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

Fifteenth Meeting
Montreal, 13-16 December 1994

PROJECT PROPOSALS: BRAZIL

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

Refrigeration

- Replacement of CFC-11/12 to cyclopentane/HFC-134a foaming agent/refrigerant factory conversion (Metalfrio S.A.)	IBRD
- Conversion to reduced CFC technology in the manufacture of Refrigerators at Refrigeracao Parana S.A., Unidade Sao Carlos	IBRD

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Brazil
PROJECT TITLE:	CFC-11/12 to cyclopentane/HFC-134a foaming agent/refrigerant factory conversion at METALFRIO S.A.
BUDGET:	US $2,526,780 Incremental Capital Costs
INCREMENTAL COSTS:	US $2,526,780
ODS PHASE-OUT:	160 MT of CFC-11, 45 MT of CFC-12, 0.8 MT CFC-502 and 5 MT TCE (206 MT/yr. total ODP eliminated)
COST EFFECTIVENESS:	US $12.27 per Kg. ODP saved
PROJECT DURATION:	1.5 years
IMPLEMENTING AGENCY:	World Bank
NATIONAL COORDINATING AGENCY :	Interministerial Ozone Technical Group
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. The project covers conversion of the freezer manufacturing plant METALFRIO S.A., Brazil. Implementation of the project will result in eliminating 160 MT of CFC-11, 45 MT of CFC-12, 0.8 MT of CFC-502 and 5 MT of TCE. This represents about 8 per cent of ODS consumption in the refrigeration sector in Brazil.

2. The project includes the redesign of all current freezer models and the conversion of the plant. The existing fabrication lines will be refitted and converted to permit production with cyclopentane as foam blowing agent, HFC-134a and HP-162 as refrigerants and with non-chlorinated chemicals as cleaning solvents. Cyclopentane, HFC-134a, HP-62 and chlorinated solvents are ultimate conversion solutions. The project will be implemented within 18 months.

3. Refrigeration model redesign and the technical aspects of the conversion, including safety measures associated with cyclopentane application (protection, gas detector system, exhausting and ventilation) will be implemented with assistance from the equipment and new foam formulation suppliers, including training of METALFRIO S.A. personnel. In addition, specialized engineering personnel will be hired to supervise project implementation management. The safety statement will be issued upon commissioning and total installation. These arrangements would ensure a proper technology transfer and safe operations.

4. Incremental operating costs are not requested under this project. These costs will be assessed and requested for reimbursement on a post-facto basis at a later stage.

5. The contingencies calculated at 15 per cent of costs of the project are at the highest level of the admissible range.

6. The cost-effectiveness of the project is adequate for this type of conversion.

SECRETARIAT'S RECOMMENDATION

7. The Secretariat recommends approval of the project and approval of capital costs of US $2,526,780.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Brazil
PROJECT TITLE:	Conversion to Reduced CFC Technology in the Manufacturing of Refrigerators
BUDGET:	US $306,053 (Capital Costs)
INCREMENTAL COSTS:	US $286,007[1]
ODS PHASE-OUT:	95.5 MT of CFC-11
COST EFFECTIVENESS:	US $2.99 per Kg. ODP saved
PROJECT DURATION:	2 years
IMPLEMENTING AGENCY:	World Bank
NATIONAL COORDINATING AGENCY :	Interministerial Ozone Technical Group
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. This project covers the transition to 50 per cent ODS reduced insulation foam. Fifty per cent reduced technology is an interim solution. The company is planning to switch over to HCFC-141b in the near future. The assurance has been transmitted to the Secretariat, however, that the company will not request any funds in switching over to HCFC-141b technology. The letter is attached to this evaluation sheet for reference.

2. HCFC-141b and cyclopentane technology are readily available on the market and are being implemented by many Article 5 countries. The Secretariat seeks guidance from the Executive Committee regarding funding of 50 per cent ODS-reduced foam projects in the future.

3. Capital costs requested under the project proposal are associated with replacement and conversion of existing equipment and testing. Several cost items are completely or partially not eligible for funding. These issues have been discussed with the World Bank. A full agreement has been reached regarding the revision of these cost items.

4. The project is cost-effective.

SECRETARIAT'S RECOMMENDATIONS

5. The Fund Secretariat recommends approval of the project, as revised, in the amount of US $162,603.

1. Adjusted to reflect local ownership of 93.45 per cent.

Facsimile Transmital Cover Sheet

To: Mr. Paulo Fetal
Company: FINEP - Financiadora de Estudos e Projetos
Phone: 021 276-0768
Fax: 021 276-0581

From: Elzio T. Barreto / CFC Project Coordinator
Company: Refripar - Unidade São Carlos
Phone: 0162 71-9000 / 0162 72-7241
Fax: 0162 72-6590

Date: 18/11/94
Total Number Pages,
Including Cover Sheet: 01
Copy For: Mr Valery Smirnov: Fax Num. 514 282-0068
Mrs. Laura Tlalye: Fax Num. 202 676-0377

Ref.: Project 1134/93

As we talked about and as we declared on section 5.3, it is perfectly possible after 2 years of usage, from the processing with 50% of CFC 11 reduction to the processing with some minor modifications in the installations.

In other words, we will not need any additional financial resources to process with HCFC 141b.

Best regards,

Elzio Trindade Barreto

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	Brazil
PROJECT TITLE:	CFC-11/12 to cyclopentane/HFC-134a foaming agent/refrigerant factory conversion
BUDGET:	US $2,526,780 Incremental Capital Costs
INCREMENTAL COSTS:	US $2,526,780
ODS PHASE-OUT:	160 MT of CFC-11, 45 MT of CFC-12, 0.8 MT CFC-502 and 5 MT TCE (206 MT/yr. total ODP eliminated)
COST EFFECTIVENESS:	US $12.27 per Kg. ODP saved
PROJECT DURATION:	1.5 years
IMPLEMENTING AGENCY:	World Bank
NATIONAL COORDINATING AGENCY :	Interministerial Ozone Technical Group
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. The project covers conversion of the freezer manufacturing plant METALFRIO S.A., Brazil. Implementation of the project will result in eliminating 160 MT of CFC-11, 45 MT of CFC-12, 0.8 MT of CFC-502 and 5 MT of TCE. This represents about 8 per cent of ODS consumption in the refrigeration sector in Brazil.

2. The project includes the redesign of all current freezer models and the conversion of the plant. The existing fabrication lines will be refitted and converted to permit production with cyclopentane as foam blowing agent, HFC-134a and HP-162 as refrigerants and with non-chlorinated chemicals as cleaning solvents. Cyclopentane, HFC-134a, HP-62 and chlorinated solvents are ultimate conversion solutions. The project will be implemented within 18 months.

3. Refrigeration model redesign and the technical aspects of the conversion, including safety measures associated with cyclopentane application (protection, gas detector system, exhausting and ventilation) will be implemented with assistance from the equipment and new foam formulation suppliers, including training of METALFRIO S.A. personnel. In addition, specialized engineering personnel will be hired to supervise project implementation management. The safety statement will be issued upon commissioning and total installation. These arrangements would ensure a proper technology transfer and safe operations.

4. Incremental operating costs are not requested under this project. These costs will be assessed and requested for reimbursement on a post-facto basis at a later stage.

5. The contingencies calculated at 15 per cent of costs of the project are at the highest level of the admissible range.

6. The cost-effectiveness of the project is adequate for this type of conversion.

SECRETARIAT'S RECOMMENDATION

7. The Secretariat recommends approval of the project and approval of capital costs of US $2,526,780.

THE MONTREAL PROTOCOL
ON SUBSTANCES THAT DEPLETE THE OZONE LAYER

PROJECT COVER SHEET

COUNTRY:	Brazil
PROJECT NAME:	CFC-11/12 to cyclopentane/HFC-134a foaming agent/refrigerant factory conversion.
SECTORS COVERED:	Commercial horizontal and vertical freezers
ODS CONSUMPTION IN AFFECTED SECTORS:	Estimated for 1993 2,500 MT of CFC-11 and CFC-12
PROJECT IMPACT:	Phase out of annual consumption of 160 MT of CFC-11, 45 MT of CFC-12, 0.8 MT of CFC-502 and 5 MT of Trichloroethane (206 MT/yr total ODP eliminated).
PROJECT DURATION:	1.5 years
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	<u>Total capital cost:</u> US$ 4,170,000 (includes estimated US$ 1 million import taxes which may be exempted). <u>Incremental capital cost:</u> US$ 2,526,780 <u>Incremental operating costs:</u> To be determined after each of first four years of operation.
PROPOSED ODS GRANT:	<u>Incremental capital cost:</u> US$ 2,526,780 <u>Incremental operating costs:</u> As incurred (Estimated range: US$ 0-1 million annually)
UNIT ABATEMENT COST:	Annualized capital cost: US$ 2.06/kg ODP Annual incremental cost (non-discounted) Up to US$ 4.86/kg ODP.
IMPLEMENTING AGENCY:	The World Bank/Financiadora de Estudos e Projetos (FINEP)
COORDINATING NAT. AGENCIES:	Interministerial Ozone Technical Group GTO)
BENEFICIARY ENTERPRISE:	METALFRIO S.A.

PROJECT SUMMARY

Please Refer to attached Executive Project Summary

PROJECT SUMMARY

1. The project consists of the refitting of Metalfrio's existing horizontal and vertical freezers fabrication lines which currently use CFC-11/-12 technology for foaming agent and refrigeration respectively, to permit production with cyclopentane foaming agent and HFC-134a refrigerant. Due to the flammability of cyclopentane, the foaming area will require explosion proof design standards, and supervisory and worker training must incorporate safe operating practices in hazardous environments. Project implementation will result in the definitive phase-out of 100% of CFC-11, CFC-12, HCFC-502 and chloride cleaning solvents used in the production of commercial and domestic freezers and coolers at METALFRIO S.A. The total estimated project capital cost is US$ 4.17 million of which incremental capital costs are US$ 2.61 million. Metalfrio S.A.'s 1994 production level will be an estimated 150,000 units. Unit costs of production are expected to be higher after conversion. Nevertheless, due to the uncertainty involved in ante facto quantification, reimbursement of incremental operating costs will be on a post facto basis. They will be reimbursed to the extent that Metalfrio can demonstrate transparently that: i) unit production costs were higher than before the conversion; ii) the additional costs were not passed on through adjusted selling prices; and iii) as a result of ii), profits for this portion of production were reduced over the base year before conversion. The reduction in profits is what will be eligible for compensation.

2. The project will be implemented over an 18 month period, including model redesign and field prototype testing. Annex 1 contains the project implementation program, capital cost estimate and outline equipment specifications. Annex 2 is the report of the refrigeration technical consultant. Annex 3 is the report of the technical consultant who reviewed the project's safety aspects. Annexes 4 and 5 are the reports of the OORG reviewers for foams and refrigeration, respectively, both of whom approved the project. Annex 6 is the letter of FINEP, formerly requesting consideration of the project by the MFEC. These are no MP policy issues related to this project as the proposed technologies have already been approved as definitive zero ODP solutions; and none of Metalfrio's production is exported to non-Article 5 nations.

PROJECT OBJECTIVE

3. The objective of this project is to eliminate the use of 205 tons annually of ozone depleting substances (ODS) including CFC-11, CFC-12, CFC-502 and trichloroethane in the production of commercial and domestic freezers manufactured by METALFRIO.

SECTOR BACKGROUND

4. The subsector for commercial and domestic refrigerators and freezers in Brazil consists of 6 large producers who control most of the market and a number of smaller ones. The total installed production capacity for refrigerators and freezers is more than 4,000,000 units per year, but production capacity utilization is currently 66%.

5. Brazil's production of CFC-11 and CFC-12 was estimated to be 8000 MT in 1987 and 9300 MT in 1989. The total consumption of CFCs in the production of polyurethane foam was about 3.400 MT in 1989 but not all has been used for this sector. In 1993, the estimated total consumption of ODS in the refrigeration sector, based up on a sale of approximately 2,750,000 refrigerators and freezers was about 2500 MT. Based on an estimated average useful life of 15 years, the existing total stock of refrigerators and freezers in use in Brazil is estimated at 28 million. Approximately 2-5% are re-charged annually during servicing. Due in part to lack of equipment for the services sector, service staff very often use CFC-12 for washing/flushing cooling systems, instead of using vacuum pumps and charging boards, thereby increasing ODS consumption during servicing to twice the unit's refrigerant circuit capacity. Estimated annual CFC-12 consumption for servicing is 400-800 MT, although it is possible that it may be even higher.

