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

Seventeenth Meeting
Montreal, 26-28 July 1995

PROJECT PROPOSALS: CHINA

This document includes the Comments and Recommendations from the Fund Secretariat on the following projects:

- Conversion from CFC-11 to Cyclopentane in Domestic Refrigerator Manufacturing Plant at Chang Ling Co. Ltd. — World Bank
- Conversion of Compressor Production for Domestic Refrigerators from CFC-12 to Hydrocarbon Refrigerant at Jiaxipera Compressor Factory — UNIDO

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China
PROJECT TITLE:	Conversion from CFC-11 to Cyclopentane in Domestic Refrigerator Manufacturing Plant at Chang Ling Co. Ltd.
BUDGET:	Capital Costs: US $3,989,000 [1] Operational Costs: US $ 778,000
INCREMENTAL COSTS:	US $4,601,000[2]
ODS PHASE-OUT:	430 MT of CFC-11
COST EFFECTIVENESS[3]:	US $8.36 per kg. ODP saved
PROJECT DURATION:	1.5 years
IMPLEMENTING AGENCY:	World Bank
NATIONAL COORDINATING AGENCY:	NEPA
TECHNICAL REVIEW COMPLETED:	YES __X__ NO _____

SECRETARIAT'S COMMENTS

1. The project covers the conversion of a domestic refrigerator manufacturing company which comprises two factories. The total annual output of the company is about 537,000 household refrigerators and freezers. This project proposes to replace the CFC-11 used as a blowing agent in the production of insulation foam with cyclopentane. The proposal is included in the strategy of the Government of China for the phase out of CFC in the domestic refrigeration sector.

[1] Including a 10 per cent contingency fee.

[2] Including 3 per cent financial agent fee.

[3] Determined as the ratio of incremental costs, excluding safety-related costs, to the estimated annual savings of ODP ($/ODP kg.). For CFC-11 and CFC-12, ODS=ODP.

2. The proposal includes: modification of existing equipment where applicable; procurement and installation of new equipment or machinery including safety measures for the use of cyclopentane, modification of assembly lines, refrigerator redesign, testing and development of prototypes, and a training programme.

3. Chang Ling is in the process of implementing a project to test the performance of a binary blended refrigerant (HFC-152a)/HCFC-22) approved by the Executive Committee at its 13th Meeting at a cost of US $853,000. No additional funds will be requested to complete the ODS phase-out at Chang Ling.

4. The incremental operating costs include the additional costs of raw materials for a six-month duration. The requested operating costs need to be clarified since a new production line has been recently installed. Operating costs arising from this new line should be subtracted from the requested operating costs.

5. A technical review was provided by the World Bank.

6. The enterprise has converted to 50 per cent CFC reduced technology. It is reported that implementation of this project will result in the phase-out of 430 ODP tonnes of CFCs. This figure will have to be verified to exclude past consumption and consumption due to the new line.

7. The Secretariat reviewed the project proposal to assess the eligibility and costs of the requested equipment for the conversion to cyclopentane foaming, in light of similar projects approved by the Executive Committee and other projects submitted from China to the 17th Meeting in the subsector. Costs requested for several items substantially exceed costs for similar items in projects approved by the Executive Committee and in projects submitted from China for the current meeting by other implementing agencies. Additional information was provided from the World Bank. However, major issues concerning eligibility and level of costs are still outstanding, and the project can not be recommended for approval at this stage.

SECRETARIAT'S RECOMMENDATIONS

8. The Fund Secretariat recommends the project be deferred.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China
PROJECT TITLE:	Conversion of the compressor production for domestic refrigeration from CFC-12 to hydrocarbon refrigerant at Jiaxipera compressor factory
BUDGET:	Capital Costs: US $3,310,000 Operational Costs: not claimed
INCREMENTAL COSTS:	US $3,310,000
ODS PHASE-OUT:	296 T
COST EFFECTIVENESS[4]:	US $11.18 per kg. ODP saved
PROJECT DURATION:	Two years
IMPLEMENTING AGENCY:	UNIDO
NATIONAL COORDINATING AGENCY:	National Environment Protection Agency ((NEPA)
TECHNICAL REVIEW COMPLETED:	YES __X__ NO ____

SECRETARIAT'S COMMENTS

1. The project covers the conversion of a production of CFC-12 compressors to isobutane refrigerants at Jiaxipera company. The annual output of the company is 600,000 compressors. The proposal is included in the strategy of the Government of China for the phaseout of CFC in the domestic refrigeration sector. The Executive Committee approved at the 13th Meeting, two compressor manufacturing conversion projects from CFC-12 to HFC-134a refrigerant. This project is the first of its kind to produce Isobutane compressors in an Article 5 country. A project was approved for Germany-USA bilateral assistance to produce 100 per cent hydrocarbon based refrigerators at the 16th Meeting. Two more projects are being submitted to the 17th Meeting.

[4] Determined as the ratio of incremental costs to the estimated annual saving of ODP by end-users of Jiaxpera's compressors (indirect impact) ($/ODP kg.). For CFC-12, ODS=ODP.

2. The proposal includes: redesign, prototyping and testing; modification of existing equipment where applicable; procurement and installation of new equipment or machinery; modification of assembly lines and safety measures.

3. A technical review was provided by UNIDO.

4. The Secretariat reviewed the project proposal to assess the eligibility and costs of the requested equipment and other project components for the conversion to isobutane refrigerant technology. The Secretariat discussed with UNIDO the incrementality of all cost components and their amounts.

5. It was agreed that replacement of capital equipment will be eliminated where retrofitting was possible. Thus, only retrofit costs of existing boring machines and drilling and calorimeter are recommended. Technological upgrades were identified and the relevant costs have been deducted from the budget.

6. Operating costs were not claimed.

7. Consequently, it was agreed that the new project budget should be recommended for approval.

8. It was also agreed that cost-effectiveness cannot be meaningfully calculated for compressor manufacturer conversion project. The Executive Committee might wish to use conversion cost per unit as an indicator to compare relative cost-effectiveness of this type of projects. The conversion cost per unit in Jiaxipera project is US $2.48 per unit.

SECRETARIAT'S RECOMMENDATIONS

9. The Fund Secretariat recommends approval of US $1,490,000 for the implementation of the project at Jiaxipera, and recommends US $193,700 in support costs for UNIDO.

10. It is further recommended that the funding approved should be considered as part of future allocation for the implementation of China's strategy in the domestic refrigeration sector.

11. The Fund Secretariat recommends also to transfer the approved allocations to UNIDO from the amount of US $8,900,000 reserved by the Executive Committee for funding of projects in mobile air-conditioner and compressor sub-sector in 1995.

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER

PROJECT COVER SHEET

COUNTRY:	The Peoples Republic of China		
PROJECT TITLE:	Conversion from CFC11 Foaming Agent to Cyclopentane		
SECTOR COVERED:	Household Refrigerator		
ODS USE IN SECTOR:	17,773 MT of CFC-11 in 1991		
PROJECT IMPACT:	430 MT CFC-11 and 86 MT CFC-12 (1994 basis)		
PROJECT DURATION:	1.5 years		
PROJECT ECONOMIC LIFE:	15 years		
TOTAL PROJECT COST:	Total Incremental Investment Cost	**US$**	**3,626,450**[1]
	Contingency (10%)	US$	362,550
	Incremental Operating Cost:	US$	478,000
	Total Investment Cost:	**US$**	**4,467,000**
	Financial Agent Fee (3%)	US$	134,000
	Proposed OTF Grant	**US$**	**4,601,000**
PROPOSED OTF FINANCING:	**US$4,601,000**		
COST EFFECTIVENESS:	$8.76 per kg ODP		
IMPLEMENTING ENTERPRISE:	Chang Ling (Group) Co. Ltd.		
COORDINATING MINISTRY:	National Environmental Protection Agency (NEPA)		
IMPLEMENTING AGENCY:	The World Bank		

PROJECT SUMMARY

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators manufactured at Chang Ling (Group) Co.Ltd. The project will comprise one phase and will convert the production lines to household refrigerators using cyclopentane as the foam blowing agent . This project will provide for product development using CFC alternatives and will identify all equipment and process changes needed to implement the alternative technology. During the project, Chang Ling will secure engineering assistance and training from various companies including Liebherr (Germany). The project will result in the elimination of 430 MT/year of CFC-11 (foam blowing agent) based on 1994 production and a 100% CFC use basis. Chang Ling are in the process of implementing a Montreal Protocol funded project to test the performance of a binary blended refrigerant (HFC152a/HCFC22). Both projects will be implemented concurrently. No additional funds will be requested to complete the ODS phaseout at Chang Ling.

