.8 (See note 4)	
b No of compressors (see note 1)	149,567	149,567	
2. Cost for compressors = a x b.	5,907,897	6,551,035	643,138
3. Condensers			
a Cost per condenser	No	No	
b No of condensers	Change	Change	
3. Cost for condensers = a x b.			
4. Filter Dryer			
a Cost per filter dryer average	0.042	0.062 (See note 5)	
b No of filter dryers (see note 1)	149,567	149,567	
4. Cost for filter dryers = a x b	6,282	9,273	2,991
5. Capillary tubes.			
a Cost per Capillary tube (average)	0.494	0.682	
b No of Capillary tubes (see note 1)	149,567	149,567	
5. Cost for Capillary tubes = a x b	73,886	102,005	28,119
INCREMENTAL OPERATIONAL COST FOR 1 YR (US$) (1+2+3+4+5)		795,714	
INCREMENTAL OPERATIONAL COST FOR SIX MONTHS (US$)		397,857	
TAKING 37.6% NON-ARTICLE-FIVE OWNERSHIP INTO ACCOUNT		248,263	

Note 1: Figures in the above table are based on the actual production volume for the 12 month period 1 Jan 94 to 31 Dec 94 obtained from Multibras at the time of the project preparation. As incremental costs are claimed for 6 months only, 50 % of this 12 months production volume has been used in the calculation.

Note 2: Refrigerant chemical prices are actual prices paid by Multibras since UNDP has not prepared other refrigeration projects in Brazil.

Note 3: The calculated incremental costs for the HFC freezer are based on a 10 % reduction in the mass charge compared with CFC 12.

Note 4: Differential prices computed on a weighted average were estimated in a table in paragraph 3.5 at US$ 7.5 per compressor. However, in order to be compatible with other projects, this differential cost was reduced to US$ 4.3. This is higher than the case for domestic refrigeration since the chest freezer compressors are larger, and are produced in smaller quantities.

Note 5: For the dryer, costs are for the active ingredient only, and ignore the cost of the dryer housing.

Country of origin: BRAZIL
Project title: Elimination of CFCs in the manufacture of domestic chest freezers at Multibras S.A. Eletrodomesticos
Sector/sub-sector Domestic refrigeration
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 Multibras Company does not have a formal technology transfer agreement. However, it is stated that the technology has been developed with the help of "their overseas partner". Additional information of the company revealed that the co-operating partner is Whirlpool USA (and Europe). Developments take place in the company's own Refrigeration Technology Center in Joinville which is supported by compressor and refrigerant suppliers. Taking these facts into consideration, a successful project implementation can be expected.
- Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of the state of development, safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.
- Multibras has chosen to gradually phase in the HFC-134a alternative; it may be that a conversion of a larger part of the production facility will be cheaper and will avoid "cross-contamination" problems. However, since this gradual conversion has already been studied and approved by the government, it is not further commented to.

Environmental impact

HFC-134a has an ODP of zero and a GWP of 1300 compared to carbon dioxide (100 year time horizon). For domestic refrigeration a GWP of this magnitude is fully acceptable.

Project costs

- The equipment requested is essential for the conversion process. Costs of equipment (including new and retrofitted vacuum pumps), training and testing are reasonable.
- It is stated that a "helium leak detector" has been used in the past and that this detection system has to be replaced. It is doubted whether a new helium leak detection system will be installed, however, if so, the instalment of a helium system is not approved. Nevertheless, the costs for the leak detection system as given are reasonable and comparable to the HFC-134a ones mentioned in other projects; this item is therefore approved.
- Incremental operational costs are reasonable (after adjustment of the compressor price difference) and correctly applied (for six months).
- If the UAC value is calculated for the refrigerant conversion part (not taking into account foreign ownership) a value of 11 USD/kg/year is obtained, which is similar to other projects.
- The foreign ownership percentage of the Multibras company is correctly applied.

Implementation timeframe Reasonable given development stage.
Relevance and adequacy of information provided Sufficient.
Recommendations Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands, 16 February 1995

Kuijpers L.J.M.,
Technical University Eindhoven, NL

TECHNICAL REVIEW.

1.Country:

Brazil.

2.Project Title:

Elimination of CFCs in the Manufacture of Domestis Chest Freezers at MULTIBRAS S.A. ELECTRODOMESTICOS.

3.(Sub)Sector:

Domestic Refrigeration.
This review covers only the foam part.

4.CP-Relationship:

Brazil's country program for elimination of ODS was presented in July 1994.The project is approved by the Gouvernment Departments, which were visited by UNDP in December '94.

5.Technology:

The change from CFC11 technology to HCFC141b as an auxiliary blowing agent, can be accepted as an intermediate step in the development of an ODS free system.UNDP, together with the Brazil Grupo Tecnico de Ozonio, should, if necessary, encourage further steps.
As an intermediate step, the proposed technology is correct,certainly since already two high pressure CANNON machines were bought in 1994. It can however be deplored that the changeover to HCFC141b is only done partly. Indeed, this partial substitution entails extra costs to the project, eg extra bulk storage capacity for CFC11 and HCFC141b (see remark 1).