ENTERPRISE BACKGROUND

6. METALFRIO S/A - INDÚSTRIA E COMÉRCIO DE REFRIGERAÇÃO has been operating over the last 27 years in the manufacture and sale of commercial and domestic refrigeration products for the Brazilian and South American markets. It is owned by the Continental 2001 Group, a 100% Brazilian owned firm. The company employs 580 staff and the installed annual capacity is about 200,000 units per one and one half shifts daily. Production in 1993 was 131,469 units. Estimated production for 1994 is 150,000 units.

7. METALFRIO is a leader in the Brazilian commercial chest freezer/cooler market segment. It commands approximately 33% of that market and, in 1993, it exported 30,000 units to Argentina, Paraguay, Mexico and other South American countries. It does not export to any non Article 5 countries. The company has its own research and development department, and the designs and technology applications used in its current product line have been developed in house. Metalfrio also has its own performance test laboratory, part of which will be refitted within the project scope, to permit the testing of the HFC-134a/cyclopentane freezer designs. Metalfrio has a sound financial structure, and is debt free, although along with the rest of the refrigerator industry, it operated at slightly below break even in 1991-93 due to the economic crisis. It is expecting a profitable 1994.

PROJECT DESCRIPTION

8. The projects consists of the refitting of the existing fabrication lines, which use CFC-11/-12 technology for foaming agent and refrigeration respectively, to permit production with cyclopentane foaming agent and HFC-134a refrigerant. Due to the flammability of cyclopentane, the foaming area will require explosion proof design standards, and supervisory and worker training must incorporate safe operating practices in hazardous environments. Project implementation will result in the definitive phase-out of 100% of CFC-11, CFC-12, HCFC-502 and chloride cleaning solvents used in the production of commercial and domestic freezers and coolers at METALFRIO S.A. The chosen replacement alternatives are cyclopentane as foam blowing agent, HFC-134a and HP-62 (R404a) as refrigerants, and non chloride based cleaning solvents.

9. The project scope includes: i) procurement of new machinery and equipment; ii) rebuilding of presently used equipment, such as vacuum pumps and foaming jigs and plugs; iii) assembly line rearrangement and some related civil works; iv) redesign of freezers and coolers; and v) installation, commissioning, on-the-job training, trial operation and start-up of foam injection systems. For use in non ODS refrigeration circuits, METALFRIO will purchase Brazilian produced EMBRACO and SICOM HFC-134a and HP-62 compressors, which have been commercially available for export markets since late 1992. The cyclopentane storage tank and transfer system is included within the project. A dependable supply of imported foam grade cyclopentane has been promised by three potential suppliers, Bayer and ATOCHEM and ICI. The polyol storage and mixing tanks, which will be furnished by raw material suppliers, are outside the scope of the project. Recovery and recycling units for CFC-12, as well as equipment which will be used for servicing HFC-134a refrigeration systems will have to be provided for Metalfrio's refrigeration service centers, but these are also not included within the scope of this project.

10. The thermodynamic properties of HFC-134a differ sufficiently from those of CFC-12 to require critical design modifications of the components of the refrigeration system. Redesign of the existing freezer and cooler models will require prototyping, performance testing, trial manufacturing and adaptation, as well as reliability tests. Lab and field testing of 30 prototype units produced in Germany under factory conditions will be conducted to define design parameters and production costs for full conversion of the factory output to HFC-134a refrigerant, and cyclopentane blown foam. The conversion of the production facilities for HFC-134a refrigerant systems, requires more precise assembly, cleaning and testing operations than for CFC-12, including modification of vacuum pumps, a new charging system and more sensitive leak detection systems, including a helium leak detector.

11. Introduction of flammable cyclopentane as a blowing agent requires not only new foaming equipment, gas detection and controls designed for use under explosion proof conditions, but also modification of the foaming molds that encase the cabinets during the foaming operation. Modified product design and testing must also take into account the need to assure material compatibility with the new foam, and to compensate for the new foam's somewhat poorer thermal insulating value. For conversion of the foam injection operation from CFC-11 to cyclopentane, Metalfrio will select equipment and technology from either Hennecke (Germany) or Cannon (Italy), the suppliers of virtually all cyclopentane foam injection systems now being used in commercial production in Europe, (see Annex 3, Appendices II and III). Both potential suppliers have indicated that as part of the procurement package, factory personnel will be provided to supervise erection, and carry out safety training and technology transfer. Both have also agreed to provide designs and specifications for gas detection and ventilation systems required for safe system operation, but which are not included as part of the injection system procurement package. Specific recommendations to be incorporated into project design to allow for the different properties of HFC-134a and cyclopentane are discussed in Annex 2, Review of Project Concept and Basis of Design. Annex 3, Safety Review and Assessment, details the safety precautions which must be incorporated into

project design, installation and operation, based upon recommendations of both prospective vendors.

12. Outline equipment specifications for the refrigeration and foaming operations, and ancillary works are given in Annex 1, Part C, Outline of Equipment Specifications.

PROJECT IMPLEMENTATION

13. Project implementation, including product line redesign and testing, rearrangement of assembly lines, installation of equipment for foam injection and refrigerant circuit installation; and technology transfer; will take place over a period of 18 months. The project implementation schedule is included in Annex 1, Part A, Project Implementation Program. To supervise project implementation, Metalfrio will contract an experienced mechanical installation project manager, and three technical foremen. This team, working under the guidance of Metalfrio's plant engineering staff, will be directly responsible for installation, including supervision of sub contractors. The successful foam injection system vendor will supply factory technicians for installation; commissioning, start up and operator and safety training of Metalfrio personnel. The refitting of the foam injection systems, and related modifications will take place during the first 11 months. The conversion of the foaming operation will include a transition period when a reduced CFC-11/water mix will be used to approximate the thermal characteristics of cyclopentane blown foam. Full conversion to cyclopentane blown foam will take place after month 16. Prototype testing and redesign of models for HFC-134a will take place during the first twelve months, concurrently with the mechanical installation of foam injection and HFC-134a charging and test equipment.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

14. HFC-134a has been accepted worldwide as the principal replacement for CFC-12 refrigerant in domestic refrigerators. Its thermodynamic properties are similar to CFC-12, it is non-flammable, non-toxic, and has a zero ODP. Two of the worlds major suppliers of refrigerator compressors, EMBRACO and SICOM, who have been among the first to commercialize HFC-134a compressor technology, are located in Brazil, and are working closely with METALFRIO on refrigerant circuit design for HFC-134 and HP-62 gases.

15. Development of a replacement for CFC-11 as a blowing agent for rigid polyurethane refrigerator insulation has been more problematic. Among the replacements which have been tried are HCFC-141b, HCFC-142b and HCFC-142b/HCFC-22. All have ODPs between 0.06 and 0.1, and are therefore considered transitory substitutes. On the other hand, all are non flammable. HFC-134a is zero ODP but is currently too expensive for use as a foaming agent, and has an elevated GWP for this purpose. It is unlikely that it will become the ultimate blowing agent for polyurethane foam. The K value for CO2 blown foam is unacceptable from an energy consumption standpoint. In the US, HFC-141b is emerging as a CFC-11 substitute, even though it is transitional. It has the added disadvantage of also requiring more costly plastic liners

when used in domestic refrigerators. Cyclopentane has an ozone depleting potential (ODP) of zero and has been approved by the MFEC as a definitive zero ODP solution for foaming rigid polyurethane. Currently all major European manufacturers are carrying out tests, or have already started using cyclopentane blown foam in commercial production.

16. Metalfrio S.A. has opted for the HFC-134a/cyclopentane solution as it is definitive. The technology is ready to be incorporated immediately for its product line, which does not require liners; it is eligible for MFEC funding; and most importantly, Metalfrio S.A. has the in house technical capacity to develop the modified product designs and production technology required for conversion to these substances.

PROJECT TOTAL CAPITAL AND INCREMENTAL COSTS

17. The total estimated project capital cost is US$ 4.17 million of which incremental capital costs are US$ 2.61 million. All costs specific to supply and installation of the new technology, and which would otherwise not be incurred if the existing fabrication line could continue to be used, are considered incremental capital costs. The existing fabrication line, while old, would not require replacement for some time, but, at the same time, its components have little resale value. As demonstrated by their plan to rebuild vacuum pumps and moulds, Metalfrio is converting usable existing equipment wherever possible in the most cost effective manner. Project costs which are not incremental, include layout rearrangement (US$ 200,000), new moulds for foaming doors (US$ 200,000), compressor cooler (US$ 15,000), automatic transport of foam head (US$ 45,000), additional training at supplier's plants (US$ 100,000) and import duties and other Brazilian taxes (estimated US$ 1 million). A breakdown of incremental capital costs included in the OTF grant request is given in Annex 1, Part B, Revised Project Cost Estimate.

INCREMENTAL OPERATING COSTS

18. Units produced after conversion will have more expensive compressors ($5-10). HFC-134a is likely to be more expensive than CFC-12, but cyclopentane less expensive than CFC-11. Net unit production costs are therefore likely to be higher, but not accurately quantifiable at this time. Reimbursement of incremental operating costs consequently, will be on a post facto basis. They will be reimbursed to the extent that Metalfrio can demonstrate transparently that: i) unit production costs were higher than before the conversion; ii) the additional costs were not passed on through adjusted selling prices; and iii) as a result of ii), profits for this portion of production were reduced over the base year before conversion. The reduction in profits is what will be eligible for compensation.

19. The Unit Abatement Cost Calculation is shown in Annex 1, Part D. The annualized capital cost is US$ 2.06/kg ODP. The annual incremental cost (non-discounted), based on an estimations made during project preparation may range anywhere from zero up to an estimated of US$ 4.86/kg ODP. The true figures, will however, only be able to be calculated post facto.

PROPOSED OTF GRANT

20. The proposed OTF grant request of US$ 2,610,000 is based on 100% Brazilian ownership of Metalfrio, and covers the incremental capital costs,including a 15% contingency. FINEP's fee of 2.5% of actual disbursements will be additional.

TECHNICAL REVIEW

21. Subsequent to the preliminary OORG Review in February 1994, a Technical Review Mission consisting of a Refrigeration System Design and Production Technology Consultant, and a Consultant in Safety Design for flammable environments was carried out. The purpose of the review was verify the conceptual soundness, safety design and reasonableness of cost estimate for the project and to address information gaps noted in the Preliminary OORG Review. The consultants reports are included in Annexes 2 and 3.

22. Annex 2, is the report of the refrigerant consultant who reviewed the project concept and basis of design. His conclusions are that: i) the proposed design and prototype development program proposed by Metalfrio is acceptable; and ii) Metalfrio's in house technical expertise, and access to compressor suppliers is such that there is no need for any additional technology partner for implementation of the project. Annex 3, "Safety Review and Assessment" is the report of the technical consultant who reviewed the safety aspects of the cyclopentane injection, design and operation. The consultant concludes that based upon the experience of the prospective vendors with this technology, and taking into account the design standards, and training and operational safety programs anticipated, the project should be able to be designed, constructed and operated on an acceptably safe manner.

OORG REVIEW

23. Annexes 4 and 5 are the reports of the OORG reviewers for foams nd refrigeration respectively, giving their approval of the project. The foam project reviewer concurs with the safety consultants findings concerning safe design and vendor participation, and recommends that regular audits of adherence to procedure be added to the safety review. Both potential vendors, and Metalfrio S.A. itself, will have as a matter of standard practice incorporated such audits into their standard operating procedure. The refrigeration project OORG reviewer concurs with the refrigeration consultants' conclusion that as a result of Metalfrio's in house technical capacity, and its close collaboration with SICOM and EMBRACO, no additional technology partner licensing agreements will be required.

METALFRIO S.A.