TECHNICAL ASSESSMENT: The project has been reviewed and is supported by Dr. G.M.F. Jeffs, OORG Expert for the Foam sector

Revised May 31, 1995

[1] Total Incremental Investment Cost is net of salvage value of replaced equipment.

PROJECT OBJECTIVE

The objective of this project is to phase out CFC-11 used in household refrigerators in two factories owned by Chang Ling (Group) Co. Ltd. The project provides for the purchase of equipment, the transfer of technology, and the training necessary to facilitate an effective transition to cyclopentane as the new blowing agent in polyurethane insulation foam. This project will help to popularize the use of Cyclopentane foam blowing agent by other refrigerator manufacturers.

SECTOR BACKGROUND

Table 1
China - ODS Consumption in Domestic Refrigeration (1993)
(metric tons)

	CFC-11	CFC-12
Original Equipment	6740	1580
Servicing	0	170
Total	6740	1750

The total consumption of chlorofluorocarbons (CFCs) in the foam industries has been estimated in 1993 at approximately 17,773 MT CFC11. Of this, it is estimated that 6,740 MT of CFC-11 were used in the production of polyurethane (PU) appliance insulation foam. An additional 1750 MT was consumed as refrigerant. The total consumption by the domestic refrigeration sector was 8490 MT, 11% of the total CFC consumption in China.

China is the largest manufacturer of refrigerators and freezers in the world. Production has grown at 16% per year over the last past three years, to approximately 8.0 million units in 1993. In 1993, less than 6% of the units produced were exported.. There are 15 major domestic refrigerator manufacturers in China accounting for about 87% of the refrigerator/freezer market. Production facilities consist of 70 refrigerator lines and 30 freezer lines with a total annual capacity of 11.5 million units in 1993. Capacity utilization is currently less than 70%. Refrigerator lines were imported Europe, US and Japan over the past 15 years while freezer lines have been developed locally.

A total of 43 million units are estimated to be in use at the beginning of 1994. Refrigerator life averages 20-25 years during which refrigerant is replaced every 8-10 years. The average charge of CFC-12 in refrigerators, freezers and coolers manufactured in China is 0.15-0.30 kg. An additional 0.6 to 0.8 kg of CFC-11 is used in making the rigid polyurethane foam in the cabinet. Most of the refrigerator manufacturers in China have already started using 50 percent CFC-11 reduced PU foams formulations. Recently, NCLI has decided to introduce Cyclopentane technology in several factories. At the same time other technologies are also being explored, including HCFC141b, liquid HFCs, and vacuum panels. The sectoral objective is stop the use of CFCs in refrigerator foam insulation by 2003. .

Five projects for implementation of cyclopentane technology are active in China. Kelon (500MT CFC11);Zhong Yi (460MT CFC11); Haier Group (250MT CFC11); Hua Yi (200 MT CFC11); and Chang Ling (500MT CFC11). The Chang Ling project is the first to be presented through the World Bank for MPEC approval.

ENTERPRISE BACKGROUND

Chang Ling (Group) Co. Ltd.is located in Bajoi City, Shanxi Province approximately 100 km west of Xian, China. The company is 100% Chinese owned. Chang Ling employs 6,000 people including 1860 engineers and technicians. The plant area is 450,000 sq. meters. The first refrigerator line was imported from Perros (Italy), the second line from Cannon (Italy) in 1989, and the third line from Hennecke (Germany) in 1993. The plant now consists of 3 refrigerator lines in two factories. Annual capacity is 650,000 units. Chang Ling's refrigerator market share is currently about 7%. Chang Ling stock is listed on the Shanzhan stock market.

Production of Refrigerators and Freezers - Chang Ling

	Actual				Forecast			
(000 units)	91	92	93	94	95	96	97	98
Refrigerators & Freezer Production	--	--	395	537	730	730	730	730

Chang Ling (Group) Co. Ltd was established in 1992. Previously it had been part of the Chang Ling Machine Factory producing military electronic products. In 1994, Chang Ling will produced approximately 537,000 refrigerators comprising 6 different models that can be categorized as tropical double-doors models. Chang Ling expects to reach its maximum capacity in 1995.

In 1991, Chang Ling began to phaseout CFCs in refrigerator foam in cooperation with Bayer Company. By 1993, 50% reduced CFC production was started, however, Chang Ling was not satisfied with the results and believing that a complete replacement of CFCs would be necessary, started investigating alternatives. The preferred alternative was found to be cyclopentane. Chang Ling was selected by the China Household Electric Appliance Assn (CHEAA) as one of three demonstration projects for this technology.

This project will complete the need for funding through the Multilateral Fund to phaseout CFC use by Chang Ling by the end of 1997.

PROJECT DESCRIPTION

There are two factory workshops in Bajoi, No. 27 and No. 29. Workshop No. 27 has two production lines. The first line has a cabinet position consisting of a Cannon 100 foaming unit and 8 Perros foaming fixtures, and a door position consisting of a Cannon 40 foaming unit and 12 fixtures. The cabinet position in the second line consists of a Hennecke model HK foaming unit and 6 fixtures and the door position of and OMS foaming unit and 17 fixtures. Because the second line was built in 1993 (after China joined the MP), revision of this line is excluded from the project. Workshop No. 29 consists of a cabinet position with Cannon 100 foaming unit and 12 fixtures (6 Canon and 6 locally made) and door position with a Cannon Model 40 foaming unit and 13 Cannon fixtures. The premixing area in Workshop No. 27 has a 1000 liter MDI tank, a 600 liter metering mix tank, and an 800 liter intermediate tank. The premixing area for Workshop No. 29 in larger and has a 200 liter MDI tank, a 1000 liter mixing tank and a 2000 liter intermediate tank. Foaming equipment is not suitable for handling flammable foaming agents and therefore must be modified or replaced. The most cost effective plan was determined to be to modify all Cannon units and replace the Hennecke and Perros units.

In this project, Chang Ling (Group) Co. Ltd.will eliminate the use of CFC-11 in household refrigerators by converting its manufacturing facility to one that is compatible with cyclopentane.The project will be realized in two phases. In phase 1, workshop No. 29 will be converted to cyclopentane, and after 6 months of operational experience, phase 2 will be accomplished in workshop No. 27. The project will provide for the acquisition of new technology, the procurement and installation of the necessary machinery and equipment, engineering assistance and training. Upon completion, Chang Ling will have totally converted its production lines to the alternative technology and start full production of CFC-foam free refrigerators.

To implement this project, the following actions will be necessary:

o Install/modify two cabinet foaming plants and two door foaming plants designed for use of flammable cyclopentane. These plants are to include foaming fixtures, high pressure injection heads, cooled metering unit, preheating ovens, ventilation and safety alarm systems.

o Modify moulds and jigs by changing from electrical heating to hot water heating.

o Because of the high flammability of cyclopentane, a complete safety system will be installed. This consists of double wall piping, gas sensors, alarms and a ventilation system in the foaming area.

o Ground all equipment and install anti-static floor in the foaming area to eliminate buildup of static electricity which could detonate flammable mixtures of cyclopentane and air.

o Install an underground storage tank for cyclopentane meeeting established safety standards.

The last stage of the project will consist of finalizing the transition to CFC-free technology for mass production. During this time, production trials of non-CFC refrigerators will be conducted to enable Chang Ling's personnel to get more acquainted with the new equipment and to fine-tune the production lines, resulting in a better quality product.

Chang Ling has selected LIEBHERR (Germany) as its technical cooperation partner for this project and is in the process of formalizing an agreement for technical traning and startup assistance.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

Several different alternative blowing agents to CFC-11 are being developed, such as HCFC-141b, HCFC-22, HCFC-22/HCFC-142b and HFC-134a. Chang Ling has decided to use cyclopentane as its new blowing agent for the following reasons:

- China's Refrigeration Sector Strategy is fo focus on the use of cyclopentane and HCFC141b.
- LIEBHERR, Chang Ling's technology partner, is already using cyclopentane as the blowing agent in its domestic refrigerators.
- Cyclopentane has a boiling point and thermal conductivity suitable for refrigerator foam.
- Aging characteristics of cyclopentane foams are superior to CFC11 foams.
- Cyclopentane has a zero ODP and a negligible GWP.
- Cyclopentane can be imported and eventually will be available at a competitive price in China.