6.Environmental Impact:

The ODP of HCFC 141b is 0.11, the ODP of CFC11 being 1.0. The GWP of HCFC 141b is 10% of the GWP of CFC11.

7.Project Costs:

It is believed that all capital costs for the CFC11 conversion can be accepted. It must however be checked whether the polyol/CFC11 mixture is not readily available from the supplier.In this case the costs have to be revised(see remark 2).
The operational costs are correct, but a small calculation error appears,resulting in a difference of only USD 28.It is hence proposed to leave it as it is.
The costs for elimination of 1 kg of CFC is then:USD(156,437+ 361,368)/142,200, or USD 3.64.
As stated earlier, some extra costs are incurred because the changeover happens not in one time.
The change in polyol price from a CFC formulation to an HCFC formulation is high (USD 2.21-USD 3.18) and must be checked (see remark 3).

8. Implementation:

Can be agreed as proposed.

9. Recommendation:

It is proposed to accept the project, taking into account the remarks made: 1. watch further steps to ODS free systems.
2. check whether polyol/ HCFC 141b mixture is readily available.
3. check polyol price in HCFC formulation.
4. the additional costs resulting from a "phased phase-out" per production line is a policy issue to be resolved by the Executive Committee.

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date: 210395.

Remark 1
The reviewer has launched the question of the "phased phase-out" of CFCs. It is now understood that at this moment a total phase-out cannot be considered for compagny strategy reasons. The reviewer considers it for the sake of the ozone layer in principle better to realise an immediate partial phase-out, than to wait for several years for a total phase-out. It is therefore suggested to agree with the "phased phase-out".

Remark 2.
From additional questioning, the reviewer understands that no polyol/HCFC 141b mixture is readily available today. It is hoped that raw material suppliers can be encouraged (via UNDP?) to bring this mixture on the market, since it may decrease raw material and operation costs.

Remark 3.
Information was obtained indicating that the mentioned polyol prices were correct.

Hubert Creyf.

DRAFT

Project Proposal for the Multilateral Fund for the Implementation of the Montreal Protocol Financing

Country	Brazil		
Project Title	Conversion of the assembly of refrigeration compressors to phase out CFC-12 and CFC/HCFC-502 by using HFC-134a and R-404A		
Sectors Covered	Commercial Refrigeration		
ODS Use in Sector	3,330 MT of CFC-12 and 30 MT of CFC/HCFC-502 annually		
Project Impact	Indirect phase out of an annual consumption of 88.6 MT of CFC-12 and 1.4 MT of CFC/HCFC-502 (Total ODS = 89 MT)		
Project Duration	4 years (starting July 1995)		
Project Economic Life	10 years		
Proposed MF Financing	Investment	US$	614,580
	Incremental operating cost	US$	474,000
	10 % contingency	US$	108,858
	13 % agency's overhead	US$	155,667
Total	**Amount requested**	**US$**	**1,353,100**
Total Project Cost	Portion of capital cost and 6 months incremental cost		
Cost Effectiveness	**13.45** US$/kg (1,197,438/89,000 = 13,45)		
Counterpart Enterprise	ELGIN MAQUINAS S.A. in Mogi des Cruzes, Brazil		
Implementing Agency	UNIDO		
Coordinating Ministry	IBAMA (Brazilian Institute for the Environment)		

Project Summary

The project objective is to convert the assembly of compressors for the operation with the refrigerants CFC-12 and CFC/HCFC-502 to the alternative refrigerants HFC-134a and R-404A which do not effect the ozone layer. The total (indirect) impact of the planned phase out is 89 MT of ODS per year.

Due to the delayed phase out of the Brazilian Commercial Refrigeration Sector, the Company predicts a gradual phase out up to the year 1999. It must be stated that the planned phase out is in compliance with the Brazilian Country Programme for the Commercial and Domestic sectors.

The project includes the redesign of the compressors, the introduction of special laboratory equipment for testing new lubricants compatible with HFC-134a, R-404A, and the new compressors, the development of a new assembly line for non-ODS compressors as well as the training of service man to repair and maintain the new compressors.

1. Background

1.1 Refrigeration sub-sector

The sub-sector for the production of refrigeration compressor includes several Brasilian companies, like Embracco, SICOM (TECUMSEH), and ELGIN Maquinas S.A.

ELGIN holds the number "three" in the Brasilian market.

1.2 Company background

ELGIN Maquinas S.A. is a private 100 % Brazilian owned company. The company has been created already 45 years ago, and has been in the refrigeration market since 1964. As already mentioned ELGIN is the third largest hermetic compressor manufacturer in the country. The company accounts for an extensive range of products, including condensing units for commercial refrigeration application, window air conditioners, fans, heat exchangers, printers, and sewing machines among others.

The production of hermetic compressors has grown during the last 15 years as follows, see Exhibit 1.