CFC-11/12 TO CYCLOPENTANE/HFC-134a

FACTORY CONVERSION PROJECT

ANNEX 1

PART A: PROJECT IMPLEMENTATION PROGRAM

PART B: REVISED PROJECT COST ESTIMATE

PART C: OUTLINE EQUIPMENT SPECIFICATIONS

PART D: UNIT ABATEMENT COST CALCULATION

PART A: PROJECT IMPLEMENTATION PROGRAM

GENERAL	MONTHS 1 2 3 4 5 6 7 8 9 10 11 12 14 16 18
1. Make detailed specs for main equipment	XX
2. Sign the project	X
3. Contract project MGR	X

REFIGERANT HFC 134a	MONTHS 1 2 3 4 5 6 7 8 9 10 11 12 14 16 18
4. Redesign of 5 basic models	XX
5. Field test prototypes	XXXXXXXXXXX
6. Redesign of other models	XXXXXXXXXXXXXXXXXXXXXXXX
7. Selection/purchase of imported equip.	XX
8. Local equip./inst. design/sub contracts	XXXXXXXX
9. Try-out and training	XX
10. Installation and start up	XX
11. Start production with HFC 134a and 50% red CFC 11 foam partly with CFC 12	XXXXX
12. Production with HFC 134a and cyclopentane foam partly with CFC 12	XXXXXXXXXXXXXXXXXXXX
13. 100% production with HFC 134a	XXX

CYCLOPENTANE FOAM	MONTHS 1 2 3 4 5 6 7 8 9 10 11 12 14 16 18
14. Selection/purchase of equipment	XXX
15. Safety project development	XX
16. Local equip./inst. design/sub contract	XXXXXXXXXXXXXXX
17. Try-out and training	XX
18. Installation and commisioning	XX
19. Try-out	XX
20. Start production with cyclopentane	XXXXXXXXXXXXXX

NOTES:

a. Aquisition of equipments necessary for performance tests for HFC 134a will be provided before project approval.

b. All HFC 134a prototypes will be built according to final design:
  - Evaporator coil wrapped around the inner liner
  - 70 mm thick foam insulation at botton of cabinets
  - 50% reduced CFC 11 polyurethane foam

c. Cabinets will be foamed with cyclopentane at Bayer-Germany for training and test confirmation of HFC 134a refr. system.

d. As soon as the foam equipment supplier recives the order a safety engineer will be sent to Metalfrio for the safety project development.

e. Metalfrio's staff will be trained extensivelly by Bayer and the equipment manufacturers specialists.

f. A continuos training safety program will be implemented at Metalfrio and conducted by Metalfrio personnel.

g. A CFC recovery program will be implemented in the Metalfrio's 400 authorised service shops.

h. A qualified Metalfrio safety engineer will be prepared to supervise the safety requirements of the operation and conduct a continuos training safety program of Metalfrio personnel.

PART B: METALFRIO - REVISED PROJECT COST ESTIMATE (10/19/94)

Annex A: Equipment Specification and Cost Breakdown

	Description	Qty.	Unit cost US$	Total cost US$
	A. Refrigeration System:			
1	- Charging board for HFC134a	2	39,000	78,000.-
2	- Charging board for HP 62	1	39,000	39,000.-
3	- Vacuum pump (renovation)	40	420	16,800.-
4	- Vacuum control	40	1,000	40,000.-
5	- Leak detector	5	12,100	60,500.-
6	- Helium Leak Detectors	3	25,000	75,000.-
7	- Helium Recovery Unit	1	70,000	70,000.-
8	- Test equipment + prototype	1	60,000	60,000.-
9	- Tests Kits	6	5,000	30,000.-
		SUB-TOTAL A		469,300.-
	B. Foam System			
10	- High pressure foaming mach with two heads	2	160,000	320,000.-
11	- High pressure foaming machs	1	50,000	50,000.-
12	- Pipe installation for 3 mc.	3	15,000	45,000.-
13	- Mixing station	2	80,000	160,000.-
14	- Tank (cyclopentane)	1	37,000	37,000.-
15	- Pipe installation from tank	1	24,000	24,000.-
16	- Pumps, pipework for tank	1	60,000	60,000.-
17	- Cyclopentane tank pit/piping			20,000.-
18	- Rebuilding of foam jigs	19	3,000	57,000.-
29	- Rebuilding of foam plug	16	1,000	16,000.-
20	- New foaming Jigs/plugs			118,000.-
21	- House for foaming jigs	21	1,000	21,000.-
22	- Water heater	8	4,800	38,400.-
23	- Antistatic floor			3,000.-
24	- Steel structure/foaming area			60,000.-
25	- Pre-heating ovens	6	20,000	120,000.-
26	- Foam test equipament	1	13,000	13,000.-
27	- Conductivity tester (Rapid K)	1	20,000	20,000.-
28	- Exhausting and ventilation for lab			20,000.-
29	- Gas detector System	1	61,500	61,500.-
30	- Gas detector control board	1	44,000	44,000.-
31	- Exhausting and ventilation	1	90,000	90,000.-
32	- Fire protection system	1	45,000	45,000.-
		SUB-TOTAL B		1,442,900.-

C. Equipment Rearrangement 140,000.-

All moulds (jigs) of the current six foaming stations will be moved to one central foaming area and this will require following main investments: service lift to transfer cabinets from the basement to the foaming area, rearrangement of the equipaments and eletrical, air and water installations in the main floor and basement.

D. Project Management 120,000.-

For the implemention of the project METALFRIO will use the technical people from the equipament's suppliers for installation, commissioning of total installation to issue the safety statement, try-out and training of METALFRIO personnel. In addition METALFRIO will require engineering people specialized in project implementation management:

1 Project manager/one year contract	60,000.-
3 Technical personnel/one year (contract 20,000/tech)	60,000.-

E. Training (Travel and logding expenses) 25,000.-

TOTAL	2,197,200.-
Miscelaneos (15% contingency find)	329,580.-
Total Capital Cost	2,526,780.-

* The following equipment and installation work investments are not included in the budget:

a. Layout rearrangement (not eligible). US$ 200,000.-
b. Tank and installation for pipe lines for HFC134a to the charging boards.
c. Tanks for the polyurethane foam main materials
d. Import duties and other taxes not included in the price of the machinery or possibly to be exempted by the Brasilian government. US$ 1,000,000.-
e. New moulds for foaming doors US$ 200,000.-
f. Compressor cooler (chiller) US$ 15,000.-
g. Automatic Transport of foam head US$ 45,000.-
h. Training to be financed by Metalfrio US$ 100,000.-

PART C: OUTLINE EQUIPMENT SPECIFICATIONS

Specifications for Machinery

A - Refrigeration System:

1 - Charging board for HFC 134a for production.
Fully automatic charging board with leak check
8 storable charging amounts
Voltage: 115-127V/60HZ
Refrigerant: HFC134a
Charges: Min 50g - Max 700g +/- 1% or 1g
Single piston
One sided evacuation at 8 M^3/H
Process valve: 2Ltr per minute

2 - Charging board for HP62 for production
Fully automatic charging board with leak check
4 storable charging amounts
Voltage 115-127V/60HZ
Refrigerant: HP 62
Charges: Min 50g Max 1200g +/- 1% or 2g
Single piston
One sided evacuation at 12 M^3/H
Process valve: Hansen quick connector 2HK for 6mm tube
Liquifier: 2 ltr per minute

3 - Vacuum pump for renovation
Min capacity 8 M^3/H
Time for evacuation to vacuum level for the appliances
Max 20 minutes
Maximum limit of non-condensable gases 1% (vol) after evacuation

4 - Vacuum control for vacuum pump for production
Thermal conductivity vacuum gauge with one threshold
Switching point
Measuring range: 10^{-3} to 1000m bar
Sensing volume: $10cm^3$
Adjustable control set-point with LED display
Inaccuracy: +/- 1 scale division

5 - Leak detector for production for HFC 134a
Voltage: 115-127V/60HZ
Sensitivity range: 0.5 to 150g/year.
Microprocessor controlled.
Calibration gas: HFC 134a
Calibration: Automatic by the incorporated leak standard
Troubleshooting: Automatic

6 - Helium Leak Detector
Voltage: 220V/60HZ
Sensitivity range: 0.1g/year.
Microprocessor controlled.
Calibration gas: Helium
Calibration: Automatic
Troubleshooting: Automatic

7 - Helium Recovery Unit
Voltage: 220V/60HZ
Capacity: 3 NM^3/H
Reclaim efficiency: 98 %

8 - Test equipment for Performance Test for HFC 134a
- a. Charging board for laboratory
- b. Leak detector as specified
- c. Pressure transducers for HFC 134a for suction and discharge pressure range +/- 0.005 bar
- d. Materials for prototypes

9 - Test Kits
Portable microprocessor compatible with ASCII System for saving the following data in HFC 134a prototype field tests: Voltage, Current, Power and Temperatures.

B - Foam System

10 - High pressure foaming machine for cyclopentane for cabinets
Voltage: 3 x 220V/60HZ
Output capacity: 16 to 100 litres/minute
Raw material tanks: Polyol 250 Ltr and Isocyanate 250 ltr Insulated tanks
Stirrer: ISO: Electrical, Poly: Magnetic Ex-proof
Level control: Automatic
Air drier
PLC control
PC - flow quality control
Tempering: automatic
Ex-proof: Polyol part of machine Class Ia (NBR 9518-Grupo II)
Polyol hoses: Double hoses without assembly connectors
Foaming head; 2 pcs with recirculation with heat exchanger
Reservoir by leak: For polyol tank min 250 ltr for leaking of polyol tank

11 - High pressure Foaming Machine for cyclopentane for lids and doors
Voltage: 3 x 220V/60HZ
Output: 6 to 40 Litres/min
Raw material tanks: Polyol: 250 Ltrs, Isocyanate: 250 Ltr
Insulated
Stirrer: ISO: Electrical, POLY: Magnetic Ex-proof
Level control: Automatic
Air driver
PLC Control
PC-flow quality control
Tempering: automatic
Ex-proof: Polyol part of machine Class Ia (NBR 9518-Grupo II)
Polyol hoses: Double hoses without assembly line connectors
Foaming head: Single with recirculation with heat exchanger
Reservoir by leak: For polyol tank min 250 ltr for leaking of polyol tank

12 - Pipe installation from mixers to foaming machines double wall tubes or hoses without any assembly, with leak control for polyol.
Built in of SD valves for separation into sectors on the polyol line.

13 - Mixing station for Polyol and Cyclopentane
Voltage: 3 x 220V/60HZ
Ex-proof: Class Ia (NBR 9518-Grupo II)
Capacity: 16 ltr/min
Tank: 250 litres
Stirrer: magnetic
Build in chamber with inspection glass
Exhausting/ventilation to be connected

14 - Tank for cyclopentane
20 m^3 steel carbon
Pressure: 7 bar
Insulation of tank
Valves and fittings for connection
Connection for nitrogen pre-pressure

15 - Pipe installation from tank for cyclopentane
Double wall tubes from tank to mixing stations w/leak control
Built in of SD valves for separation into sectors

16 - Pumps and Pipe work for cyclopentane tank
Voltage: 3 x 220V/60HZ
Double pumps ex-proof: 2 pcs of which one is only used during repair of the other
Control board ex-proof
Level control for tank with shut down valve
Pump for tank for loading at tank

17 - Building work for installation of the underground pentane storage tank and place for the truck and delivery system.

18 - Rebuilt of Foaming Jigs
Electrical heating elements have to be replaced by inserting tubes for water circulation, connected to hoses with quick connectors.
Micro switches and other electrical components have to be changed to ex-proof Class Ia components.
Earth connection of jigs.

19 - Rebuilt of Foaming Plugs
Plugs have to be adjusted to new foam.
Built in tubes for heating or hot air ex-proof system
Hoses with quick connectors have to be connected.
Earth connection of plugs.

20 - Two new jigs and plugs to replace the existent made of wood and not adaptable for pentane foam.