PROJECT COSTS

Total Project Cost

As described below and presented in detail in the relevant annexes, the total project cost is **U.S.$4,467,000.**

Investment Cost

As detailed in Annex 1, the total investment cost for this project is **US$3,989,000.** Major components of the costs include costs associated with CFC-free refrigerator product development, technical assistance, testing and training. The investment cost exclusive of safety related items is **$2,845,400.**

Operating Costs

If the project is implemented, the annual incremental operating cost will be **US$478,000** based on 6 months of operation at current rates. A detailed breakdown of operating costs is provided in Annex 2 based on reimbursement for 6 months of incremental costs associated directly with the use of cyclopentane.

Unit Abatement Cost (UAC) & Cost Effectiveness (CE)

As shown in Annex 3, the UAC is US$ 2.19 per kg ODP and the CE is $8.76 per ODP-weighted kg of ODS phased out per year based on non-safety related project costs.

Proposed OTF Grant

The proposed OTF grant for Chang Ling is **US$4,601,000** A 3 percent Financial Agency Fee was added to the total project cost to yield the grant amount. A 10% contingency fee was included in the estimate of incremental capital costs to compensate for some price fluctuations in equipment to be purchased. Incremental operating costs, based on 6 months operation, are estimated and included in the present grant request. There are no incremental operating revenues.

FINANCIAL AND ECONOMIC ANALYSIS

Economic Internal Rate of Return (ERR)

Because the project entails an initial investment followed by a net annual incremental operating cost, there will be a net outflow of cash each year for the project's entire economic life. The ERR for the project is thus undefined.

Financial Internal Rate of Return (FRR)

Because the project entails an initial investment followed by a net annual incremental operating cost, there will be a net outflow of cash each year for the project's entire economic life. The FRR for the project is thus undefined.

FINANCIAL STATUS OF ENTERPRISE

Based on a review of the company's annual reports, the financial status of this enterprise appears to be sound and satisfactory for the purposes of the proposed activities.

PROJECT IMPLEMENTATION

Management

China Investment Bank (CIB) will oversee the successful implementation of this project. The project will be carried out by Chang Ling (Group) Co. Ltd. with technical assistance from LIEBHERR.

Schedule

TASK	1995	1996	1997
Model Development, Technical Assistance	xxxx		
Procurement, Rennovation and Installation	xxx		
Training	xx	x	
Production Trials in Workshop No.29	x	xx	
Production Trials in Workshop No.27		xx	xx
Full Production			xxx

Note: x = one quarter of the year

Procurement

Chang Ling will be responsible for ensuring that procurement under the Projects follow the agreed guidelines, including foreign and domestic equipment. Bidding documents will be prepared based on model bidding documents acceptable to the World Bank. NEPA and NCLI will review compliance with the agreed procedure.

RESULTS

Direct Project Impacts

Chang Ling plans to eliminate the use of CFCs by 1997. In 1994, the company would have consumed 86 MT CFC-12 refrigerant plus 430 MT of CFC-11 had the test program for 50% CFC reduction not been implemented. Chang Ling initiated use of 50 percent CFC-11 reduction technology in 1992, for which it currently consumes approximately 0.36 kg of CFC-11 per set.The average CFC-12 charge size in refrigerators is 0.152 kg

. Indirect Project Impacts

This project will facilitate a more rapid conversion of China's refrigeration industry to nonODP foaming agents.

ENTERPRISE COMMITMENT:

NEPA and NCLI have confirmed with executives of Chang Ling that the enterprise is committed to undertaking the project described above provided that funds are approved and available as scheduled.

ANNEX 1

BREAKDOWN OF INVESTMENT COSTS

Foam Insulation System

A. Phase 1 - Conversion of WorkshopNo.29		**Item Cost**	**Safety Related Cost**
1) Cabinet foaming unit :	$820,000		
- Preheating ovens (1)		16,500	
- Foaming fixtures (12)		500,000	50,000
- High pressure injection heads (2)		30,000	
- Metering unit		128,500	
- Explosion proof suction fans (13)		90,000	90,000
- Alarms and control board (18)		55,000	55,000
2) Door foaming unit:	$801,700		
- Foaming fixtures (13)		500,000	50,000
- High pressure injection heads (2)		10,700	
- Metering unit		187,700	
- Alarm and control board (2)		26,700	26,700
- Suction box (2)		76,600	76,600
3) Centralized Polyol and Isocyanate System:	$338,000		
- Underground 35m^3 storage tank (2)		60,000	
- Tank accessories		16,000	
- Pump room		65,000	30,000
- Piping		50,000	
- Mixing unit for polyol and cyclopentane		64,000	30,000
- Intermediate tank (2)		38,000	
- Alarm and control board		45,000	45,000
Sub-total - Phase 1 Equipment	**$1,959,700**		**$453,600**

B. Phase 2 - Conversion of WorkshopNo.27

1)	Cabinet foaming unit :	$728,050		
	- Preheating ovens (1)		16,500	
	- Foaming fixtures (8)		330,350	33,000
	- High pressure injection heads (8)		117,700	
	- Metering unit		128,500	
	- Explosion proof suction fans (13)		90,000	90,000
	- Alarms and control board (10)		45,000	45,000
2)	Door foaming unit:	$801,700		
	- Foaming fixtures (12)		500,000	50,000
	- High pressure injection heads (2)		10,700	
	- Metering unit		187,700	
	- Alarm and control board (2)		26,700	26,700
	- Suction box (2)		76,600	76,600
3)	Premixing Unit	$159,000		
	- Premixer		114,000	
	- Alarm and Control Board		45,000	45,000
	Sub-total - Phase 2 Equipment	**$1,688,750**		**$366,300**

C.	**Prototyping and Testing**			
	1) Preparation of non-CFC refrigerator prototypes for testing (100 units @ $130/unit)		13,000	
	Sub-total	**$ 13,000**		
	D. Technical Assistance and Training			
	1) Consultancy fee for Foam Technology		25,000	
	2) Foreign consultants		20,000	
	3) Training		20,000	20,000
	Sub-total	**$ 65,000**		**$ 20,000**
	E. Total Investment Cost (ex. Contingency)	**$ 3,726,450**		
	F. Contingency Fee (10%)	**$ 362,550**		**$ 84,000**
	G. Scrap Value of Foaming Equipment	**($ 100,000)**		
	TOTAL INVESTMENT COST	**$ 3,989,000**		**$923,600**
	NON-SAFETY RELATED INVESTMENT COST		**$ 3,065,400**	

CALCULATION OF OTF GRANT

Costs in US Dollars

Total Investment Cost	**$**	**3,989,000**
Incremental Operating Cost	**$**	**478,000**
Foreign Ownership (0%)	**$**	**(0)**
Export Deduction (5% - 10%= 0%)	**$**	**(0)**
Financial Agency Fee (3%)	**$**	**134,000**
TOTAL OTF GRANT REQUEST	**$**	**4,601,000**

ANNEX 2

BREAKDOWN OF INCREMENTAL OPERATING COSTS/SAVINGS[2]

Estimated Costs in US Dollars

Item	Basis	CFC11	CYCLO-PENTANE
Polyol/Isocyanate	10% increase in foam density plus higher price of foam chemicals	12.163	13.628
Foaming Agent	755 gms CFC11 @$1.40/kg 334 gms C-pentane @ $3.80/kg	1.057	1.269
Total		13.220	14.897

TOTAL INCREMENTAL COSTS PER UNIT (based on 570,000 Units Produced)	**$**	**1.677**
TOTAL INCREMENTAL COSTS PER YEAR	**$**	**956,000**
INCREMENTAL OPERATING COST (6 months)	**$**	**478,000**

[2] Recurrent costs will be evaluated on an current basis, due to the rapid changes in foam technology and associated costs.