Exhibit 1: Production growth of hermetic compressors in units per year

year							
1980	1981	1982	1983	1984	1985	1986	1987
70,000	72,000	80,000	85,000	70,000	75,000	80,000	85,000
year							
1988	1989	1990	1991	1992	1993	**1994**	1995
100,000	120,000	130,000	135,000	140,000	155,000	**180,000**	200,000

The production of hermetic compressor in 1994 was 180,000 units with the following distribution:

A. 2,800 units for the operation with CFC/HCFC-502 (ODP = 0.3)
B. 177,200 units for the operation with CFC-12 (ODP = 1.0).

It has to be mentioned that the compressors are designed to be applied in different temperature regions, e.g. low temperature application (commercial) and high temperature application (air conditioning). This results in different motor sizes, and consequently different pressure regions. As concerns the year 1995 the following numbers of compressors will be manufactured: 54,000 units for low pressure (low temperature), and 146,000 units amongs 20,000 units for the utilization with HCFC-22 for high pressure (high temperature) application.

These figures will be applied for the calculation of the total indirect impact of the planned phase out of CFC's. See the following chapter.

The company is planning to gradually raise the production of compressors to a level of 250,000 by the year 1999 but this will not profit from the conversion. The share of ELGIN in the commercial refrigeration market is as follows:

1. Hermetic compressors: 60 % (10 % overall, including commercial and domestic refrigeration)
2. Condensing units: 70 %.

The company is third in the window air conditioners market. Besides supplying the internal market (95%), the company exports refrigeration products (5%) to the USA, and Arab as well as South American countries. ELGIN imports 1% of its current compressor output from BRISTOL, USA, to enlarge the scale of compressors available especially as concerns the largest units.

The company works with "in house" technology, which until 1972 was shared with Westinghouse (USA).

ELGIN is commited to phase out its current production of compressors for ODS operation responding to the market demand. Due to factors such as relatively low price of CFC's and unawareness of the refrigerant problem, commercial refrigeration market has been slow in implementing phase out procedures in the country. As a result the demand for CFC's compressors is still high, and the phase out must proceed in a lower pace as predicted by the Country Programme. Strategic plans by the company predict a complete phase out by 1999. ELGIN is considering HFC-134a as substitute for CFC-12 and the zeotropic blend 404A as substitute for CFC/HCFC-502. **Annex 3** shows a compressor in a cutaway view, whereas **Annex 4** shows a condensing unit equipped with a hermetic compressor manufactured by ELGIN. Maquinas S.A.

1.3 ODS's Consumption

According to the Country Programme, the total ODS consumption in the sector is 3,330 MT of CFC-12 and 30 MT of CFC/HCFC-502. If we assume that each compressure installed at a refrigeration plant needs 0.5 kg of refrigerant to run the refrigeration cycle, the total amount of refrigerant phased out will be as follows

2,800 units x 0.5 kg/unit x 0.3 (ODP)	=	0.42 MT ODS/year
177,200 units x 0.5 kg/unit x 1.0 (ODP)	=	88.60 MT ODS/year
Total		**89.02 MT ODS/year**

1.4 Conversion strategy

The strategy applied considers to

- redesign the compressors from the use of the CFC-12 and CFC/HCFC-502 to the application of HFC-134a and R404A respectively.
- test new compressors with respect to the new refrigerants and their compatibility with synthetic polyolester-based oils
- development of a new assembly line for the manufacture of the new compressors which will be produced in parallel over a certain period.
- training of the production staff, and training of the service man in order to be able to repaire and maintain the new generation of compressors and refrigeration installations.

The substitution of the production of CFC-based compressors to the new generation will be implemented in the following manner. **See Exhibit 2.**

Exhibit 2. Strategy for the phase out of CFC-12 and CFC/HCFC-502 by HFC-134a and R404A resp.

Substitution of CFC-12 by HCFC-134a		Substitution of CFC/HCFC-502 by R404A	
year	per cent	year	per cent
1996	25	1996	50
1997	50	1997	75
1998	75	1998	100
1999	100	-	-

1.5 Used technologies

As already mentioned the following alternatives available to replace CFC-12 and CFC/HCFC-502 have been chosen:

1. CFC-12 by HFC-134a
2. CFC/HFCF-502 by R404A.

Both alternative refrigerants have to be imported. **Exhibit 5** explains some specific data regarding the substitutes. The zeotropic mixture R404A (FORANE FX 70) has been developed to replace CFC/HCFC-502 in new refrigeration installations. Both refrigerants replacing CFC's need the application of synthetic polyol-ester based oils. **Exhibit 4** explains some thermophysical data in comparing CFC/HCFC-502 and R404A.

Exhibit 4. Thermophysical data of both CFC/HCFC-502 and R404A (based on experimental results)

No	Description	CFC/HCFC-502	R404A
1	suction pressure [bar]	1.4	1.3
2	suction temperature [C]	0.2	-1.2
3	discharge pressure [bar]	15	16
4	discharge temperature [C]	91.2	81.5
5	condensing temperature [C]	32.5	34.1
6	evaporator temperature [C]	-39	-40
7	evaporator inlet temperature [C]	-21	-26
8	evaporator outlet temperature [C]	-19.7	-23
9	temperature before expansion valve [C]	25	23.7

Exhibit 4 demonstrates that thermophysical data are compatible between both refrigerants. Some compressor manufacturers like SICOM in Brazil have already converted their production and explain that results achieved with R404A are sufficient.