21 - House for foaming jigs
Steel house with connection for ventilation and exhausting
built around the foaming jigs

22 - Water heaters for Foaming jigs
Voltage: 115/127V - 60HZ
Temperature range: 10-95 degr. C
Heating capacity: 6 kw
Cooling capacity w/difference up to 60 degr.C: 14500kcal/h
Tank volume: about 15-20 ltrs
Pump capacity: about 4000 ltrs/h
Circulation medium: water

23 - Antistatic floor
Painting of floor in foaming area with antistatic paint

24 - Steel construction for floor for new foaming equipaments.

25 - Preheat ovens by hot water coils adapter to the new foaming layout.

26 - Foam Test Equipment
Scale 0-1000gr +/- 0.01g
Measuring glass 0-1000 cm^3 +/- 1 deviation
Shearing box for foam
Foam knife
Stirrer
Laboratory cup for foam

27 - Prodution K Tester for close control of the new cyclopentane foam "Thermatest Rapid - K Instrument" or similar.

28 - Ventilation to attend safety standards in lab for cyclopentane foam testing.

29 - Gas detector system
Voltage: 115-127V/60HZ
Number of sensors: 7 pcs
Flammable limits: In air 1.4-8%

30 - Gas Detector Control board
Voltage: 115-127V/60/HZ
PLC control of fan motors
Flammable limits: In air 1.4 - 8%
Ex-Proof
Control board cabinet

31 - Exhausting and ventilation
Voltage: 115-127V/60HZ and 3 x 220V/60HZ
Capacity: 2 steps a min 4000 m(3)/H and min 8000 m(3)/H
Air change: 53 times per hour
Total capacity: Min 16000 m(3)/H
Point exhausting: Min 30 pts
Ex-proof or placed outside 0-Zone

32 - Fire protection systems
Foam spray system for polyurethane chemicals and cyclopentane or sprinkler watering system, according to local regulation

PART D: CALCULATION OF UNIT ABATEMENT COST

A	ODS Phase out		Total Project
A1	Average use of CFC 11 per year	MT	160
A2	ODP of CFC 11		1
A3	ODP-weighted CFC 11 phase (A1*A2)	MT	160
A4	Average use of CFC 12 per year	MT	45
A5	ODP of CFC 12		1
A6	ODP weighted CFC 12 phase out (A4*A5)	MT	45
A7	ODP-weighted HCFC 502 + triclore tane (0.43 and 0.1)	MT	0.844
A8	Total ODP-weighted phase out	MT	205 844
B	Annualized capital cost		
B1	Total investment cost (model redefinition + production conversion)	US$	2610 000
	Equipment life	Year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627	US$	424 647
C	Annual incremental recurrent cost	US$	999 984
D	Unit Abatement cost		
D1	Annualized capital cost per kg ODS phased out (B4/A8*1000)	$/kg	2.06 Over 10 yr. project life)
D2	Annual incremental recurrent cost per kg ODP phased out (C/A8*1000)	$/kg	Up to 4.86 (1st four years)
D3	Unit abatement cost (D1+D2)	$/kg	Up to 6.92 (Total 1st four years)

METALFRIO S.A.

CFC-11/12 TO CYCLOPENTANE/HFC-134a

FACTORY CONVERSION PROJECT

ANNEX 2

REVIEW OF PROJECT CONCEPT AND BASIS OF DESIGN

PREPARED BY: BEN HORVAY
June 20, 1994

J. BENJAMIN HORVAY, P.E.
Consulting Engineer

11 Linkside Court
Isle of Palms
S.C. 29451
Tel:(803)886-2978
Fax:(803)886-2982

June 20, 1994

Subject: METALFRIO S.A. CFC PHASE OUT PROJECT

Background

The project objective is the complete phase out of the use of CFC-11, CFC-12 and CFC-502 in the freezers and coolers produced by METALFRIO. As the blowing agent in polyurethane foam, CFC-11 will be replaced by cyclopentane, and refrigerants CFC-12 and CFC-502 will be replaced by HCFC-134a and HP-62 (R404a) respectively in the cooling systems.

METALFRIO is a leading producer of commercial and household freezers, with a projected 150,000 units to be produced in 1994. The estimated ODP of the substances to be phased out is 206 MT annually.[1]

Montreal Protocol Technical Review Mission

The purpose of the mission, composed of Donald J. Rhatigan, Task Manager; Frank A. Munoz, Safety Engineering Consultant; and J. Benjamin Horvay, Refrigeration Technology Consultant, was "to review in close collaboration with the METALFRIO project team, the refrigeration technology, fabrication line, and safety engineering design, and prototype testing program in sufficient depth to develop an informed, definitive recommendation concerning the technical acceptability of the proposed project. The focus of the review is not to conduct a detailed design check out, but rather to verify conceptual soundness and ensure competent and safe design, implementation and operation."[2]

This reviewer was especially interested in assessing the technical competence of the applicant's staff, so that the smooth, trouble-free implementation of the project can be assured.

[1] UNIDO report dtd January 22, 1994
[2] Letter by Division Chief (LA1EI), World Bank

Discussion

1. Replacement of CFC-11 with cyclopentane

The use of a highly flammable and explosive blowing agent in the foam formulation requires not only new foaming equipment, but also the modification of the foaming molds that encase the cabinets during the foaming operation. The products themselves also need to be modified to assure material compatibility with the new foam, and to compensate for the somewhat poorer thermal insulating value of the new foam.

Fellow reviewer, Mr. Munoz, had primary interest in the safety aspects of the foaming operation, while this reviewer concentrated on determining the production capability of the equipment, and assessing the predicted cost and quality of the end products, and their physical and thermal performance. Of special interest were the dimensional stability and compression strength of the foam, its thermal conductivity, the time dependent aspects of these properties, the stresses produced in the foamed structure, and chemical reaction, if any, between the foam and polymers. As a result, a number of recommendations were made:

a. Acquire the in-plant capability of evaluating the dimensional stability, the compression strength and the thermal conductivity of the foam produced.

b. In addition to the "flip-flop" lids, that are already foam insulated, foam all the chest freezer lids to compensate for the higher thermal conductivity of the new foam.

c. Do not foam in place the inner lids of the larger models so as to avoid stress cracking of the inner lids, and to minimize the bowing effect of the lid assembly.

d. Investigate the availability in Brazil of special polystyrene and ABS coumpounds that seem to be more cyclopentane friendly.

All these recommendations were accepted by METALFRIO.

Replacement of CFC-12 with HFC-134a

The thermodynamic properties of HFC-134a differ sufficiently from those of CFC-12 to require significant changes in each of the components of the refrigeration system. The chemistry and molecular structure of the new refrigerant has a major impact on the selection of the lubricating oil, on the evacuation and charging procedure of the system, and on the manufacturing procedure. METALFRIO engineers are fully aware of the changes required in the evaporator, the condenser, the capillary tube, and the filter. Furthermore they fully understand the need for cleanliness of parts and procedures. The following suggestions were offered to enhance the product development procedure and the performance of the end products:

a. A redesign of some of the forced draft condensers might be required to minimize the danger of liquid traps.

b. The heat transfer capability of some of the natural draft condensers could be enhanced by change in geometry.

c. Investigate newly-emerging alternate techniques for making tube joints.

d. Make use of the compressor suppliers computer modeling programs to assist in system modifications.

e. Use only calibrated compressors through the development and evaluation phase of the project.

f. Use helium leak detectors to assure the quality of the components and of the final assembly.

g. Expect to increase the evacuation time on the final assembly line.

<u>The Development and Evaluation Program</u>

The development and evaluation programs and schedules for the introduction of the new foam formulation and of the replacement refrigerant were reviewed in detail and were found completely adequate. The following recommendations were made to enhance the development effort:

a. Take advantage of the foam supplier's offer to have sample cabinets foamed with cyclopentane blowing agent at their facility.

b. Use cabinets foamed with reduced CFC-11 formulation to simulate the thermal conductivity of cyclopentane cabinets, and use these for developing thermal balance with HCFC-134a charged systems until cyclopentane cabinets are available.

c. Place in the field pre-tested prototypes, and equip a number of these with test kits that record essential performance data. Bring back to the lab field test samples in accordance with a staggered schedule for retesting and the analysis of the compressor, possibly enlisting the help of the compressor supplier.

d. It is better to field test a lot of samples of a few models than a few samples of a lot of models.

These recommendations are being incorporated into a revised development and evaluation program.

Conclusions and Recommendations

While the project proposed at Metalfrio is of major magnitude, the technologies involved are operational in various parts of the World. The critical elements to success are:

a. the foaming system
b. the compressor
c. the technical competence of the implementors

a. The potential suppliers of the foaming system are Hennecke and Cannon, World class providers of foaming equipment, pioneers in the development of cyclopentane blown foam application. Both companies offer extensive technical support for the planning and installation of their equipment and for the training of the operating personnel.

b. The potential compressor suppliers are Sicom (Tecumseh) and Embraco, World class suppliers of compressors, pioneers in the development of HCFC-134a compressors, and with World-wide experience in the application of the new refrigerant.

c. This reviewer was very much impressed by the technical competence of the Metalfrio personnel he dealt with. It is at par with that of similar-sized organizations in the United States or abroad.

Assuming that the changes suggested by the Technical Review Mission are considered in the revised project proposal that is being prepared for submittal, my recommendation is to approve the project. Based on the technical competence of Metalfrio's staff, and on the very extensive training programs planned with the assistance of outstanding suppliers, I see no need for any additional technology partner for the implementation of this project.

J. Benjamin Horvay

J. Benjamin Horvay, P.E.

METALFRIO S.A.

SAO PAULO, S.P. BRAZIL

ANNEX 3

REPLACEMENT OF CFC-11 IN RIGID POLYURETHANE FOAM BY CYCLOPENTANE FOR THE PRODUCTION OF COMMERCIAL REFRIGERATORS AND FREEZERS

SAFETY REVIEW AND ASSESSMENT

PREPARED BY: F.A. MUNOZ
June 16, 1994

I. SUMMARY AND CONCLUSIONS

A safety review and assessment was carried out on the Metalfrio S.A., Sao Paulo, Brazil MP Project for the replacement of CFC-11 in rigid polyurethane foam to cyclopentane.

The focus of the review was not to conduct a detailed design check out as design documents are not available but to verify the conceptual soundness of the project and ensure competent and safe design and operation.

Two companies are presently been considered as suppliers of the cyclopentane foam technology and equipment: Hennecke of Germany and Cannon of Italy. Both of these companies are world class and have numerous plant installations worldwide. Hennecke has 50 installations and Cannon 35. Both Hennecke's and Cannon's design information manuals were reviewed and the safety measures and guidelines found satisfactory. Both companies will provide an "Operational Safety Statement" in order to guarantee a proper transfer of the new cyclopentane technology.

A list of concerns and recommendations made to Metalfrio is presented in Section II. Metalfrio has agreed to act on these recommendations.

Based on the review of the design information available, the discussions with Metalfrio and the agreement by Metalfrio to act on the recommendations the author is satisfied with the safety of the plant.

II. Safety Review and Assessment

This report covers a safety review and assessment of the Metalfrio S.A., Sao Paulo, Brazil MP project for the conversion of CFC-11 in rigid polyurethane foam to cyclopentane for the production of commercial refrigerators and freezers. The review took place at the Metalfrio manufacturing plant in Sao Paulo between June 6-10. The review included discussions with Metalfrio technical personnel, review of documents available and a detailed descriptive tour of the present manufacturing operation and proposed changes required due to the conversion to cyclopentane. A one-day meeting was held at Bayer, Sao Paulo potential supplier of Polyol and cyclopentane and owner of Hennecke, potential supplier of the cyclopentane pentane processing technology and machinery. The list of participants is presented in Appendix I.

The focus of the review was not to conduct a detailed design check out (design drawings and documentation are not as yet available as a supplier has not been selected), but to verify conceptual soundness and ensure competent and safe design and operation. Two companies are presently been considered as suppliers of cyclopentane technology and equipment: HENNECKE of Germany and Cannon of Italy. Both of these companies are world class and have numerous plant installations worldwide operating with their technology and equipment. HENNECKE has 50 installations and CANNON 35; their lists are presented in Appendix II and III. Both Cannon and HENNECKE have a significant presence in Brazil. Both HENNECKE and Cannon have published manuals with cyclopentane technology and safety information and guidelines: HENNECKE's "Work Shop Pentane-Appliance Industry, First English Edition, November 1993 and Cannon's "Refrigerator Industry and Cyclopentane-Information Report." The safety measures and guidelines were reviewed and found complete and satisfactory. Both Cannon and HENNECKE have indicated that they will provide an "Operational Safety Statement," in order to guarantee a proper transfer of the new cyclopentane technology.