ANNEX 3
CALCULATION OF UNIT ABATEMENT COST & COST EFFECTIVENESS
Estimated Costs in US Dollars

A. ODS SAVINGS: (1994 Basis w/o 50% CFC reduction)

Average use of CFC-11 per year	430 MT
Average use of CFC-12 per year	86 MT
ODP of CFC-11 & CFC-12	1.0
Total ODP weighted savings	516 MT

B. ANNUALIZED CAPITAL COST:

Total from annex 1:	$3,989,000
Project for conversion to HFC152a/HFC22 Refrigerant - Approved 7/94	$ 978,000
Project life:	15 years
Discount rate:	10%
Annualized capital cost:	$ 649,210

C. ANNUAL INCREMENTAL OPERATING COST: This Project $ 478,000

D. UNIT ABATEMENT COST:

	Cost per year	Unit Cost per kg ODP Saved
Annualized Capital Cost - Both Projects	$649,210	$1.26
Annual Incremental Operating Cost - This Project	$478,000	$0.93
Total Unit Abatement Cost ($/kg)		$2.19

E. COST EFFECTIVENESS:

Bases:	Project to Test Use of HFC152a/HCFC22 in Domestic Refrigeration - Approved 7/94	$ 978,000
	Total Investment Cost - This Project	$3,969,000
	Incremental Operating Costs - This Project	$ 478,000
	Safety Related Costs - This Project	$ 923,600

	Cost Effectiveness ($/kg ODP)
Total All Chang Ling Projects ($3,969,000+$978,000+$478,000)/516,000	$ 10.55
Total Exclusive of Safety Related Costs ($3,969,000+$978,000+$478,000-$923,600)/516,000	$ 8.76

ANNEX 4

ENVIRONMENTAL ASSESSMENT

With the exception of cyclopentane fumes collected by the ventilation system and exhusted to the atmosphere, this project will not result in any additional emissions, effluents, or wastes being produced at Chang Ling's plant. It is the best judgment of the project proposal team that the project will meet all applicable Chinese government environmental, health, and safety regulations.

CHINA - CHANGLING

TECHNOLOGY

The technology choice to replace its current reduced CFC 11-based foam of cyclopentane is increasingly being used in developed and developing countries since its introduction in Europe in 1993. Experience there has shown that this transition (reduced CFC 11 --> cyclopentane) results in only a marginal change in energy efficiency. Hence, the lower insulation value (P6) may not happen. I do not understand what the comment on longer ageing time refers to - certainly demould times are unchanged with cyclopentane.

The enterprise considered the HCFC 141b option but this would have to be eventually replaced by, for example, a liquid HFC such as HFC 245. There are many issues which have to be addressed before this product is commercially available.

Cyclopentane requires extensive safety measures because of its flammability. Comments on this are included in the Project Costs section.

ENVIRONMENTAL ISSUES

Cyclopentane has a zero ODP (and near zero GWP) and, in terms of ozone depletion, represents a long term option. It is a VOC and capable, if emitted, of producing low level pollution. The enterprise should become familiar with the local regulations which may develop.

PROJECT COSTS

At this preliminary review stage there are several comments to be made:

- Who will be the technology transfer partner and who will supply the written confirmation that required safety standards in terms of equipment and operations are being adhered to?
- For factory #27 a replacement Cannon dispenser for the low pressure OMS is on order. Is this part of the project ? Is it cyclopentane capable ? If not, why is it still required and could its cost be offset versus the equipment detailed in the project ?
- The factory #29 line was installed in 1993 - what is the disposal value of the relatively new Hennecke equipment ?
- The enterprise description on P4 does not refer to the second door lines in factory #27. Is the second door line in the project an additional production facility ?
- Have competitive quotations been sought ?
- Details are required of the training programme.

- How will the implementation task force (P4) be coordinated ?
- Is the cyclopentane bulk tank outside / underground ?
- There is insufficient detail on the recurrent costs - more information on chemical prices and foam usage required.

Annexes 1-1 to 1-5 do not mean much to me because of my poor knowledge of Chinese characters.

IMPLEMENTATION TIMEFRAME

OK

RECOMMENDATION

Overall the project should be capable of approval after the above issues are addressed

G. M. F. Jeffs
GMFJ/kd/27/2/95

CHINA - CHANG LING (GROUP) CO, LTD.

TECHNOLOGY

The enterprise is proposing to convert the polyurethane rigid foam insulation used in the manufacture of domestic refrigerators and freezers to a technology using cyclopentane. The project is concerned with one of the enterprise's two production lines in Workshop No 27 and with its production line in Workshop No 29. The current blowing agent is CFC 11 used in the 50% reduced mode.

Cyclopentane technology is now well proven in several countries including the European Union, Australia, New Zealand and in some developing countries. It is a zero ODP solution.

Other technologies were considered but cyclopentane was accepted on the basis on environmental and technical reasons. The main issue is concerned with safe operation because of the highly flammable nature of cyclopentane. The enterprise is proposing a range of equipment and training items which satisfies this need and has also selected as technology partners Liebherr and OMS who are well experienced in the field.

ENVIRONMENTAL ISSUES

The main issue is safety as outlined above. This issue is satisfactorily addressed. Cyclopentane has a zero ODP and a near zero GWP and therefore constitutes a long term solution.

The only other issue in this category is for the enterprise to confirm that it satisfies local regulations on VOC emissions.

PROJECT COSTS

At the time of preparing this assessment the exact national CFC consumption at the enterprise and per unit has not been finalised. The enterprise is calculating the project cost effectiveness on the basis of converting from a situation of using a full rather than a reduced CFC system. On this basis the project falls below the EC guideline limit. This method of calculation is a policy issue but could be logically applied if no funds were received for the conversion to the reduced CFC system. The capital items listed in Annex 1 are all justified and in line with best practise for such conversions. One point of clarification (which does not hold up the project) - no metering unit is indicated for the cabinet line for Workshop No 29 - is the current unit to be used ?

The operating costs are dependent on the increase in foam density and price of cyclopentane. In the reviewer's opinion both of these are high. Density increases below the current 10% are possible with latest foam systems. These aspects should be reviewed in the light of operation after implementation.

IMPLEMENTATION TIMEFRAME

This is realistic.

RECOMMENDATION

Approved.

The items under project costs to be borne in mind.

GMFJ/kd/23/5/95

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

COUNTRY	People's Republic of China			
PROJECT TITLE	Conversion of compressor production for domestic refrigerators from CFC-12 to hydrocarbon refrigerant at Jiaxipera Compressor Factory			
SECTORS COVERED	Domestic refrigeration: compressors			
ODS USE IN SECTOR	1,706 MT (1,706 MT ODP-weighted) of CFC-12 as refrigerant in 1993 and 4,600 MT (4,600 MT ODP-weighted) of CFC-11 as foam blowing agent in 1992. Additionally, CFC-113 solvent for cleaning operations			
PROJECT IMPACT	Annually, indirect phase out of 200 MT of CFC-12 refrigerant and direct elimination of 120 MT of CFC-113 solvent. (Total 296 ODP-weighted MT)			
PROJECT DURATION	24 months			
PROJECT ECONOMIC LIFE	10 years			
TOTAL PROJECT COST	Investment (capital) costs,		US$	3,310,000
	Incremental operating costs,		US$	(not claimed)
	13 per cent agency overhead,		US$	430,300
	Total Project Costs,		US$	3,740,300
OWNERSHIP STRUCTURE	100 per cent Chinese			
PROPOSED MF FINANCING	US$	3,740,300		
UNIT ABATEMENT COST	US$	1.82	per kg of phased-out ODS	
COST EFECTIVENESS	US$	11.18	per kg of phased-out ODS (3,310,000/296,000)	
COUNTERPART ENTERPRISE	Jiaxipera Compressor Company Ltd.			
IMPLEMENTING AGENCY	UNIDO			
COORDINATING MINISTRY	China National Council of Light Industry through China Household Electrical Appliances Association			
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)			

PROJECT SUMMARY

This project will convert the CFC-12 compressor manufacture at Jiaxipera Compressor Company to hydrocarbon (isobutane) HC-600a. By this conversion, indirect phase out the annual use of 200 MT of CFC-12 will be achieved. Additionally, 120 MT (96 MT ODP-weighted) CFC-113 solvent used in cleaning operations will be eliminated directly.

The hydrocarbon refrigerant technology has been selected on the basis of: (a) Technological reasons such as zero ODP, very low GWP (Global Warming Potential), requiring lesser manufacturing process changes, its increasing international acceptance, etc.; (b) Chinese market situation, already three refrigerator factories with a combined annual production of about 1.8 million refrigerators have been committed to H-C technology; (c) Government, after a strategy study, recommends that the H-C technology should be introduced at Jiaxipera Compressor Company and three refrigerator manufacturers; and (d) Its cost-effectiveness in China in comparison to some other ODS-free refrigerant options such as 134a.

The total estimated cost for the project is US$ 3,310,000. The unit abatement cost is 1.82 US$/kg of eliminated ODS. The cost effectiveness of the project is 11.18 US$/kg of eliminated ODS.

Contents

1. Project overview

This project will phase out the annual use of 200 MT of CFC-12 which is charged into refrigerators by the refrigerator manufacturers equipped with compressors built by the Jiaxipera Compressor Company. Additionally, annual consumption of around 120 MT of CFC-113 cleaning solvent will be eliminated.

In order to accomplish the above-mentioned phase-out programme, necessary changes in the products, that is compressors, and manufacturing processes will be made. Hydrocarbon refrigerant technology and isobutane refrigerant have been selected as the new CFC-12 substitute technology.