Exhibit 5. Comparison of alternative refrigerants

Refrigerant	Assessment	Consequences
R404A	• ODP = near zero GWP = 0.937 relative to CFC-11 • The COP may be a little bit higher for new designed equipment compared with CFC-12 depending on the conditions	R404A is a mixture of HFC125/HFC143a/ HFC134a and is considered to be a new or retrofit refrigerant to replace CFC/HCFC-502.
HFC-134a	• ODP = 0. GWP = 0.325 relative to CFC-11 • Lower Coefficient of Performance compared to CFC-12 expressed by a lower refrigeration capacity and higher consumption of energy.	Product design can largely stay the same. Increased service requirements. Specially high cleanliness necessary. Components affected by the refrigerant must be free of mineral oil. Special filter-dryer is needed. Thermostatic expansion valve suitable for HFC-134a should be used. Refrigerant is not flammable.
HCFC-22	• ODP = 0.055 GWP = 0.425 relative to CFC-11 The COP is in the same magnitute as CFC-12, but the system pressure is much higher. HCFC-22 is considered to be a transitional solution.	HCFC-22 is a transitional solution

1.6 Ownership and licences

As already mentioned ELGIN Maquinas S.A. is a private 100% Brazilian owned company.

1.7 Future developments

As already mentioned and outlined in Exhibit 1 the company works to enlarge the manufacturing capacities of refrigeration compressors to an output of 250,000 units by 1999 due the great demands. This growth in capacity will not be influenced by the change of the refrigerant and the appropriate investments.

2. Project objectives

Three main objectives for the project are outlined:

(I) Complete elimination of the use of CFC-12 and CFC/HCFC-502 as refrigerant.
88.6 MT of CFC-12 and 1.4 MT of CFC/HCFC-502 consumed in 1994 will be phased out annually.

(II) The same operational costs and the same high quality level must be guaranteed following the implementation of the project.

(III) A new service and maintenaice technology will be introduced by the project.

3. Project description

The following paragraph describes the solution of the project. In paragraph 1.5 alternative substances of refrigerants were already discussed.

Through the project assistance will be provided to enable to

- transfer know-how.
- redesigning and testing the refrigeration compressors in the laboratory and in the field.
- purchase of some special measuring equipment for laboratory tests
- designing and construction of a new assembly line for the production of the new compressors in parallel to the present assembly line in order to make possible a transient phase out of the CFC technology
- purchase new equipment, oil, gaskets, laminated steel and copper wire, and capacitors.
- On-the-job-training of the staff and of the service crews.

4. Inputs

4.1 Compressor redesign

Advantages of the use of HFC-134a are:

- The technology has already been tested. The steps and measures to be taken are known.

Disadvantages of the HFC-134a technology are

- A much thorough technology for the production of refrigeration compressors has to be applied in order to ensure dryness, cleanliness of the refrigeration cycle.
- Mineral oil charged into the compressor has to be replaced by synthetic polyol-ester based oil.

4.2 Equipment changes or modifications

The list of required activities and additional equipment is given in **Annex 1.**

- retrofitting and/or adaptation of present vacuum pumps
- installation of a new oil dehydrating and oil cleaning equipment
- installation of a new oil charging equipment
- installation of a special measuring and testing equipment to ensure the lubrication of all moving parts of the compressor
- installation of additional test equipment for compressors
- installation of a new assembly line including special filters (clean room)
- training of the staff working on the assembly line and of the service man working in the field.

4.3 Conversion of the compressors

The conversion process of the current compressors covers all activities to make sure that the converted compressors are on the same level of functionality, quality and reliability as the original. Several stages in this process have to be considered taking into consideration that two different compressor models, i.e. one for high pressure and one for low pressure application have to be manufactured:

- calculation
- prototype production
- functionality and performance testing with respect to the new refrigerant
- capacity measurements on different compressor models (high and low pressure models resp.)
- field tests for functionality, safety and reliability
- training on-the-job of the staff
- external problem solving consultancy

The individual steps and the expected time frame are outlined in the work plan given in **Annex 2**.

5. Project implementation

The project will be implemented by UNIDO and controlled by the Brasilian Ministry of Environment. UNIDO as the implementing agency has the appropriate experience and capabilities for the successful implementation of projects on the enterprise level. Upon the approval by the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, the project's fund will be transferred to UNIDO. A respective project allotment document will then be issued by UNIDO financial section. Any substantive alterations of the project will be subject to approval by the Brasilian Government and the ExCom of the Multilateral Fund.

Annex 2 shows a draft work plan, as already mentioned.

Despite the fact that the following company is considered to be a competitor it will provide specific information to the ELGIN Company with respect to the conversion process because.