Both companies will train the Metalfrio personnel and provide start-up assistance. Cannon has provided a table of contents for their "General Instructions for the use of Cyclopentane in a Foaming Process," which extensively addresses the safety aspects of the plant. This document is presented as Appendix IV.

Brazil's ABNT-Associação Brazileira de Normas Técnicas (Brazilian Association of Technical Standards) publishes the Brazilian National Systems Standards and Quality Codes. The electrical area classification definitions are similar to those of NFPA (National Fire Protection Association, U.S.A.). The Brazilian standards for electrical equipment to be used in flammable and explosive atmospheres are very extensive and, I suspect, based on the U.S.A. electrical code.

Project implementation was extensively discussed. This is a plant revamp (conversion), which is the most complex and demanding of construction projects. Metalfrio was recommended to consider very seriously contracting an experienced Brazilian Engineering of Construction Firm to perform the construction management of the project, which will include the project accounting and contracts administration documentation necessary for reimbursement and avait.

With regards to Environmental Considerations, the author agrees with Mr. D. Rhatigan's assessment that it is not sufficient to assume that the design for VOC emissions to German standards will be acceptable to CETESB. In their letter to Metalfrio of April 18, 1994, CETESB concludes that "they have no objection to the use of new equipment to replace existing equipment and the use of new raw materials" and then they state "However, the firm must obtain the required Construction-Operating Licenses before installation and Operation of the new Equipment." I reviewed the documentation Metalfrio presented to CETESB and the expected plant emissions do not appear to be presented anywhere. It is suggested, as Mr. D. Rhatigan did in his letter to Metalfrio dated February 25, 1994 that Metalfrio get a reading from CETESB.

The following is a list of concerns and recommendations made to Metalfrio during the discussions. Metalfrio has agreed to act on these recommendations, and if so, the author is satisfied with the safety aspects of the plant.

1. Once the plant layout has been prepared and the electrical area classification defined, the selected supplier is to send a "Safety Specialist" to Metalfrio to perform a *complete* safety check-out in situ and make recommendations.

   Areas of concern are:

   a) Does the new foaming area need to be isolated and ventilated from the rest of the plant which is very large and chuckfull of machinery? The proposed location of the new foaming area is adjacent to a large area where welding is done.

b) The foaming system is completely enclosed and ventilated. However, the foam mix-head is moved from mould to hold. What guarantee do we have that the mix-head will not leak cyclopentane into the area due to valve wear and tear after thousands of openings and closings?

c) Maintenance of the moulds is to be done in situ and sparks may be produced. HENNECKE indicated that they take out the moulds for repair, but Metalfrio does not plan to do so. Consider the use of spark proof tools is possible.

d) Fire protection system.

e) Possible rupture of movable flexible hose system feeding the mix head.

2. An electrical Area classification drawing is to be prepared showing all parts of the plant, so that no safety aspect is overlooked. All existing electrical installation to be modified as required.

3. All components of local construction are to be reviewed and approved by the selected supplier is to agree to be responsible for the safety aspects of the entire new foaming system, including whatever Metalfrio or a third party does.

4. The design must meet as a minimum the requirements of the Brazilian electrical and other codes.

5. Metalfrio to discuss with the selected supplier the need for nitrogen evacuation of the air in the appliance cavities just before foam injection.

6. Consider use of excess flow valves at Cyclopentane storage tank. Brazilian code to be checked for this requirement.

7. The design of the ventilation of the moulds to be provided by the selected supplier. Actual construction of the system can be done by a local firm.

8. Storage and handling of Cyclopentane to meet Brazilian codes and standards.

9. Fire protection system to meet local national standards and regulations.

10. Metalfrio to prepare formal written equipment specifications for inquiry. All of the bids received have been based on verbal discussions with no record of such discussions. A minimum of three bidders is recommended.

11. It is not sufficient to state "spark proof" or "explosion proof." The following paragraph needs to be added to all equipment specified for inquiry or purchase. "All equipment to be suitable for Class I, Division I, Group D or Class I, Division 2, Group D as applicable.

12. Metalfrio to designate a person trained and experienced in safety matters, who will have the responsibility of authorizing by his signature on a "work order" form the various types of work to be performed each and every day. No work (maintenance, repair, construction), no matter how small may be performed without his knowledge and authorization. This is to be a daily safety ritual.

13. Metalfrio to train and retrain all personnel on a scheduled basis on safety. All new personnel, of course, needs to be safety trained before given work responsibilities.

APPENDIX I
PARTICIPANTS

FINEP meeting, Sao Paulo, June 6, 1994

Paulo S.Coutinho	FINEP
Walter A. Gross Braun	FINEP
Paulo Fetal	FINEP
Roberto A. Prixoto	IPT (Tech. Research Inst.)
Donald Rhatigan	World Bank
Ben Horvay	World Bank consultant
Frank A. Muñoz	World Bank consultant

METALFRIO Meeting, Sao Paulo, June 6-10, 1994

*Paulo S. Coutinho	FINEP
Walter A. Gross Braun	FINEP
*Roberto A. Prixoto	IPT
Pedro José Rocha	Metalfrio
Antonio A. Cury	Metalfrio
David Nery Rocha	Metalfrio
Diego Parra	Metalfrio
Julio Vosyima	Metalfrio
Luis Carlos T. Yamada	Metalfrio
Donald Rhatigan	World Bank
*Ben Horvay	World Bank consultant
Frank A. Muñoz	World Bank consultant
*Luis Eduardo M. Caio	Metalfrio-Managing Director

*Partime

BAYER meeting, Sao Paulo, June 9, 1994

Walter A. Gross Braun	FINEP
Pedro Jóse Rocha	Metalfrio
David Nery Rocha	Metalfrio
Antonio A. Cury	Metalfrio
Dr. Reinhard Kaufung	Bayer
Dr. Karl-Heinz Keller	Bayer
Adercio Savignani	Bayer
Donald Rhatigan	World Bank
Ben Horvay	World Bank consultant
Frank A. Muñoz	World Bank consultant

APPENDIX II

HENNECKE-LIST OF INSTALLATIONS JN/94

Maschinenfabrik Hennecke GmbH

Referenzliste Pentamat		Stand		18.02.1994	
Nr.	Kunde	Land	Typ	Auslieferung	Anwendung
1	Miles	USA	D 10	1993	Labor Lab
2	AEG	Deutschland	P 10	1993	Kühlschrank Ref.
3	AEG	Deutschland	P 10	1993	Kühlschrank
4	AEG	Deutschland	P 10	1993	Kühlschrank
5	AEG	Deutschland	P 10	1993	Kühlschrank
6	AEG	Deutschland	P 10	1993	Kühlschrank
7	Bauknecht	Deutschland	P 10	1993	Kühlschrank
8	Bauknecht	Deutschland	P 10	1993	Kühlschrank
9	Bauknecht	Deutschland	P 10	1993	Kühlschrank
10	Bayer AG	Deutschland	P 10	1993	Labor
11	Bayer AG	Deutschland	P 10	1993	Labor
12	Electrolux	Schweden	P 10	1993	Kühlschrank
13	Gold Star	Korea	P 10	1993	Labor
14	Gorenje	Slovenien	P 10	1993	Kühlschrank
15	Korea Polyol	Korea	P 10	1993	Labor
16	Linde AG	Deutschland	P 10	1993	Kühltheken
17	Maruka	Japan	P 10	1993	Kühlschrank
18	Maruka	Japan	P 10	1993	Kühlschrank
19	Merloni	Italien	P 10	1993	Kühlschrank
20	Merloni	Italien	P 10	1993	Kühlschrank
21	Merloni	Italien	P 10	1993	Kühlschrank
22	Merloni	Portugal	P 10	1993	Kühlschrank
23	Samsung	Korea	P 10	1993	Labor
24	ABB Möller, Dänemark	Dänemark	P 30	1993	Rohrisolierung Pipe Ins
25	Bosch-Siemens	Deutschland	P 30	1993	Kühlschrank
26	Bosch-Siemens	Deutschland	P 30	1993	Kühlschrank
27	Bosch-Siemens	Deutschland	P 30	1993	Kühlschrank
28	Bosch-Siemens	Deutschland	P 30	1993	Kühlschrank
29	BS Spanien	Spanien	P 30	1993	Kühlschrank
30	BS Spanien	Spanien	P 30	1993	Kühlschrank
31	Electrolux	Luxemburg	P 30	1993	Kühlschrank
32	Electrolux	Schweden	P 30	1993	Kühlschrank
33	Electrolux, Siegen	Deutschland	P 30	1993	Kühlschrank
34	Gorenje	Slovenien	P 30	1993	Kühlschrank
35	Liebherr	Österreich	P 30	1993	Kühlschrank
36	Liebherr	Österreich	P 30	1993	Kühlschrank
37	Liebherr, Ochsenhausen	Deutschland	P 30	1993	Kühlschrank
38	Liebherr, Ochsenhausen	Deutschland	P 30	1993	Kühlschrank
39	Liebherr, Ochsenhausen	Deutschland	P 30	1993	Kühlschrank
40	Linde AG	Deutschland	P 30	1993	Kühltheken
41	Maruka	Japan	P 30	1993	Kühlschrank
42	Maruka	Japan	P 30	1993	Labor
43	Bosch-Siemens	Deutschland	P 30	1993	Kühlschrank
44	Samsung	Korea	P10	1993	Kühlschrank
45	Gorenje	Slovenien	P 30	1994	Kühlschrank
46	Gorenje	Slovenien	P 30	1994	Kühlschrank
47	Gorenje	Slovenien	P 30	1994	Kühlschrank
48	Gorenje	Slovenien	P 30	1994	Kühlschrank
49	ABB-Möller	Dänemark	P 30 S	1994	Rohrisolierung
50	ABB-Möller	Dänemark	P30S	1994	Rohrisolierung

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(CANNON)

APPENDIX III

CANNON - LIST OF INSTALLATIONS JN/94

Reference List: "CYCLOPENTANE"

Customer	Country
ALBILUX	Spain
ANTONIO MERLONI SPA	Italy
ARCELIK	Turkey
ATLANT PROD. ASS.	Bielorussia
AUTOSAL S.A.	Argentina
CANDY DONORA SPA	Italy
ELECTROLUX	U.K.
FABRELEC	Spain
FISHER & PAYKEL	New Zealand
FRIGOAVE	Spain
GOLDSTAR IBERNA	Italy
HANNAN DOW	Korea
IAR SPA	Italy
IARP SPA	Italy
IRMAOS AZEVEDO	Portugal
KELCO	U.K.
MERLONI SPA	Italy
NORFROST	U.K.
OCEAN SPA	Italy
OSBY AB	Sweden
PRO PROFILO	Turkey
PITSOS	Greece

CANNON

Reference List: "CICLOPENTANE

Customer	Country
POLAR	Poland
SANYO	Japan
SELNOR LESQUIN	France
SHARP	Japan
SNOWCAP CO. LTD	Russia
ULGOR	Spain
VEDERECA	Spain
WHIRLPOOL	Spain
WHIRLPOOL SPA - Cassinetta	Italy
WHIRLPOOL SPA - Siena	Italy
WHIRLPOOL SPA - Trento	Italy
ZANUSSI SPA - Firenze	Italy
ZANUSSI SPA - Susegana	Italy

TOTAL P.02

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CRIOS SpA - Via Stignani, 59 - 20081 ABBIATEGRASSO (MI) - ITALY
Ph. +39-2-94967350/1 - Fax +39-2-94967632 - Telex 326253 CRIOS I

FAX NO. 717

DATE: 17-Mar-94

APPENDIX IV

FROM : Cannon Crios
TO : METALFRIO
ATTENTION : Mr. Pedro Rocha

Cannon will supply, together with the equipment, the instruction manuals including detailed instructions for the utilization of the c/pentane as well as the certification documents for the parts which require such a procedure. During the equipment installation and start-up, our specialists will hold a stage of the training of the end-user personnel. The objective of the stage will be:

General Instructions for the Use of Cyclepentane in Foaming Process

1. Extremely important regulations
1.1 General
1.1.1 Characteristics of the substance danger depends on
1.1.2 Machine safety measures taken

1.2 Classification of the dangerous place

1.3 Characteristics of environments where c/pentane is treated
1.3.1 Stocking of c/pentane (outside)
1.3.2 Environment where the premix unit, the machine tank and the foaming unit are installed (inside)
1.3.3 Foaming area (inside)
1.3.4 Ventilation system exhaust outlets

1.4 Technological description of the metering unit: operation and identification of the centres of danger
1.4.1 Description of the part of the plant called "Multi Easy Froth"
1.4.2 Description of the metering unit
1.4.3 Return circuit
1.4.4 Identification and degree of the centres of danger
1.4.5 Definition of the ventilation conditions
1.4.6 Definition and delimination of the AD (deflagrant environment) areas
1.4.7 Definition of the electric safety installations in the box
1.4.8 Cyclepentane detectors

4. Precautions
4.1 General
4.2 Plant maintenance
4.3 Instructions for operations to be carried out by the personnel in charge as for emergency, maintenance and the resoration of the working conditions
4.3.1 Special work
4.3.2 List of the main precautionary measures to be taken when special work has to be carried out
4.3.3 Equipment isolation
4.3.4 Environment analysis (to be carried out before and during the maintenance operation and before starting the equipment again)
4.3.5 Means of operation
4.3.6 Cleaning of the equipment
4.3.7 Welding/grinding
4.4 Machines provided with rigid piping
4.5 Stocking of the components

5. Control Board
5.1 Control push button panel
5.2 Head push button panel

6. Calibration

7. Faults and trouble shooting
7.1 Warning lamps
7.2 Defects and relevant elimination
7.3 Injection head

8. Maintenance
8.1 General
8.2 Service operations performed
8.3 Preventive maintenance
8.4 Lubrication
8.5 Injection heads
8.6 Filters
8.6.1 Self cleaning filters
8.6.2 Pneumatic circuit
8.7 Pumps
8.8 Isocyanate circuit lubrication
8.9 Stream distributors

Best Regards
C. DeRossi

METALFRIO S.A.

CFC-11/12 TO CYCLOPENTANE/HFC-134a

FACTORY CONVERSION PROJECT

ANNEX 4

OZONE OPERATIONS RESOURCE GROUP (OORG) REVIEW

FOAM EXPERT

BY

DR. MIKE JEFFS

OORG TECHNICAL REVIEW - METALFRIO (BRAZIL)

This review relates to the foam elements of this project.

TECHNOLOGY

The technology chosen for the replacement of CFC 11 in the polyurethane rigid insulation foam is that based on cyclopentane. This has been supported by the OORG as a zero ODP non-transitional option. The technology choice analysis is sound. I support the conclusions.

The cost effectiveness of cyclopentane-based technology involves two factors. There is a comparatively high capital cost to cover necessary safety elements because of the flammable nature of the blowing agent. However, this is offset by the material (operating cost) element because cyclopentane is comparatively cheap, no expensive plastic liner modifications are required as is generally the case for HCFC 141b and other zero ODP options such as HFC 134a and other HFCs currently being researched are less cost effective.

To take up the point on plastic liners (Annex 2, page 2) there may need to be a modification needed if HIPS liners are to be used but not if the choice is ABS. The project write-up does not state which plastic is currently used. The capital cost implications of a change should be very low - report on OORG Foams Working Group May 1994.

ENVIRONMENTAL IMPACT

Cyclopentane has a zero ODP and an almost zero direct GWP. The total warning impact or TEWI should be reduced through the use of cyclopentane although the indirect contributions may be higher. This is partly addressed in Annex 2 through foaming of lids. It should be noted that pentane (including cyclopentane) technology is still evolving and improvements in thermal conductivity are to be expected from ongoing development. The improved technologies should be "drop-in" in the modified factory.

There is awareness of the VOC issue and it is being properly addressed. Overall cyclopentane emissions from the modified plant should be low.

The factory safety issue is paramount in this project. There has been a thorough review of safety philosophy and practical elements (Annex 3) and both Hennecke and Cannon are companies of the highest repute and have given satisfactory assurances.

A design layout is not provided but desirable features such as a 20 m^3 nitrogen blanketed cyclopentane tank are included. There appear to be separate two mixing stations (Annex 1, item 14) connected to the tank by double walled sectored pipes - this is acceptable.

The training issues are well covered.

It is recommended that regular audits of adherence to procedures be added to the safety review (Annex 3, items 12 and 13). Otherwise the recommendations in Annex 3 are fully supported.

PROJECT COSTS

The listed costs (Annex 1) are compatible with the conversion to cyclopentane. It is presumed that the items listed under Annex 1, section E (Training) are costs such as travel and lodging incurred by Metalfrio and not payments to vendors.

It is noted that items such as polyurethane raw material tanks are not included in the project.

The foam elements should not incur any appreciable operating costs although an increased foam density could affect this. The UAC of the foam elements alone is of the order of 2.2 to 2.4 $/kg/year (capital items) and is reasonable.

IMPLEMENTATION TIMEFRAME

The timeframe for implementation of the foam elements should be achievable.

RECOMMENDATIONS

The project (foam elements) is approved as proposed with the additional recommendation that the post implementation auditing of compliance to safety procedures is written into the project.

Since there will be several cyclopentane conversion projects it is recommended that the Montreal Protocol Group builds up a data bank of key features and costs as a guidance to tank managers.

G. M. F. Jeffs
GMFJ/kd/28/7/94

METALFRIO S.A.

CFC-11/12 TO CYCLOPENTANE/HFC-134a

FACTORY CONVERSION PROJECT

ANNEX 5

OZONE OPERATIONS RESOURCE GROUP (OORG) REVIEW

REFRIGERATION EXPERT

BY

DR. LAMBERT KUIJPERS

Brazil

Conversion of Commercial Refrigerator Manufacturing from CFC-12 to HFC-134a at METALFRIO S.A.

Project Proposal by The World Bank, July 1994
(and additional comments by J.B. Horvay and F. Munoz)

Scope of the project

The project describes a conversion of the production process of Metalfrio to HFC-134a (and HFC containing blends for conversion of R-502) in the refrigeration circuit; and to cyclopentane in the foam blowing operation. The latter one is not considered in this project review.

1. Technology

The technology selected for the conversion of the refrigeration circuit is environmentally sound and safe. If, in a later stage, emissions of refrigerant in servicing are avoided as much as possible, impact on the environment is fully acceptable.
The HFC-134a technology is not transitional, and the choice for this technology is an acceptable one, also from the point of view of cost-effectiveness. In principle (recommendations OORG group) a partner for technology transfer should be presented in the proposal. However, the investigation of the quality of the firm and its staff (report by Horvay), which mentions excellent technical quality, and the fact that compressors will be bought from Embraco and Sicom, both experienced in the operation of HFC-134a, both guarantee adequate implementation of the project.

2. Environmental impact

The HFC-134a substitute has no ODP, however, a certain GWP, which should be addressed in such a way that venting during servicing and repairs is minimized.
Other measures related to safety and health need not to be considered under the conversion of the refrigeration circuit.

3. Project costs

All cost components identified are essential for the conversion. The necessary equipment that was present in the facility, will be cleaned and operated with HFC-134a.
Apart from minor remarks, which are related to the fact whether a specific number of vacuum pumps or leak detectors is needed, or whether this number can be reduced, it should be stated that the experience of the firm seems to be such that it can be reasonably be assumed to be in order.

Instead of a technology transfer, followed by implementation, Metalfrio will expand its staff with four engineers for project implementation (USD 120,000). If these experts have specific expertise in project management of conversions, then this item can be considered as if it were the costs for technology transfer. If it is only the expansion for project management purposes, it does not contribute to the HFC-134a conversion per se. Metalfrio should give the guarantee that the hiring of these experts contributes to the reliable conversion to HFC-134a.

The training component to operate HFC-134a charging machines seems to be OK.

The order of magnitude for the costs for the conversion to HFC-134a seems to be in the order magnitude as estimated by the OORG Working Group in Hannover, May 1994 (production volume Metalfrio 130-150,000 units).

Operational costs are mentioned in the project proposal, but not applied for at this stage (therefore these are not further commented to).

4. Implementation timeframe

The implementation timeframe seems reasonable. Testing of a number of prototypes (30 products) in a first phase, as described, seems reasonable.

5. Recommendation

Approval as proposed, provided that the extra staff hired by Metalfrio has capacities to make a real contribution to the HFC-134a project implementation.

Kuijpers, L.J.M.

Eindhoven, 8/ 8/ 1994

METALFRIO S.A.

CFC-11/12 TO CYCLOPENTANE/HFC-134a

FACTORY CONVERSION PROJECT

ANNEX 6

LETTER OF FINEP REQUESTING CONSIDERATION

OF THE PROJECT BY THE MFEC

FINEP

FINANCIADORA DE ESTUDOS E PROJETOS

FORMULÁRIO P/ TELECOMUNICAÇÕES

☐ TELEX ☒ FAX ☐ TELEGRAMA

MSG.nº

Data 11.08.94

Rio de Janeiro
Praia do Flamengo, 200 - 1º ao 3º, 5º, 13º e 24º andar - Flamengo - RJ - Brasil
CEP 22.210.030 Tel. (021) 276.0330 PABX - Telex 212.3468 - 213.0470 Fine BR - Fax (021) 276.0402

Escritório de São Paulo
Av. Brigadeiro Faria Lima, 1886 - 12º e 14º andar - São Paulo - SP - Brasil
CEP 01.452 - Tel (011) 814.1333 PABX - Telex 1181174 FFEP - Fax (061) 815.6973

Representação em Brasília
Sas Q.AS Lote 06 Bloco H - Brasília - DF. - Brasil
CEP. 70.000 - Tel. (061) 217-6260 - Telex 614020 - Fax (061) 226-0069

Destinatário : WORLD BANK ' LA 1 EU

Endereço :

Em Atenção : ASIF FAIZ - DIVISION CHIEF, LA 1 EU

C/Cópia :

Nº Fax / Telex : 001-202-676 259

Nº de Páginas: 01

Emitente : PAULO ROBERTO DA SILVEIRA FETAL

Departamento: DCBS

Assunto :

MENSAGEM :

I am now informing you that FINEP agrees with the terms of Metalfrio project executive summary sent by your fax of 9 August and asks its transmittal to the Multilateral Fund Executive Committee for approval.

PAULO R. DA SILVEIRA FETAL
Tec. Pro ... IV
DCBS/CMA ... 14

FERNANDO NIELANDER RIBEIRO
Chefe do DCBS

THE MONTREAL PROTOCOL
ON SUBSTANCES THAT DEPLETE THE OZONE LAYER

PROJECT COVER SHEET

COUNTRY:	Brazil
PROJECT NAME:	Conversion to reduced CFC technology in the manufacture of Refrigerators.
SECTORS COVERED:	Domestic Refrigeration
ODS CONSUMPTION IN AFFECTED SECTORS:	1,420 ton/yr CFC's (1,420 ton/yr ODP) in 1993 (Data from suppliers)
PROJECT IMPACT:	Total 95.5 ton/yr of CFC, correspondiang to a partial reduction of CFC-11.
PROJECT DURATION:	2 years
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	US$ 306,053 total capital cost, being US$ 118,263 for adjustments in the cabinet foaming unit, US$ 75,000 for utilities and installations, US$ 20,000 for conductivimeter, US$ 12,500 for spare parts, US$ 10,370 for reimbursement of tests and prototypes, US$ 30,000 for transportation and US$ 39,920 for contingency.
PROPOSED ODS GRANT:	US$ 286,007
UNIT ABATEMENT COST:	Annualized capital cost: US$ .49/kg ODP
IMPLEMENTING AGENCY:	The World Bank/Financiadora de Estudos e Projetos (FINEP)
COORDINATING NAT. AGENCIES:	GTO - Interministerial Ozone Technical Group
BENEFICIARY ENTERPRISE:	Refrigeracao Parana S.A. - Unidade Sao Carlos

PROJECT SUMMARY

Please Refer to attached Executive Project Summary

October 28, 1994

Refrigeração Paraná - Unidade São Carlos

PROJECT SUMMARY

Refrigeração Paraná S.A. - Unidade São Carlos is focussing in becoming able to reduce consumption of CFC 11 as a blowing agent in the PUF processing and to reduce the losses in the present cabinet foaming unit which is not able to deal properly with the proposed alternative gases to CFC 11 and also is not able to keep the conditions for stability and repeatibility. Under this project, to reduce the consumption and the losses of CFC 11 in two years, the company after several tests and essays with technical auditing from FINEP concluded based on field results to use a new Pre Heating Oven and to install controlled eletrical resistances in the cars and moulds to assure stability and repeatibility. To give support to the project, Refrigeração Paraná S.A. - Unidade São Carlos, will train the workers directly linked with the operation and the supervising of the cabinet foaming unit at its own expenses. Refrigeração Paraná S.A. - Unidade São Carlos is going to search knowledge and know-how for this step in our chemicals and equipments suppliers working altogether.