The total estimated incremental investment cost for the project is US$ 3,120,000. It is assumed that the incremental increase in the price of the compressor will be claimed by the refrigerator companies and hence, here, no incremental operating cost claim is made.

The approach adopted here is in accordance with the strategies described in the "China Country Programme" and the "National Strategic Study on the Phaseout of CFC-12 in China's Household Refrigeration Industry."

2. Project objective

The objective of the present project is to phase out the indirect use of CFC-12 refrigerant in the production of household refrigerators equipped with Jiaxipera compressors. This target will be reached by substituting CFC-12 refrigerant with HC-600a isobutane refrigerant.

3. Sector background

The strategy of the Chinese Government for the replacement of the CFC-12 use in the household refrigeration sector is given in a recent paper "National Strategic Study on Gradual Phaseout of CFC-12 in China's Household Refrigeration Industry". This paper was still in its draft form in September 1994, however, some of its relevant parts are summarized below.

In 1993, 6.22 million refrigerators and 1.88 million freezers were built in China. China exported 450,000 refrigerators in 1993. Main export markets are USA, European and Southeast Asian countries. There are 10 refrigerator manufacturers in China with an annual production capacity of more than 300,000 units each. The total domestic production of compressors for household refrigerators in 1993 was 5.9 million units

If one considers that the distribution rate of refrigerators in urban areas is 55.9 percent and in rural areas is 2.2 percent, than the conclusion is that the Chinese domestic markets hold great potentials for the supply of household refrigerators.

ODS is consumed in the household refrigeration sector for:

a) Charging of new appliances with CFC-12.
b) Refilling of appliances with CFC-12 after repair work.
c) Insulation foam blowing using CFC-11.
d) Parts cleaning during compressor production using CFC solvents (mainly CFC-113).

In this connection, Exhibit 1 provides some actual consumption data.

Exhibit 1. Consumption of CFC-11 and 12 in China's Household Refrigeration Industry, in MT

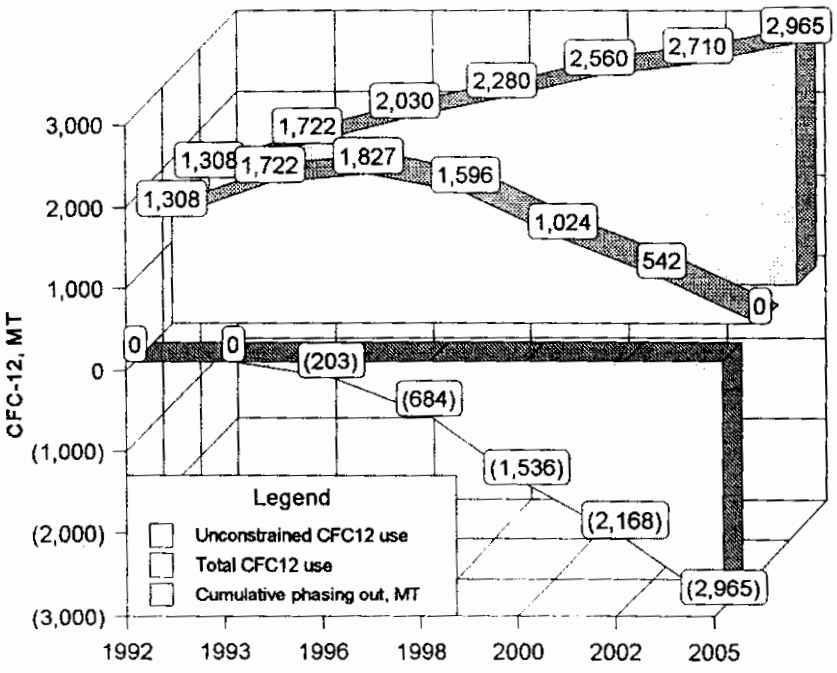
ODS type	1991	1992	1993
CFC-12 refrigerant, of which	1,145	1,308	1,722
Production	1,050	1,200	1,580
Refills during repair	95	108	142
CFC-11 foam blowing agent	5,000	5,650	6,740
Total, CFC-11 and CFC-12	6,145	6,958	8,462

Exhibit 2 and 3 give the unconstrained consumption projection for CFC-12 refrigerant to be used in the new appliance charging and shows the phasing out strategies of this ODS.

Exhibit 2. Unconstrained CFC-12 consumption and phaseout strategies, in MT

	1992	1993	1996	1998	2000	2002	2005
Unconstrained CFC-12 use	1,308	1,722	2,030	2,280	2,560	2,710	2,965
Cumulative phasing out, MT	0	0	203	684	1,536	2,168	2,965
Phasing out, %	0	0	10	30	60	80	100
Total CFC-12 use	1,308	1,722	1,827	1,596	1,024	542	0

Exhibit 3. Phaseout strategies for CFC-12 refrigerant



Experience in the selection of CFC-12 substitution technologies in China is limited. Chinese companies, universities and research institutes are cooperating with their counterparts in the developed countries in the areas of transfer of technology and fundamental research. Government, in close cooperation with all the parties involved, has selected the following technologies and corresponding enterprises for the CFC-12 phase out programme. The six World Bank projects listed in Exhibit 4 were approved for Multilateral Fund financing in July 1994.

Exhibit 4. Selected CFC-12 substitution technologies and responsible enterprises

Substitute refrigerant	Enterprise			Compressor		Implementing agency
	Name	Products	Capacity	Type	Technology source	
HFC-134a	Shanghai Compressor Factory	Compressor	400,000	Rotary	Mitsubishi	World Bank
HFC-134a	Shangling Electric Appliance Factory	Refrigerator	400,000	Rotary	Mitsubishi	World Bank
HFC-134a	Hua Yi Refrigerator Factory	Refrigerator	300,000	Reciprocating	Kirby	World Bank
H-C	Jiaxipera Compressor Factory	Compressor	1,000,000	Reciprocating	Aspera (present CFC-12 technology)	UNIDO
H-C	Xiling Refrigerator Factory	Refrigerator and freezer	400,000	Reciprocating	Jiaxipera (planned)	UNIDO
HFC-152a	Wanbao Refrigerator Factory	Refrigerator	1,200,000	Reciprocating	Wanbao	World Bank
MP-39 (ternary blend: HFC152a + HCFC22 + HCFC124)	Shuanglu Electric Appliance Factory	Refrigerator	400,000	Reciprocating	DuPont (refrigerant)	World Bank
HFC152a + HCFC22 (binary blend)	Changling Electric Appliance Factory	Refrigerator	400,000	Reciprocating	Changling	World Bank

4. Enterprise background

Detailed information about Jiaxipera Compressor Company is presented in Annex 6. That annex is based on the response of the Company to the UNIDO Questionnaire.

5. Project description

The Jiaxipera Compressor Factory will accomplish the goal to replace all models of compressors using CFC-12 refrigerant by changing over to hydrocarbon refrigerant, that is to HC-600a isobutane technology. This means that six new compressor models will be introduced and manufactured in the future.

In order to be able to describe the project properly, the exploded and cross-sectional views of a compressor are given in Exhibits 5 and 6.

Exhibit 5. Exploded view of a compressor similar to one produced by Jiaxipera

This is an exploded view of an R- 12 compressor manufctured by Jiaxipera. Changing the refrigerant to R-600a will cause a number of components to undergo design changes. In the exploded view, the names of those components which are changed are given.