SICOM (TECUMSEH)
R. Cel. J.A. de Oliveira Salles, 478
Sao Carlos
Brazil.

Due to the fact that ELGIN cooperates with

BRISTOL compressors
649 Industrial Park Road
Bristol, VA 24201
USA

this company will certainly transfer know-how with respect to the conversion process.

6. Project cost

The grant requested presents the incremental costs as additional cost that the factories incur in taking the action to phase out ODS, and such defined as the difference between the actual cost of the phase out activity and the baseline cost. The baseline cost is the cost that companies incur when staying at the same level of operation, without phasing out ODS.

Costs of conversion of the production facilities eligible for grant financing comprise the following elements:

a) Incremental investment cost (capital cost)
b) Incremental operating cost (recurrent cost)
c) Contingency.

Cost for transport and insurance of capital equipment is included in the budgeted allocations. In the prices the estimated labour cost for increased handling and quality control are included, taxes and duties are excluded. A discount rate of 10 per cent is used throughout the project.

6.1 Baseline cost

These cost are assumed to be zero. This request is based on the capacities analyzed during January 1993 and December 1994. No decommissioning of existing testing capacities is foreseen.

6.2 Incremental investment costs

Incremental investment cost will cover capital investment cost for the modification of the refrigeration compressors, for the modification of the testing facilities, for the modification of the production line, and servicing facilities, materials, training, and consultancy (see **Annex 1**).

6.3 Incremental operating costs

Recurrent incremental costs are partly dependent on the price difference between the material to be phased out, other new and/or additional components and inputs of the conversion. In this project document it is proposed to provide the recurrent costs to ELGIN Maquinas for a period of 6 months.

Exhibit 6 shows the incremental operating cost per unit resulting from the modifications:

Exhibit 6. 1 Incremental operating cost for the high pressure compressor resulting from the substitution of CFC-12 and CFC/HCFC-502 by HFC-134a and R404A

Modification	Type of incremental operating cost	Incremental cost/unit, US$
Polyol-ester oil	Synthetic oil has to be used instead of mineral oil 1)	3.65
Gaskets	Special gasket material has to be used 2)	0.10
Soldering additives	Soldering additives 3)	0.12
Copper wire	Additional copper wire is needed to compensate for the lower refrigeration capacity 4)	0.43
Laminated steel	Additional laminated steel is needed to compensate for the lower refrigeration capacity 5)	0.14
Total		4.44

1) The average charge of the oil is 690 g

	Price/unit CFC-12	Price/unit HFC-134a	Cost/unit, US$
Oil	1.36	5.01	3.65

2) New gasket material

	Price/unit CFC-12	Price/unit HFC-134a	Cost/unit, US$
Gasket Total	0.12	0.22	0.1

3) Soldering additives

	Price/unit CFC-12	Price/unit HFC-134a	Cost/unit, US$
Soldering additive, Total	0.01	0.132	0.122

4) Additional copper wire

	Price/unit CFC-12	Price/unit HFC-134a	Cost/unit, US$
Additional copper, Total	3.92	4.34	0.43

5) Additional laminated steel

	Price/unit CFC-12	Price/unit HFC-134a	Cost/unit, US$
Additional lamin. steel, Total	7.33	7.47	0.14

Exhibit 6. 2. Incremental operating cost for the low pressure compressor resulting from the substitution of CFC-12 and CFC/HCFC-502 by HFC-134a and R404A

Modification	Type of incremental operating cost	Incremental cost/unit, US$
Polyol-ester oil	Synthetic oil has to be used instead of mineral oil 1)	3.65
Gaskets	Special gasket material has to be used 2)	0.10
Soldering additives	Soldering additives 3)	0.12
Copper wire	Additional copper wire is needed to compensate for the lower refrigeration capacity 6)	1.92
Laminated steel	Additional laminated steel is needed to compensate for the lower refrigeration capacity 7)	1.00
Capacitor	A larger capacitor has to be installed 8)	0.43
Suction valve	Additional new suction valve is needed 9)	-0.02
Total		**7.20**

6) Additional copper

	Price/unit CFC-12	Price/unit HFC-134a	Cost/unit, US$
Additional copper, Total	3.26	5.18	1.92

7) Additional laminated steel

	Price/unit CFC-12	Price/unit HFC-134a	Cost/unit, US$
Additional lam. steel, Total	6.09	7.09	1.00

8) Larger capacitor

	Price/unit CFC-12	Price/unit HFC-134a	Cost/unit, US$
Larger capacitor, Total	0.61	1.04	0.43

9) New suction valve

	Price/unit CFC-12	Price/unit HFC-134a	Cost/unit, US$
New suction valve, Total	0.64	0.62	-0.02

The total per unit incremental operating costs are given in **Exhibit 7** above.