Project of the Refrigeração Paraná S.A. - Unidade São Carlos conversion to CFC-Free Technology in the Manufacture of Refrigerators.

1- Project Objective

The objective of this project is to reduce the consumption and losses of CFC 11 in the production of Refrigerators at Refrigeração Paraná S.A. - Unidade São Carlos.

2- Sector Background (Data From ABRAVA / ABINEE)

- In Brazil the annual sales in 1992 was 1.382.000 Refrigerators.
- The estimated growth rate of the refrigerators market is 15% / year.
- The domestic refrigeration used in 1993, 1420 ton of CFC's.
- The annual production of Refrigerators in 1993 was 1.643.000 products.

Refrigeração Paraná - Unidade São Carlos

3- Enterprise Background

- The Refrigeração Paraná S.A. - Unidade São Carlos - annual ODS consumption in 1993 was 127. 3 ton of CFC 11; 106.2 ton of CFC 12 and 2.4 ton of HCFC 22.
- Refrigeração Paraná S.A. - Unidade São Carlos manufacture Refrigerators, Washing Machine and parts for Air Conditionners.
- The Refrigeração Paraná S.A. - Unidade São Carlos production (1994) capacity is 780.000 products / year for all manufactured products.
- The Refrigeração Paraná S.A. - Unidade São Carlos - actual production (1994) is around 220.000 PU products / year (considering 92.5 prod / h; 10.8 h / day; 20 days / month and 11 month / year)
- In its development and research, Refrigeração Paraná S.A. - Unidade São Carlos - uses a close cooperation with is chemical and equipment suppliers (Du Pont, Hoechst, Dow, Bayer, Cannon Crios, etc.)
- Nowadays Refrigeração Paraná S.A. - Unidade São Carlos - supplies the Brazilian market and exports to the South American Market.
- Refrigeração Paraná S.A. - Unidade São Carlos has in its total capital 6,55% of foreign capital participation (from Sanyo / Japan).

4- Project Description

Refrigeração Paraná S.A. - Unidade São Carlos used 127.3 ton of CFC 11; 106.2 ton of CFC 12 and 2.4 ton of HCFC 22 in 1993.

The company is committed to phase out CFC in its products.

The company will reduce the consumption of CFC 11 by processing PU foam with 50% less in the new formulation and will reduce the losses of CFC 11 due present cabinet foaming unit which is not able to keep the process stability and repeatibility (steadiness of resulting foam properties). The cabinet foaming unit with the proposed modifications related in this project, i.e. cars and moulds with controlled electrical heating and using a new Pre Heating Oven unit will allow the use of the alternative gases to phase out CFC11(see the "conclusions" at the foaming essay report on annex3). The company will also eliminate the losses of CFC 12 related to the leakage test in the cooling system by using recovery equipments bought at its own expenses. Adjustments will have to be done in the utilities because the new level of electrical power to be required.

Training will be provided for the works directly linked with the operation and the supervising of the cabinet foaming area.

5- Technology

5.1- Overview

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

- CFC 11 > partial water / HCFC 141b > ?
- CFC 11 > partial water / HCFC 22, 142b > HFC 134a, 152b
- CFC 11 > Pentane, Cyclopentane

In addition, compounds such as perfluoralkanes, HCFC 123, fluorinated ethers and 2-Chloropropane have been suggested, but are immature in technology, limited available or toxicologically contested.

The first solution - also called the "liquid" solution - employs technology that is closely related to the existing one. The final step in this process is not yet decided.

One potential solution is HCFC-356, but full water blown foam with improved cell structure remains an option.

The second solution - also called the "gas" solution - utilizes a gaseous mixture of physical blowing agents, which requires high pressure equipment and sometimes extensive adjustments. The final step in this process is seen as the introduction of (gaseous) HCFC's. Cyclopentane technology was lately commercially introduced in Germany. Its flammable character requires safety and limits its use.

The direction in the development of CFC-free systems for cooling system is the HFC-134a and it is settled but its use still needs a constant care about contamination.

5.2- Selection

Consistency is the most important parameter in the Refrigeração Paraná S.A. - Unidade São Carlos - policy aiming to phaseout CFC's and, so, this project is based in the following points:

- As a first step it will be introduced a 50% CFC 11 reduction in P.U.R foaming process considering that at this moment there is no fixed industrial strategy in therms of Brazil;
- In Refrigeração Paraná plant in Curitiba, which belongs to the same group as Refrigeração Paraná S.A. - Unidade São Carlos - and where the P.U.R foaming process conditions allows the use of a more up-to-date technology, it will be used HCFC 141b as blowing agent and R134a as refrigerant fluid. The experience gained there will be certainly decisive in Refrigeração Paraná S.A. -Unidade São Carlos - decision for the phase out after working 2 years with 50% CFC 11 reduction.

5.3- Impact on Production Process

For the implementation of the new Pre Heating Oven and the controlled electrical heating in the cars and moulds in the Refrigeração Paraná S.A. - Unidade São Carlos - plant, it will be necessary the observation of the following points:

- Modification in the present lay-out to install the new Pre Heating Oven.
- The installation of electrical resistances in the cars and moulds.
- The installation of electrical power for the Pre Heating Oven and the cars and moulds.
- Training of workers linked with the operation, maintainance and supervising of the cabinet foaming unit.
- It is important to point out here that with the proposed modifications in this project, it is perfectly possible after 2 years of usage to change from the processing with 50% of CFC 11 reduction to the HCFC 141b processing with some minor modifications in the installations.

6- Project Costs

6.1- Capital Costs

The following incremental capital costs are expected, related to this project:

- Pre Heating Oven (see item "g" annex 4)	USD 31,250.00
- Transportation (see meeting report from 06.13.94)	USD 30,000.00
- Cars and moulds heating (see annex 5)	USD 87,013.51
- Utilities and installations (see items "h" and "i" annex 4)	USD 75,000.00
- Conductivimeter (see meeting report from 06.13.94)	USD 20,000.00
- Spare parts (see item "n" annex 4 - fraction corresponding to the Pre Heating Oven)	USD 12,500.00
- Tests reimbursement (annex 6)	USD 10,370.25
- Contigency (15%)	USD 39,920.06
- Total Incremental Capital Cots	**USD 306,053.82**

6.2- Non Eligible Costs

- Due 6,55% of foreign capital participation in RPSA-SC total capital	USD 20,046.53
- Total Non Eligible Costs	USD 20,046.53

6.3- Grant From MLF

- Total Incremental Capital Costs (= Total Project Costs)	USD 306,053.82
- Total Non Eligible Costs	USD 20,046.53
Total Grant From MLF	USD 286,007.29

6.4 Unit Abatement Costs

a) Total Grant From MLF .... US$ 286,007
b) Project life time.. 10 years
c) Discount Rate... 10%
d) Annualized Capital Cost .... US$ 46,533
e) CFC Project impact.. 95,500 kg
f) Unit Abatement Cost (UAC) .... 0.48 $/kg/yr

7. Annexes

1) Cash Flow
2) Calculations of CFC-11 reduction
3) Foaming Tests - Conclusions
4) Cannon Crios Proposal No. 7752
5) Foaming Tests - Neccessary investment to adequate the existent cabinet foaming unit
6) Foaming Tests - Costs for the realization of the foaming tests
7) Implementation Timeframe
8) Ozone Operations Resource Group (OORG) Review
9) FINEP Notice of Approval

Annex 1- Cash Flow

CASH FLOW (USD)									
TASK	TIME FOR COMPLETION (MONTHLY)								
	jul/94	ago/94	set/94	out/94	nov/94	dez/94	jan/95	fev/95	TOTAL
1- Capital Costs									
1.1- Pre Heating Oven	-	-	4,888	-	-	26,362		-	31,250
1.2- Transportation	-	-	-	-	-	30,000		-	30,000
1.3- Core and Moulds Heating	-	-	43,807	-	-	43,807	-	-	87,614
1.4- Utilities and Installations	-	-	37,500	-	-	37,500	-	-	75,000
1.5- Conductivimeter	-	-	10,000	-	-	10,000	-	-	20,000
1.6- Spare Parts	-	-	1,875	-	-	10,625	-	-	12,500
1.7- Tests Reimbursement	-	-	10,370	-	-	-	-	-	10,370
1.8- Contingency	-	-	14,362	-	-	25,568	-	-	39,930
TOTAL	-	-	122,332	-	-	[illegible]	-	-	[illegible]
2- Sources									
2.1- RPSA-SC	-	-	8,011	-	-	12,036	-	-	20,047
2.2- PNL	-	-	114,281	-	-	171,716	-	-	286,007
TOTAL	-	-	122,332	-	-	[illegible]	-	-	[illegible]

RPSA-SC = Refrigeração Paraná S.A. - Unidade São Carlos

Annex 2 - Calculations of CFC 11 Reduction

PROJECT: Refrigeração Paraná S.A. - Unidade São Carlos conversion to CFC-free Technology in the Manufacture of Refrigerators

Calculations of CFC 11 Reduction

Model	Annual Production	CFC 11 / Prod. Kg	CFC (100%) (kG)Consumption	CFC (50%) (kG)Consumption	Losses
RW 3.3	51,648	0.612	31,608	15,804	1,976
RW 3.9	10,989	0.749	8,231	4,115	514
RW 4.1	157,143	0.827	129,957	64,979	8,122
Total	219,780		169,796	84,898	10,612

NOTE:
Considering 92.5 products / h; 10.8 h / day; 20 days / month and 11 months / year and the production mix.

Refrigeração Paraná - Unidade São Carlos

Annex 3 - Foaming Tests - Conclusions

Foaming Tests with 50% CFC Reduction and with HCFC 141 b

CONCLUSIONS

1. The modifications realized in the existent foaming unit, specifically in one tunnel of the Pre Heating Oven and in one cabinet foaming car and mould, aimed to comply with the temperature uniformity in cabinet and internal liner requirement; gave good results.;

2. The tests results indicate the steadiness and stability of the process keeping the physical and chemical properties of the foam in constant levels (both in cabinet and in foamed samples plates);

3. The productivity of the pre heating oven decreases from 96 products per hour to 18 products per hour;

4. The total expenses for these tests sum up to USD 10,370.25;

5. The necessary investiment (grant)to keep the existent production level (96 product/hour), with the proposed modifications, changes from the theoretical value estimated during the meetings of june 13 and 14 / 94 of USD 461,368.00, to USD 286,007.29; which was obtained using the results of the foaming tests.

Annex 4 - Cannon Crios Proposal No. 7752

SÃO PAULO, 24/06/94
DE: METALMAC CANNON - E. FOSSATI
PARA: CLIMAX S.A. - SRS. JOSÉ LUIZ/SACILOTTI (R.303)

CRIOS SpA - Via Stignani, 59 - 20081 ABBIATEGRASSO (MI) - ITALY
Ph. +39-2-94967350/1 - Fax +39-2-94967632 - Telex 325251 CRIOS I

FAX NO. 7752 DATE: 24-Jun-94

FROM : Cannon Crios
TO : M E T A L M A C
ATTENTION : Mr. Fossati
OBJECT : C L I M A X - Your fax dd 22.06.94

24 JUN 1994

We are quoting here below what requested from Climax.