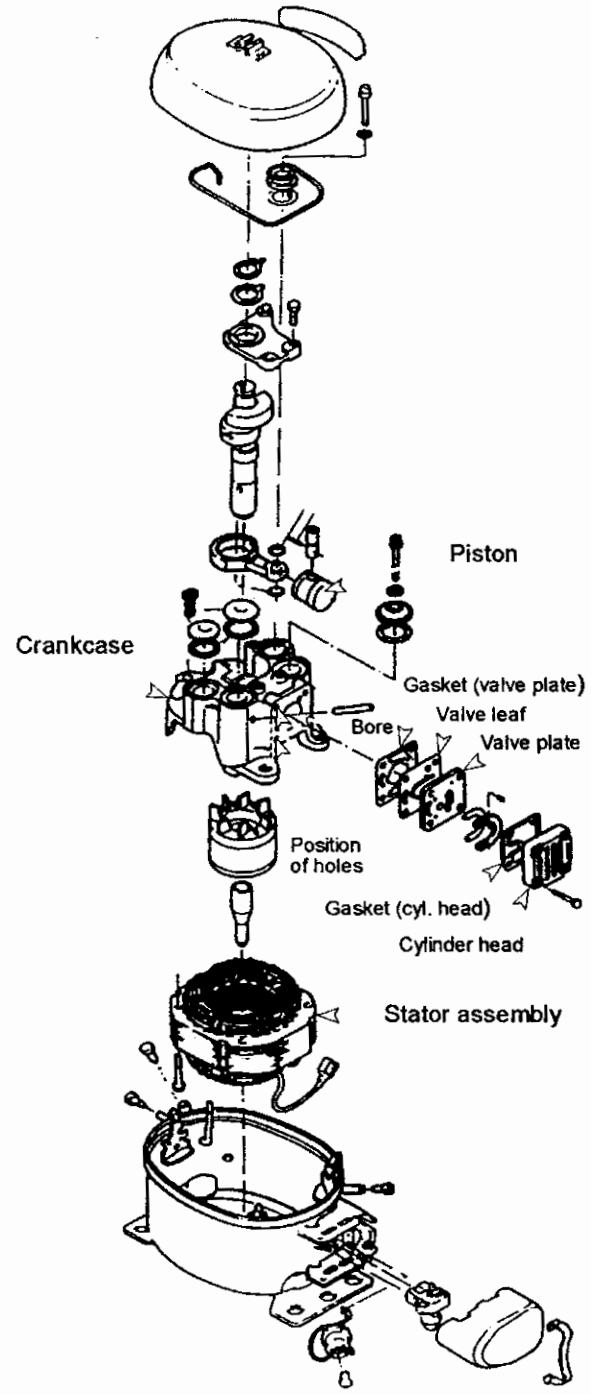
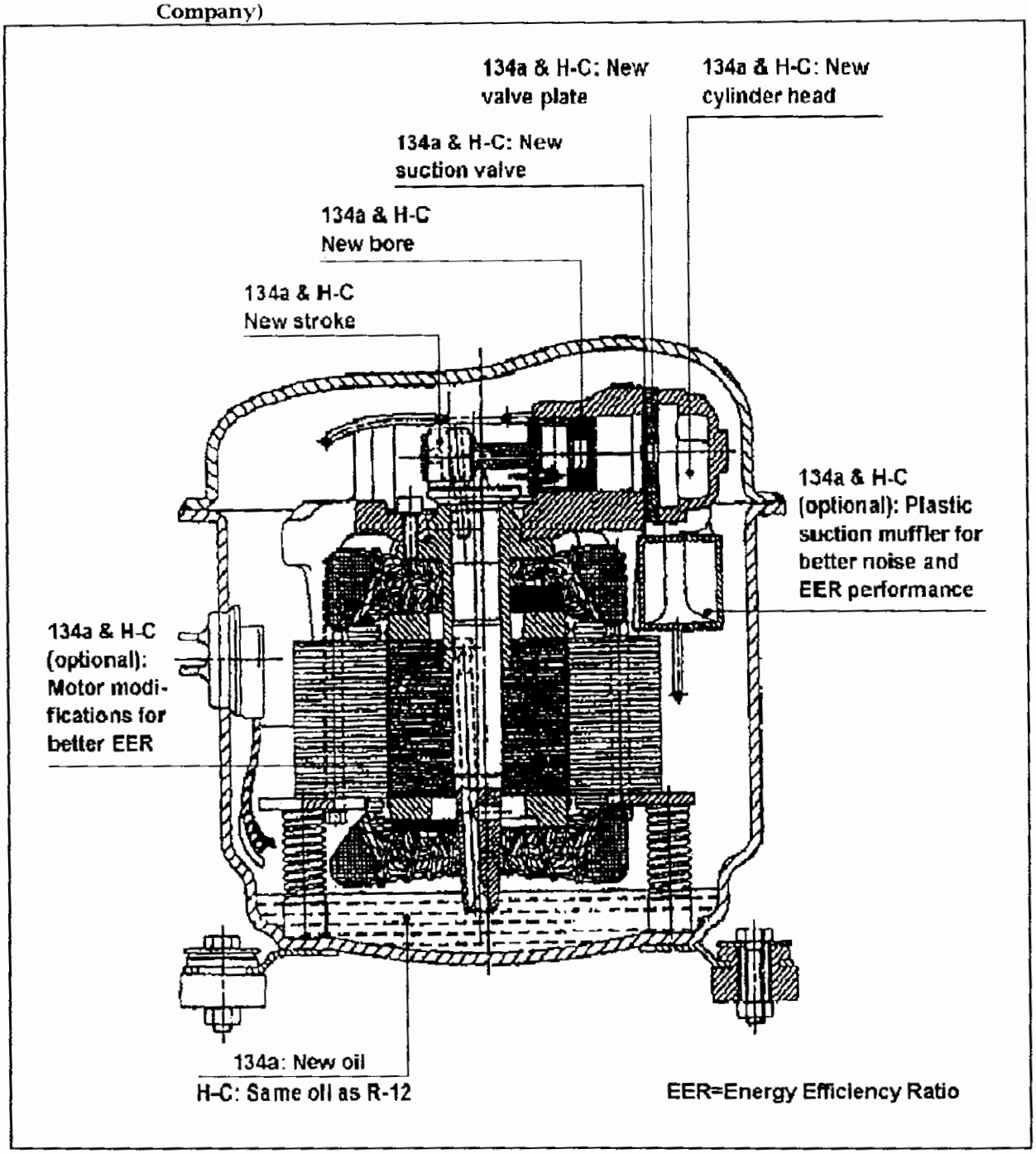


Exhibit 6. Cross-sectional view of a compressor showing parts to be redesigned when the refrigerant is changed (redrawn from an original by Electrolux Compressor Company)



Exhibits 5 and 6 indicate the components of the CFC-12 compressor which have to be (or optionally) redesigned when the refrigerant is changed to 134a or HC-600a. 134a is included here to further justify the selection of HC-600a isobutane technology. Exhibit 7 summarizes the redesign and manufacturing process change requirements of technology change.

Exhibit 7. Components of the compressor and required changes

	134a	HC-600a
Crankcase	Theoretically is the same. However, minor changes may be necessary.	Larger displacement requires bigger bore and/or longer stroke.
Product→	Redesign	Redesign
Manufacturing process→	Foundry: New mould Machining: boring, honing, drilling, chamfering, countersinking, tapping	Foundry: New mould Machining: boring, honing, drilling, chamfering, countersinking, tapping
Piston & connecting rod	Basically the same.	Due to larger displacement volumes, bigger pistons.
Product→		Larger pistons (but lower operating pressures)
Manufacturing process→		Sintering: New mould (outside supplier) Machining: turning, boring, honing, drilling, chamfering
Valve/valve plate		
Product→	Redesign	Redesign
Manufacturing process→	Sintering: New mould (outside supplier) Machining: drilling, honing, chamfering, grinding	Sintering: New mould (outside supplier) Machining: drilling, honing, chamfering, grinding
Cylinder head		
Product→	Redesign	Redesign
Manufacturing process→	Foundry: New mould Machining: drilling, grinding	Foundry: New mould Machining: drilling, grinding
Electric motor	Redesign is necessary to improve EER	Larger displacements but reduced pressure, therefore motor power is the same. Redesign is optional to improve EER
Product→	More winding (Cu) and more silicon-steel core lamination	More winding (Cu) and more silicon-steel core lamination
Manufacturing process→		
Cleaning	Cleanliness standards should be improved (re.: capillary blockage). All cleaning must be CFC free.	
Product→	Improved cleanliness	
Manufacturing process→	Aqueous or semi-aqueous cleaning machines: Non-ODS cleaning is necessary	Non-CFC cleaning should be adopted to eliminate ODS use.
Lubricant	Polyolester, should not be mixed with CFC-12 compressor production line	Mineral
Product→	Same amount	
Manufacturing process→	New charging set-up	
Energy efficiency	Design changes are necessary to improve EER of the compressor	EER does not get worse. Redesign for better EER is optional.
Product→	Electric motor redesign and addition of capacitor to motor's electric circuit Addition of plastic muffler	Optional: Electric motor redesign and addition of capacitor to motor's electric circuit and addition of plastic muffler
Manufacturing process→		
Testing	New calorimeter New peripherals for noise measurement setup New setups for life, reliability, etc. tests	New calorimeter New peripherals for noise measurement setup New setups for life, reliability, etc. tests
Safety		Safety precautions in the testing area where the refrigerant is handled.

Equipment requirements of the project are given in Annex 1. Here, further explanation on the most expensive piece of equipment is given. It is a machining centre to bore the cylinder hole in the new crankcase which will be redesigned and manufactured for the HC-600a compressors.