Exhibit 7. Incremental operating cost

	Dimension	High pressure compressors	Low pressure compressors
Number of compressors	-	126,000	54,000
Incremental operating cost per unit	US$/unit	4.44	7.20
Total incremental operating cost	US$	559,440	388,800
Total	US$		948,240
Amount to be provided by MPF	US$		**474,000**

6.4 Contingency

Ten per cent contingency fund is included in the total project budget. This fund is proposed to cover unforeseen expenses which might be incurred during project implementation, purchase of small testing instruments, miscellaneous expenses, etc.

6.5 Total cost of project

Total cost of the project is given in **Exhibit 8** below.

Exhibit 8. Total cost of the project

1	Incremental investment cost	US$	614,580
2	Incremental operating cost	US$	474,000
3	Subtotal	US$	1,088,580
4	Contingency (10 per cent)	US$	108,858
5	Agency overhead (13 per cent)	US$	155,667
	Total cost of the project	**US$**	**1,353,105**

6.6 Cost effectiveness

Refering to the table in Exhibit 8 the cost effectiveness is calculated as the ratio of trhe sum of the positions of No 3 and 4 divided by the amount of refrigerant phased out:

$$\textbf{Cost Effectiveness} = \frac{1{,}088{,}580 + 108{,}858}{89{,}000} = \frac{1{,}197{,}438}{89{,}000} = \textbf{13.45 US\$/kg CFC}$$

Annex 1

Investment cost

Item	Description of activity	Quantity	Unit cost, US$	Total, US$
1.11	International consultancy	1	25,000	25,000
1.12	Redesign of all models	-	39,100	39,100
1.13	Redesign of the production line	-	6,670	6,670
1.14	Technical supervisor	1	11,790	11,790
1.15	Laboratory tests at the refrigeration laboratory	-	22,450	22,450
1.16	Technical supervisor for refrigeration laboratory	-	33,780	33,780
1.17	Laboratory tests at the chemical laboratory	-	10,890	10,890
1.1	Sub-total			149,680
1.21	Carl Fisher Test (measuring the water content)	1	7,220	7,220
1.22	Brookfield Viscosimeter 3)	1	4,670	4,670
1.23	Kinematic Viscosimeter 3)	1	4,890	4,890
1.24	Atomic absorption spectrometer (second hand device) 4)	1	22,200	22,200
1.25	New calorimeter for HFC-134a 1)	1	222,220	222,220
1.26	Redesign of a calorimeter 2)	1	24,440	24,440
1.27	New vacuum pump for laboratory	1	8,780	8,780
1.28	Leak detector	1	6,230	6,230
1.2	Sub-total			300,650
1.31	Oil degasification and dehydration unit	1	106,670	106,670
1.32	Compressor testing unit	1	6,670	6,670
1.33	Electric testing unit	1	6,670	6,670
1.3	Sub-total			120,010
1.41	New assembly line including ventilation (clean room filter)	1	33,330	33,330
1.4	Sub-total			33,330
1.51	Printed teaching material	1	560	560
1.52	Leak detector	1	170	170

Item	Description of activity	Quantity	Unit cost, US$	Total, US$
1.53	**Manifold**	1	**170**	**170**
1.54	**Refrigeration machine for demonstration**	1	**1,670**	**1,670**
1.55	**Oil charging equipment**	1	**7,780**	**7,780**
1.56	**Acidity testing kits**	5	**560**	**560**
1.5	**Sub-total**			**10,910**
	GRAND TOTAL			**614,580**

1) , 2)
It has to be explained that due to the conversion process in the near future different compressors for the refrigerant

CFC-12, CFC/HCFC-502, HCFC-22 (old), low and high pressure
HFC-134a, R404a (new), low and high pressure

will be manufactured in parallel for a certain time. This requests additional calorimeters. One calorimeter will be redesigned. Another calorimeter has therfore to be bought.

3)
The two viscosimeters are needed to make testss with the new synthetic polyol-ester based oils needed to work with HFC-134a.

4)
The atomic absorption spectrometer - bought from second hand - will be needed to carry out wear test in connection with the new lubricating oil and new materials applied in connection with the new refrigerant. Absorption spectrometer allows to shorten the testing time needed to evaluate wear inside moving parts of the hermetic compressor unit.

Annex 2

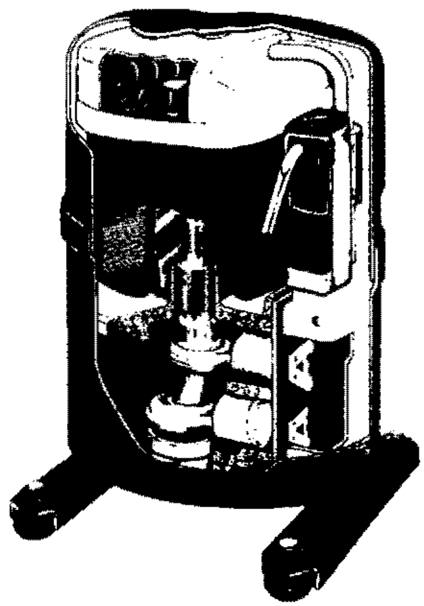
Work plan for the conversion of the refrigeration compressors from refrigerant CFC-12 to HFC-134a

and from CFC/HFC-502 to R404A

#	Activity	1995		1996		1997		1998		1999	
1	Preparation of detailed work plan	■									
2	Redesign of the first model	■									
3	Laboratory tests, test evaluation		■								
4	Pilot production of first model, field test		■	■	■						
5	Redesign of remaining models		■	■	■						
6	Selection of production equipment		■	■	■						
7	Pilot production of remaining models				■	■	■	■			
8	Field test of remaining models				■	■	■	■			
9	Mass production				■	■	■	■	■	■	■
10	Training of the staff, service man				■	■	■	■	■	■	■