TECHNICAL FEATURES

- Stop-and-go conveyor
- Forming fixtures with automatic opening/closing by means of pneumatic cylinder
- Forming fixtures with independently heating by means of electrical heaters
- Cabinet into the fixtures with down opening
- Manual operation of the loading, unloading and injection thru operator
- Total number of the fixtures : 20
- Pre-heating oven with three parallel conveyors (one for each model)
- Pre-heating oven with heating thru hot air forced by fan with electrical heaters
- Manual operation by means of the operator for the loading/unloading from/into the oven

PLANT COMPOSITION AND PRICES

a.	(20)	Forming fixtures	Lit.	600.000.000.-
b.	(12)	Plugs model 4.1	Lit.	240.000.000.-
c.	(4)	Plugs model 3.5	Lit.	20.000.000.-
d.	(2)	Plugs model 3.9	Lit.	10.000.000.-
e.	(1)	Conveyor with hydraulic movement	Lit.	100.000.000.-
f.	(1)	Hydraulic unit and connections	Lit.	45.000.000.-
* g.	(1)	Pre-heating oven	Lit.	50.000.000.- *
* h.	(*)	Electrical wing and connections	Lit.	40.000.000.- *
* i.	(1)	Plant control panel	Lit.	80.000.000.- *
l.	(1)	Assembling and start-up at Crios	Lit.	20.000.000.-
		TOTAL AMOUNT	Lit.	1.335.000.000.-
m.	(*)	Packing and Fob Italian Port	Lit.	50.000.000.- **
** n.	(*)	Set of suggested spare parts	Lit.	45.000.000.- **
o.	(*)	Assistance for the plant installation and start-up at the End-User (travel and lodging expenses excluded)	Lit.	60.000.000.-

Foaming Tests

Necessary Investment to Adequate the Existent Cabinet Foaming Unit in order to become able to work with 50% CFC 11 reduction or HCFC 141b

1- Based on the obtained results in the foaming tests, keeping the productivity level of 96 products per hour; and considering the budgets of equipments, components and installations contained in the proposals used in the meeting of 13 and 14.06.94, and yet the fax sent to FINEP IN 28.06.94, there are two possible situations:

1.1- Situation "A"

1.1.1- Adequate the Pre Heating Oven in the same way that has been done for the tests;

1.1.2- Buy more 5 heating chambers each one equal to the existent one with three tunnels and infrared lamps;

1.1.3- Heat by mean of electrical resistances 19 cars and moulds in the same way that has been done for the tests;

1.1.4- Include electrical rail source to supply energy to the cars and moulds in the cabinet foaming carrousel;

1.2- Situation "B"

1.2.1- Buy the Pre Heating Oven proposed by Cannon to work properly with the existent foaming unit and carrousel;

1.2.2- Heat by mean of electrical resistances 19 cars and moulds in the same way that has been done for the tests;

1.2.3- Include electrical rail source to supply energy to the cars and moulds in the cabinet foaming carrousel;

2- Costs

2.1- Situation "A"

2.1.1- Adapted Pre Heating Oven

- (15+2) tunnels x 3.422,76 USD / tunnel .... USD 58,186.92
- (6 - 1) chambers each one with 3 tunnels and infrared lamps: 05 chambers x 35,000 USD / chamber........................ USD 175,000.00

Total Situation "A" USD 223,186.92

Refrigeração Paraná - Unidade São Carlos

2.1.2- Electrified Cars and Moulds

- (20-1) cars x 3,388.29 USD / car.......USD 64,377.51
- electrical rail.......USD 19,136.00
- rail structure and installation.......USD 3,500.00

Subtotal USD 87,013.51

2.1.3- Utilities and Installations

- for the 05 Pre Heating Chambers and 19 new electrified cars.......USD 75,000.00

2.1.4- Conductivemeter.......USD 20,000.00

2.1.5- Prototypes and Tests (Reimbursement).......USD 10,370.25

Subtotal USD 425,570.68

NOTA: The need for 05 more chambers implies in an additional area of about 82,25 m2.

2.2- Situation "B"

2.2.1- Pre Heating Oven Cannon.......USD 31,250.00

2.2.2- Electrified Cars and Moulds

- (20-1) cars x 3,388.29 USD / car.......USD 64,000.00
- electrical rail.......USD 19,136.00
- rail structure and installation.......USD 3,500.00

Subtotal USD 87,013.51

2.2.3- Utilities and Installations

- for the Pre Heating Oven Cannon and 19 new electrified cars.......USD 75,000.00

2.2.4- Conductivemeter.......USD 20,000.00

2.2.5- Spare Parts.......USD 12,500.00

2.2.6- Prototype and Tests (Reimbursement).......USD 10,370.25

2.2.7- Transport.......USD 30,000.00

Total of Situation "B" USD 266,133.76

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3- Revised Project Cost Profile

From the exposed in item (2) it can be concluded that the situation "B" is the one which indicates the lowest cost mainly because in this solution a Pre Heating Oven specifically designed by Cannon for the existent plant represents a reduction in the in the investments . Moreover, the solution to adequate the existent cars and moulds in São Carlos, instead of buying it from others, equaly leads to a reduction in the investment.

Thus, the cost profile for this project becomes:

- Total Situation "B"	USD 266,133.76
- Contingency (15%)	USD 39,920.06
Subtotal	USD 306,053.82
- Sanyo Participation (6,55%)	(-) USD 20,046.53
Total	USD 286,007.29

Foaming Tests

Costs for the realization of the foaming tests with 50% CFC reduction and HCFC 141b

1- Total Cost for the Tests:

1.1- Pre Heating Oven (1 tunnel)	USD	3,422.76
1.2- Injection Mould and Car (1 car and mould)	USD	3,388.29
1.3- Subtotal Installations	**USD**	**6,811.05**
1.4- Cabinets Used in the Tests (40 cabinets)	USD	3,559.20
1.5- Total Cost	**USD**	**10,370.25**

Note: In the total cost for the tests it was not included neither material and labour hour costs for modifications in the plate sample system, nor the REFRIPAR - USC people hours spent to perform all the tests.

Refrigeração Paraná - Unidade São Carlos

2- Pre Hesting Oven modifications

Description	Quant.	US$	Supplier
Material and Labour Hours For Duct Construction	--	2.300,00	AMF /
Air Conditioning Frame	01 un	28,43	Refripar SC
Condenser Chamber	01 un	1,71	Refripar SC
Fan Electric Motor Suport	01 un	1,46	Refripar SC
Fan Propeller	01 un	4,40	Refripar SC
Electrical Motor	01 un	31,80	Refripar SC
Electrical Resistances 850w	08 un	280,72	Daniel Martins/Fax 1916/94
Pt-100 SL Sensor	01 un	74,63	S&E Instr. / orç. 2923 / 94
Temprature Control Pt-100 with 2 points	01 un	379,50	S&E Instr. / orç. 2923 / 94
Eletrical Panel 40x30x20	01 un	41,71	Jabu Eng. / orç. 10727
Counter 3TB44	01 un	88,83	Jabu Eng. / orç. 10727
Counter 3TF43	01 un	121,68	Jabu Eng /
Thermal Relay	01 un	28,15	Jabu Eng. /
On/Off Switch Mar-Girus 14223	01 un	5,07	Jabu Eng. /
Flexible Wire	100 m	26,00	Jabu Eng. / orç. 10727
Photos	32 un	30,88	Quality Color
	Total =	3.422,76	

Refrigeração Paraná - Unidade São Carlos

3- Injection Mould and Car Modifications

Description	Quant.	US$	Supplier
Electrical Resistances	35 un	258,75	Blecaulor / N.º 276
Screw to Fix The Resistances W5/16"X3/4"	38 un	8,32	Refripar SC
Self Tapping Screw	100 un	2,16	Refripar SC
Wire 4mm	100 m	108,91	Coan S.A / Nº 401793
Insulation Plate 3/4"x1,00x1,00m	03 un	24,00	
Temperature Control Incon	05 un	1.000,50	Incon / orç.230894-5
TBMU8P Control Sensor	06 un	151,80	Incon / orç.230894-5
Electrical Panel For Temperature Control	01 un	41,71	Jabu Engs. / orç.10767
Electrical Panel For Counters	01 un	67,94	Jabu Engs. / orç.10767
Counter 3TB44	03 un	199,89	Jabu Engs. / orç.10767
Electrical Connector Sindal S412	06 un	1,58	Jabu Engs. / orç.10767
Eye Type Terminal	100 un	7,40	Jabu Engs. / orç.10767
Higth Temperature Insulating Tape	01 un	8,85	Jabu Engs. / orç.10767
Type "T" Thermocouple Cu/Ct	100 m	819,00	S&E instr. / orç. 2923/94
Switch Seletor with 20 points	01 un	327,75	S&E instr. / orç. 2923/94
Temperature Indicator	01 un	300,15	S&E instr. / orç. 2923/94
Electrical Resistances	05 un	33,80	Blecaco Bruno
	Total =	3.3[illegible],29	

4- Cabinets Used in the Tests

Description	Quant.	US$	Supplier
Cabinet 4.1 SF	40 un	3.559,20	Refripar SC
	Total =	3.558,20	

Annex 7

Implementation Timeframe

	Time for Completion (One in One Month)							
Task	M1	M2	M3	M4	M5	M6	M7	M8
1. Preparation								
-MLF Approved	*							
-Procurement Preparation	*	*						
-Vendo Selection		*						
2. Installation and Start-Up								
-Purchase and Customs Clearance			*	*	*	*		
-Machime Installation Start-Up, Try-out and Training						*	*	
-Certification								*

Annex 8

BRAZIL - REFRIGERCAO PARANO - UNIDADE SAO CARLOS

TECHNOLOGY

CFC 11 is a viable and well proven first step towards CFC phaseout for refrigerator and freezer manufacturers. However, in 1994, it should be only considered when low or zero ODP technologies cannot readily be implemented. The enterprise (section 5.2) will follow developments at a sister factory who are converting (directly ?) to HCFC 141b with a view to implementation within about two years.

Overall, the reduced CFC 11 technology can be considered if the costs involved are low and the equipment purchased is compatible with a later technology - this latter point is confirmed in section 5.3.

A minor point, the technology overview (section 5.1) is outdated, discussing products long extinct and should itself be consigned to a museum.

ENVIRONMENTAL ISSUES

The reduced CFC 11 phase is clearly recognised by the enterprise as an intermediate step.

There are no safety issues related to this phase.

PROJECT COSTS

The UAC of the project appears to be wrongly calculated. Taking 1993 CFC 11 consumption at 127 te, a 50% reduction gives 64 te leading to a UAC of about 0.78 $/kg/yr (not 0.30 $/kg/yr). This is still relatively cost effective and in line with OORG Working Group estimates.

No operating cost changes are considered. The project demand dated 19/8/94 does not address the proposal raised by Mr. Horvay (consultant) relating to a low cost mould modification.

IMPLEMENTATION TIMEFRAME

Where is it ?

RECOMMENDATION

Approved subject to a satisfactory answer to the consultant's proposal and inspection of the implementation timeframe.

Annex 9

FINEP - Financiadora de Estudos e Projetos

To : Lau a Tlaiye
Task Manager Ozone Operations for Brasil
The Vorld Bank - LA 1 EU Division
Fax numl er : 001-202-6760377

From : P ulo Roberto da Silveira Fetal
F INEP - Financiadora de Estudos e Projetos
Fax numl er : 055-021-2760581

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Date : Oc 28th, 1994
Pages nur iber : 01

Message :

Oz. 3/94

Dear Ms. T aiye,

I an now informing you that FINEP agrees with the terms of Refripar São Carlos project exc utive summary sent on 29th September and with the implementation schedule sent yesterc ay to you and asks its transmittal to the Executive Commitee for approval.

PAULO R. DA SILVEIRA FETAL
Tec. Projetos e Programas IV
DCBS/CMA - DO. II