Exhibit 8 shows the present and future product line of Jiaxipera Company.

Exhibit 8. Present and future product lines of Jiaxipera Company

	Present CFC-12 compressors									
HP	1/12	1/9	1/7	1/6	1/5	1/4				
ccm	3.44	3.38	4.85	5.90	8.00	8.85				
				↕	↕	↕				
				5.90	8.00	8.85	9.93	12.10	14.93	ccm
				1/12	1/9	1/7	1/6	1/5	1/4	HP
				Future HC-600a compressors						

As it is seen from the exhibit, the lower end of the new R-600a product line will be similar in size to the higher end of the present R-12 product line. Therefore, there will be no major machining bottlenecks for the smaller three compressors. However, the higher end of the new series will be entirely new requiring larger displament volumes and larger crankcases. Therefore, there will be major machining bottlenecks. Here, one should also remember that, presently, 80 percent of the Jiaxipera sales is 5.9 ccm R-12 compressor. It will be replaced by the 9.93 ccm HC-600a compressor and it is a new model. After a thorough analysis, it was found that the worst bottleneck will occur at the crankcase machining line.

Exhibit 9 shows a part of the crankcase machining line layout within the machining workshop. It is a zoomed part of this line. The line consists of very specialized and dedicated machining centres and has a maximum throughput capacity of 1 pc in every 12 secs, that is, 300 pcs/h. The operational capacity is about 80 percent of the rated capacity and it is about 240 pcs/h. This rate is absolutely necessary to reach the rated annual capacity of 1 million compressors.

Decision making is needed for two machines: boring machine and lapping machine. The following are the possible options:

a) Buy one new boring and one new lapping machine (cost, approximately US$ 2 to 3 millions. Most expensive but also most reliable. Attainment of highest quality is possible. No setting and/or tool changes are needed when the machined part is changed.

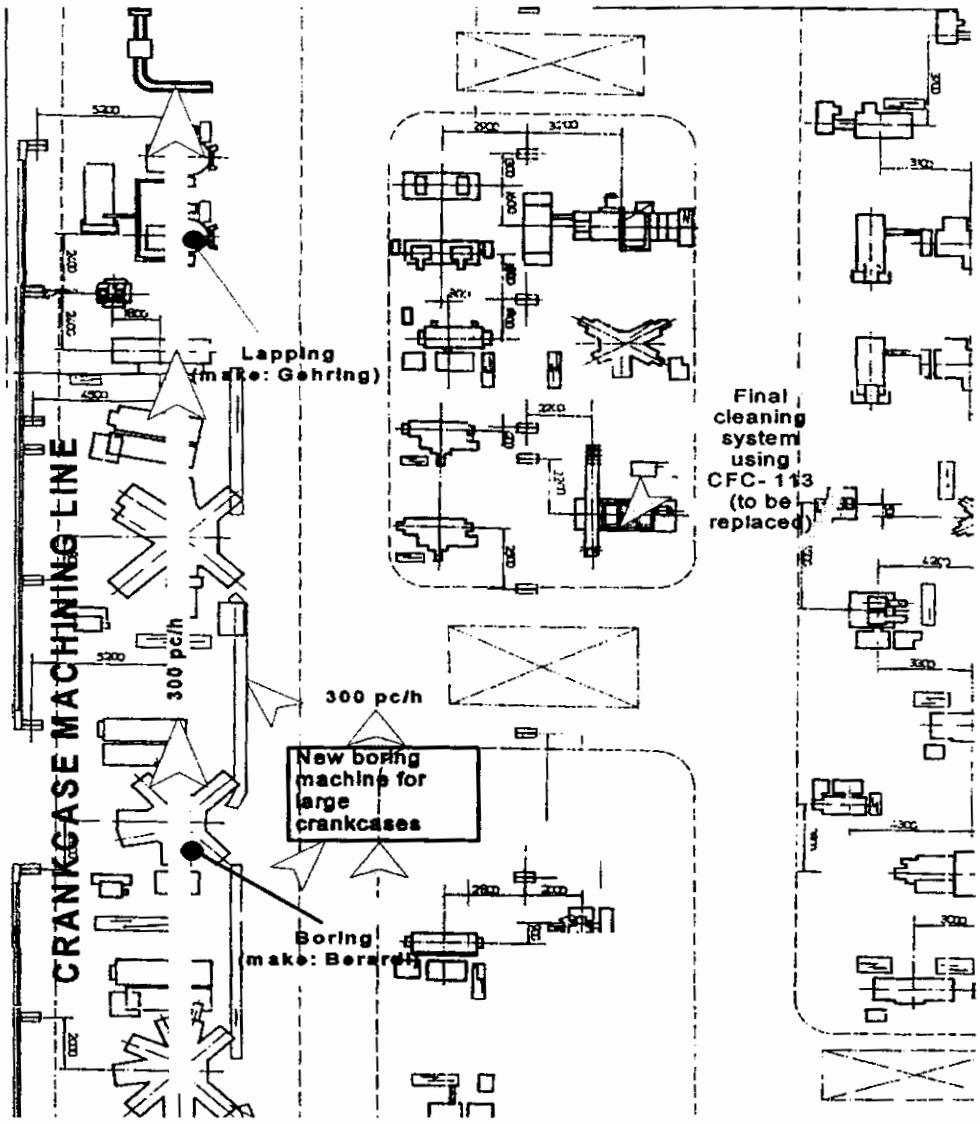
b) Retrofit both machines. Major retrofitting of these equipment is possible and may cost around US$ 600,000 to 900,000. This retrofitting will involve new tools, tools changers, manipulators, etc. This is the most complicated route. Continuous problems with resetting of machines can be expected. Quality will suffer from possible human errors.

c) Buy a new boring machine at a cost of about US$ 1.2 million (Jiaxipera ordered the present boring machine at the end of 1988 and received it at the end of 1990. The price of this Berardi machine was US$ 1.28 million) and retooling of the lapping machine which is a model from Gehring series.

d) Buy a new lapping machine and retrofit the boring machine. The overall cost of this option is similar to option (c). However, the boring machine requires a large number of adjustments each time the crankcase size is changed. This is a possible source of problem and a serious threat to quality.

It is clear that option (c) is the most appropriate. This option is also shown on Exhibit 9.

Exhibit 9. Crankcase machining line and the new boring machine



6. Justification of selection of alternative technology

The substitute refrigerant technology for this project has been selected on the basis of following parameters:

a) Technical/technological factors:

- The technical merits of different substitute refrigerant technologies were discussed in recent meetings such as:
  - The World Bank, Ozone Operations Resource Group (OORG), "Domestic Refrigeration Refrigerant Alternatives", Washington, May 1994.
  - International Institute of Refrigeration, "New technology in refrigeration", Padove, September 1994.

  Both meetings recommended hydrocarbons as a zero-ODS substitute refrigerant technology for CFC-12. OORG further identified isobutane (HC-600a) as a "fully proven commercially available technology".

- Isobutane technology is gaining increasing international acceptance. As a refrigerant, isobutane has zero ozone depleting potential (ODP) and very low global warming potential (GWP).

- Although HC technology compressors require larger displacement volumes and additional fire protection in the appliance design and manufacturing, there are compensating advantages of this technology:
  - Requires lower output pressures, therefore good energy efficiency ratios (EER) can be achieved.
  - Permits the use of mineral oil similar to that used in CFC-12 compressors which avoids the technical difficulties and cost involved in the use of polyolester synthetic oils needed in the 134a technology.
  - The relatively low corrosiveness and high quality of the refrigerant enhances the overall technical reliability.
  - Operating noise reduction has been reported by some manufacturers.

b) Market factors:

- Referring to Exhibit 4 and additional market information, in the domestic market, three refrigerator manufacturers (Kelong, 850,000 capacity; Qindao Hei'er, 500,000; Xiling, 400,000) already opted for the HC technology. Therefore, Jiaxipera Company should not have marketing difficulties.
- HC technology is gaining acceptance in international markets.

c) Government policies and strategies:

NEPA and China National Council of Light Industry through the China Household Electrical Appliance Association recommended the introduction of HC technology at the Jiaxipera and the three refrigerator manufacturers.

7. Project cost

The total estimated incremental investment cost of the project is given in Exhibit 10 below. It is assumed that the incremental increase in the price of the compressor will be claimed by the refrigerator companies and hence, here, no incremental operating cost claim is made.