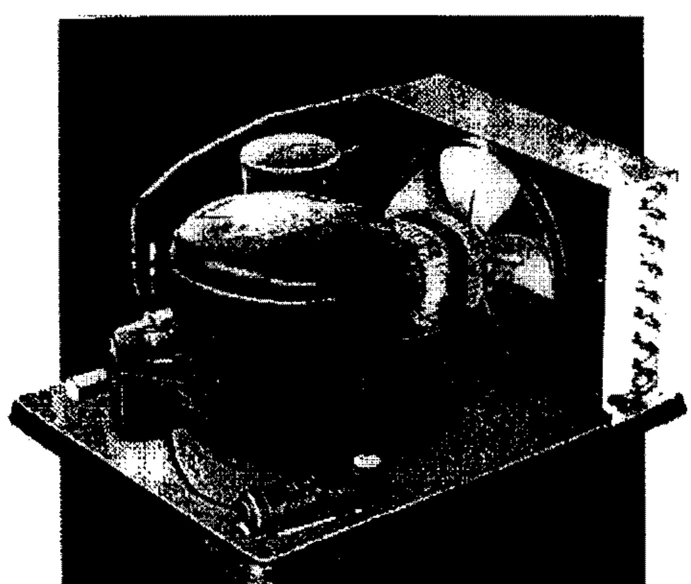
Annex 3

Cutaway view of a hermetic comporessor manufactured by ELGIN



Annex 4

View of a condensing unit equipped wth hermetic compressors manufactured by ELGIN



FKW

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KÄLTETECHNIK UND WÄRMEPUMPEN
GmbH

Technical Review
Project Proposal for Commercial Refrigeration
ELGIN Maquinas S.A.
in Mogi des Cruzes, Brazil

1. Country of Origin:

Brazil

2. Project Title:

Conversion of the Assembly of Refrigeration Compressors to Phase Out CFC-12 and R502 by Using HFC-134a and R404A

3. Sector:

Commercial Refrigeration

4. Relationship to Country Program:

a) The Country Program has not been seen

b) It is stated in the proposal that due to the public unawareness of the ozone depletion problem and the relatively low price of CFC-12 and R502, the conversion of the commercial refrigeration market in Brazil towards non ODS will take more time than predicted by the Country Program. ELGIN Maquinas plans a complete phase out of the production of compressors for the operation with ODS by the year 1999.

5. Technology

a) HFC-134a is the leading substitute to replace CFC-12 all over the world in most applications. The steps and measures to convert from CFC-12 to HFC-134a are known and the technology has become mature in all industrialized countries. The components necessary in HFC-134a refrigeration cycles have been developed and are available on the market.

The choice of HFC-134a as substitue for CFC-12 is reasonable for production at ELGIN Maquinas. It has been accepted as a good replacement for CFC-12 in all sectors of refrigeration technology and probably will become the leading substitute in Brazil, too. Adequate dryness and cleanliness in the production of the refrigeration compressors has to be ensured.

R404A is one of the leading, zero ozone depletion potential substitutes for R502. Due to its small temperature glide, this zeotropic mixture can be handled as a pure fluid. The conversion from R502 to R404A has started in industrialized countries and refrigeration components for the refrigerant R404A are available. It is stated that some competitors on the Brazilian market like SICOM also converted from R502 to R404A and thet results are sufficient.

Both refrigerants substituting CFCs need the application of synthetic polyol-ester based lubricants.

b) The refrigerants suggested as substitutes are not transitional because both HFC-134a and R404A have zero ozone depletion potential.

c) Qualified training of the production and service staff is essential in order to ensure a proper repairing and maintaining of the new compressors and refrigeration installations.

d) The technologies selected as replacement for CFC-12 and R502 are cost effective, available and non-transitional solutions.

6. Project Description:

a) The suggested changes and modifications in equipment appear to be necessary for the development of new compressors and the conversion of the production facilities.

b) The individual steps in the conversion process of the current compressors are realistic and necessary. The time frame as outlined in annex 2 seems to be very narrow regarding the pilot production and the mass production of the first compressor model.

7. Project Implementation:

The SICOM Company (Tecumseh) is cited as competitor on the Brazilian compressor market as well as possible know-how partner to ELGIN Maquinas. This contradiction should be cleared and some formal description of this relationship in terms of technology transfer should be included.

8. Project Costs:

a) The cost elements detailed in the budget appear to be necessary for the development in testing of new compressors in the conversion of the production lines.

Investment Costs

b) Considerable new laboratory equipment is required for redesigning and testing of all compressor models for use with HFC-134a and R404A. An existing calorimeter will be converted to HFC-134a. Further justification should be given for the necessity of new viscosimeters (Brookfield viscosimeter, kinematic viscosimeter) and the atomic absorption spectrometer. Also the need for a second calorimeter (1/3 of total investment costs!) should be explained further.

A production increase of 25 % by 1999 is planned in parallel to the conversion of the production lines and installing the new assembly line. It is made clear that the funds requested by this project are in no way associated with these expansion plans.

Incremental Operating Costs

c) The incremental operating costs as listed in exhibit 6 for the conversion from CFC-12 to HFC-134a seem appropriate. It is proposed to refund the incremental costs of 6 months.

d) The conversion of compressors from R502 to R404A has not been adressed, the costs might be different from converting from CFC-12 to HFC-134a.

Other Costs

e) A contingency fund of 10 % has been included to cover unforeseen expenses.

f) Consultancy costs and implementing agency overhead costs are reasonable.

Cost Effectiveness

The computed costs effectiveness for the overall project is 13.45 US$/kg ODS (including contingency fund of 10 %). This indicates a good level of cost effectiveness.

9. Recommendations

The project objective is the conversion of refrigeration compressors to phase out CFC-12 and R502 by using HFC-134a and R404A. Thiss includes the redesign of the compressors, the introduction of laboratory equipment, the installation of a new assembly line as well as the training of the service staff.

The Project Proposal contains a detailed work plan for this phase out. The time frame is feasible and the costs appear to be necessary for the conversion. This project should be approved after modifications as follows :

More detail should be given

- how the redesign and the field tests will be carried out
- about the tasks of the know-how partner and the international consultancy as well as the formal description of this relationships.
- about the programme for training of the staff and the service man.
- about the necessity of some laboratory equipment as already mentionesd in sector 8b)

10. Other Comments:

a) To 1.2 "Company background": The distribution between the low and high pressure compressors should be mentioned here, since this might be essential for calculating the incremental operating costs. O.k

b) To 1.5 "Used Technologies": In exhibit 4 no thermophysical data of R502 and R404A is given. The given data represents experimental results of a test rig and are therefore worthless as a comparison between refrigerants. For a comparison of these two refrigerants some thermodynamical data may be appropriate.

c) To exhibit 5: The GWP of HCFC-22 is 1,700 relative to CO_2 or 0.425 relative to CFC-11. The GWP of HFC-134a is 0.325 (relative to CFC-11), the GWP of R404A is 0.937 (relative to CFC-11). Therefore, the GWP of the two alternative refrigerants should not be stated as "near zero". O.k

d) To 5. "Project Implementation": The role of the Romanian Government in this project is not clear (type error?). O.k.

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Received: 31 MAY 1995
By: US
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INITIALS/DATE: [illegible] 31/5

MINISTÉRIO DO MEIO AMBIENTE, DOS RECURSOS HÍDRICOS E DA AMAZÔNIA LEGAL
Secretaria de Coordenação dos Assuntos do Meio Ambiente
Departamento de Cooperação Internacional
Fax nº (061) 322-8939
Esplanada dos Ministérios, Bl. "B" - 5º andar
Brasília/DF - Tel.: (061) 317-1281

DESTINATÁRIO: **KLAUS BILLAND**
Diretor da UNIDO no Brasil
Brasília, DF

Nº DE FAX: 225-9275 DATA: 31 / 05 / 95

Nº DE PÁGINAS: Esta + ______ Nº DO DOCUMENTO: 071

MENSAGEM

Faço referência ao Ofício nº 1108, de 10/05/95, endereçado ao Secretário de Coordenação dos Assuntos do Meio Ambiente - SMA/MMA, e à reunião de 30/05/95, realizada no MICT, para aprovação dos projetos a serem submetidos ao Fundo Multilateral do Protocolo de Montreal.

2. Nesse sentido, informo que os projetos abaixo listados foram aprovados e a UNIDO poderá apresentá-los para a XVII Reunião do Comitê Executivo do Fundo Multilateral, a ser realizada em Montreal, de 26 a 28/07/95:

- Investment Project for Phasing-out of ODS at FRISOKAR Equipamentos Plásticos Ltda;

- Conversion of the assembly of refrigeration compressors to phase-out CFC-12 and CFC/HCFC-502 by using HFC-134A and R-404A.

3. Quanto ao Projeto "Investment Project for Phasing-out of ODS at BICICLETAS CALOI S.A.", conforme acordado, foi aprovado, em princípio, e poderá ser reapresentado após sofrer as alterações previstas.

Atenciosamente,

GARRY SOARES DE LIMA
Diretor do Departamento de
Cooperação Internacional

fmw/es

Em caso de má transmissão, favor ligar para
In case of bad transmission, please call (061) 317-1281

Expedido em: ___/___/___ às ___:___ hs duração: ________ por: ________