Exhibit 10. Total cost of project

	US$
Total incremental investment costs (Annex 1)	3,310,000
Annual incremental operating costs (Annex 2)	Not claimed
Total project cost	3,310,000
Agency overhead (13 per cent)	430,300
Total MF funding	3,740,300

8. Project implementation

The United Nations Industrial Development Organization (UNIDO) will provide technical assistance to the Jiaxipera Compressor Company during the project. The final implementation schedule will be made later and attached to project as an annex. Now, only an approximate schedule of activities has been decided upon and is given below in Exhibit 11.

Exhibit 11. Schedule of activities

	Activity	Responsible	Timing
1	Approval of the project	Multilateral Fund	Start
2	Make a detailed project work plan	Jiaxipera, UNIDO	1 Q
3	Make specifications of the technology transfer package	Jiaxipera, UNIDO	1 Q
4	Invite companies to bid for the technology package	Jiaxipera, UNIDO	1 Q
5	Evaluate bids and award the contract	Jiaxipera, UNIDO	2 Q
6	Start of technology transfer	Jiaxipera, UNIDO, Contractor	2 Q
7	Train Jiaxipera technical personnel	Jiaxipera, Contractor	3 Q
8	Modify the compressor design and construct prototypes	Jiaxipera, Contractor	4 Q
9	Order process and test equipment	Jiaxipera, UNIDO, Contractor	4 Q
10	Design and contract tools, jigs, moulds, etc.	Jiaxipera, UNIDO, Contractor	4 Q
11	Order materials for the pilot runs	Jiaxipera, UNIDO, Contractor	5 Q
12	Install and commission process and test equipment	Jiaxipera, UNIDO, Contractor	5 Q
13	Implement pilot runs	Jiaxipera	5 Q
14	Testing of compressors from pilot runs	Jiaxipera, UNIDO, Contractor	7 Q
15	Start of regular production of HC compressors	Jiaxipera	8 Q

9. Required regulatory actions

No regulatory actions other than routine permitting are required to implement the project.

10. Results

The present project will be completed within 2 years after the start of implementation.

11. Overview of annexes

Annex 1: Breakdown of investment (capital cost)
Annex 2: Breakdown of incremental benefits
Annex 3: Calculation of total unit abatement cost
Annex 4: Environmental assessment
Annex 5: Information package on Jiaxipera Compressor Factory

Annex 1. Breakdown of total investment (capital) cost

	Description of cost item	Unit	Unit cost, US$	Qty	Total cost, US$
1	Technology transfer and engineering assistance, including: design data, training, expert assistance and performance test of new compressor	set	500,000	1	500,000
2	Production line changes				
2.1	Boring machine for the new, large crankcase	pc	1,200,000	1	1,200,000
2.2	Oil charging station	pc	130,000	1	130,000
2.3	Non-ODS washing/cleaning machine	pc	200,000	1	200,000
2.4	Assembly line modifications	set	70,000	1	70,000
2.5	Drilling machine for cylinder head	pc	20,000	1	20,000
2.6	Helium leak testing equipment	pc	120,000	2	240,000
	Sub-total				1,860,000
3	Jigs, fixtures, gauges, tools, moulds and dies				
3.1	3 compressor models with larger volumes	set	200,000	3	600,000
3.2	Casting moulds	set	50,000	1	50,000
	Sub-total				650,000
4	Test equipment				
4.1	Calorimeter	pc	200,000	1	200,000
4.2	Modification of the noise tester	set	30,000	1	30,000
4.3	Modification of the life tester	set	20,000	1	20,000
	Sub-total				250,000
5	Safety systems: gas detection, ventilation for quality control areas where H-C is used	set	25,000	2	50,000
TOTAL INVESTMENT COSTS					3,310,000

Note:

a) (re. 2.2 Oil charging station): A new oil charging station is needed because the present station will be used in the continued production of R-12 compressors in a transient period.

b) (re. 2.3 Non-ODS washing/cleaning machine): The final cleaning of the R-12 compressors are made in a washing machine using CFC-113 as the solvent. The consumption of CFC-113 is about 120 g/compressor, or 120 MT annually. A non-ODS washing/cleaning machine will eliminate the CFC-113 consumption.

c) (re. 2.6 Leak detector): Present water testing procedures with compressed air inside the compressor housing is not sufficient to guarantee leakage rate of less than 0.3 gram/year in H-C compressors.

Annex 2 Breakdown of incremental benefits

There will be no incremental benefits through the implementation of this project.

Annex 3. Calculation of unit abatement cost (UAC)

A.	ODS phase out		
A1	Average (indirect) use of CFC-12 per year (200 g charge per refrigerator, 1 million refrigerators per year)	MT	200.00
A2	ODP of CFC-12		1.00
A3	ODP-weighted CFC-12 phase out (A1*A2)	MT	200.00
A4	Average use of CFC-113 based solvent per year (120 g solvent per compressor, 1 million compressors per year)	MT	120.00
A5	ODP of CFC-113		0.80
A6	ODP-weighted CFC-113 phase out (A4*A5)	MT	96.00
A7	Total ODP-weighted phase out		296.00
B.	Annualized capital cost		
B1	Total investment cost from Annex 1	US$	3,310,000
B2	Equipment life	Year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	538,537
C.	Annual incremental operating costs from Annex 2	US$	0
D.	Unit abatement cost		
D1	Annualized capital cost per kg ODS phased out (B4/(A7*1000))	US$/kg	1.82
D2	Annual incremental operating savings per kg ODS phased out (C/A13*1000)	US$/kg	0.00
D3	Unit abatement cost (D1+D2)	US$/kg	1.82

Annex 4. Environmental assessment

In the proposed project, the manufacturing processes are well-established and have easy-to-implement environmental pollution control methods. These are related to metal forming and machining industries, including precision cleaning, surface finishing and painting. Present project will additionally replace the CFC-based metal cleaning systems with non-ODS systems and hence will further reduce the environmental impact of the production.

Country of origin: CHINA

Project title: Conversion of compressor production for domestic refrigerators from CFC-12 to hydrocarbon refrigerant at Jiaxipera Compressor Factory

Sector/sub-sector Domestic refrigeration

Relationship to country program (UNIDO)

Technology

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

The compressor manufacturer (Jiaxipera) has no formal technology agreement yet with an industry in developed countries. However, the company is in the negotiation phase with Aspera (Italy), from which Jiaxipera is using its current production technology, and Electrolux (Zanussi, Italy). In principle, both companies are capable of supplying the correct technology for the isobutane compressor manufacturing process. Provided an agreement will be signed, an adequate technology transfer can be expected and a successful implementation of the conversion project.

A preference was given to isobutane technology above HFC-134a because of the negligible GWP value and the applicability of mineral oil. This despite the large displacement volume adjustment requested and the safety issues associated with a flammable refrigerant. This selection does not conflict with current global experience with alternative refrigerants in domestic refrigeration.

Environmental impact

Isobutane has an ODP of zero and a negligible GWP. Due to its flammability it has a local environment impact. It is to the understanding of the reviewer that in China, a National Standard on the application of flammable refrigerants is scheduled to come out, which should give guidelines and must address the problem of distinguishing appliances with different refrigerants.

Project costs

Incremental capital costs:

- The fact that no technology partner has been chosen yet, and consequently no final design is established, has the effect that some costs items are not completely clear yet. This holds especially for the new boring machine requested for the large crankcase, 1.200.000 USD. The price is in itself realistic for a new machine of the given production capacity. Whether the current machinery can be retrofitted or not, and for what costs, depends on the design ultimately being adopted.
- The costs of the technology transfer are realistic.
- The replacement of the cleaning machine by a non-ODS washing/cleaning machine is in itself already a cost effective way to reduce the current CFC-113 solvent use.
- The other equipment requested is essential for the conversion process or is necessary for the, temporary, parallel production of CFC-12 and isobutane compressors (e.g. oil charging station). Prices of the equipment requested are reasonable.

Incremental operational costs:

- No incremental operational costs are being claimed.

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To properly evaluate the refrigerant conversion project the UAC value can best be based on current production quantities and excluding the CFC-113 replacement. In that case a value of 5.3 USD/kg/year is obtained which is reasonable compared to other projects.

Implementation timeframe

Reasonable

Relevance and adequacy of information provided

The project description contained most of the necessary information. Some outstanding issues were answered by the UNIDO responsible and the Jiaxipera company itself. Altogether sufficient information for a judgment was present.

Recommendations

Approval provided:

- a technology transfer agreement will be signed with a company experienced in the application of the isobutane technology
- a demonstration will be given that the new boring machine is a real prerequisite and a retrofit is not feasible (this after the selection of the final design)

Janssen M.J.P., Eindhoven, the Netherlands, 15-November-1994

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