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

Twelfth Meeting
Montreal, 28-30 March 1994

PROJECT PROPOSALS: CHINA

This document includes the following project proposals and the Fund Secretariat's Comments and Recommendations:

Project presented by UNDP

1. ODS-free cleaning equipment manufacturing centre for phasing out ODS consuming solvents across China

Projects presented by the World Bank

1. Zhongshan Fine Chemical Aerosol Filling Center (CFC-12 Substitution Project)

2. CFC-12 to HCFC-22 plant conversion (Shanghai Chlor-Alkali Chemical Co.)

3. Application development for conversion of compressor manufacturing to HFC-134a rotary compressor designs (Shanghai Refrigerator Compressor Co. Ltd.)

4. Engineering assistance for conversion of refrigerator manufacture to HFC-134a refrigerant with rotary compressors (Shanghai Shangling General Refrigerator Factory)

5. Engineering assistance for conversion of refrigerator manufacture to HFC-134a refrigerant with Tecumseh designed HFC-134a compressors (Hua Yi Electrical Appliance General Co.)

6. Engineering assistance for conversion of refrigerator manufacture to a ternary blend refrigerant (MP-39) using conventional compressors (Shanghai Shanglu Electrical Appliances Co. Ltd.)

7. Engineering assistance for conversion of refrigerator manufacture to use of HFC-152a refrigerant using conventional compressors (Wanbao Electric Appliance Industrial Corp.)

8. Engineering assistance for conversion of refrigerator manufacture to HFC-152a/HCFC-22 blended refrigerant in conventional compressors (Chang Ling (Group) Co. Ltd.)

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China
PROJECT TITLE:	ODS-Free Cleaning Equipment Manufacturing Centre for Phasing Out ODS Consuming Solvents Across China
BUDGET:	US $1,446,542
INCREMENTAL COSTS:	US $524,734
COST EFFECTIVENESS:	N/A
PROJECT DURATION:	Two years
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	National Environment Protection Agency
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. The project will provide for installation of a manufacturing facility of ODS-free cleaning equipment. The Manufacturing Centre is a part of the national strategy to replicate the demonstrated technology and equipment in an economical, expeditious manner. It is expected that within 3 years approximately 800 enterprises will be converted to non-ODS processes using the equipment manufactured at this centre.

2. The project is eligible for funding from the Multilateral Fund. When the manufacturing equipment centre is brought on-line, then the equivalent CFC equipment manufacturing capacity will be shut down.

3. The total project expense is estimated to be US $1,446,542.

4. The requested amount of US $524,734 will cover the cost and installation of imported equipment.

SECRETARIAT'S RECOMMENDATION

1. The requested incremental costs of US $524,734 are recommended for approval provided that any further project proposals in the solvent sector in China will be considered within the context of this project.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China
PROJECT TITLE:	Zhongshan Fine Chemical Aerosol Filling Center (CFC-12 Substitution Project)
BUDGET:	Capital Cost: US $8,359,000 Incremental recurring savings: US $6,759,000 Financial agent fee: US $ 48,000 Total: US $1,648,000
INCREMENTAL COSTS:	US $1,648,000
ODS PHASE-OUT:	Estimated 6,590 tonnes of CFC-12 annually in 1996
COST EFFECTIVENESS[1]:	US $0.24/kg of CFC-12 phased out
PROJECT DURATION:	2 years
IMPLEMENTING AGENCY:	The World Bank
NATIONAL COORDINATING AGENCY:	National Environmental Protection Agency
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. Zhongshan Fine Chemical Industrial Limited is a state-owned enterprise that deals with aerosol products and fine chemicals.

2. The project proposal is to establish chemical facility to produce 5000 tonnes per year of dimethyl ether (DME), a substitute propellant for CFC-12; to retrofit three automatic and two semiautomatic filling machines; to construct buildings and provide quality control and safety equipment and training; and to provide facilities for storage, transportation and distribution.

3. The project estimates to phase out 6,590 tonnes of ODS annually in 1996.

4. Since the enterprise is not a producer of controlled substances, cost of production of their substitutes is not regarded as incremental cost (Indicative List of Categories of Incremental Costs, paragraph 2 (i)).

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[1] Determined as the ratio of incremental costs to the estimated annual saving of ODP ($/$ODP_{kg}$).

5. The only component of the project that is incremental is the retrofit of the existing filling lines.

6. Cost of production of DME will become eligible if an equivalent capacity producing CFC-12 is closed.

SECRETARIAT'S RECOMMENDATIONS

1. The project raises the issue of eligibility. Production of substitutes without termination of production of equivalent capacity of ODS is not eligible for funding.

2. If the Government of China will commit to the closure of CFC-12 production capacity equivalent to that of dimethyl ether, the project would become eligible for funding.

3. The Secretariat therefore recommends to defer the consideration of the proposal pending clarification from the Government of China.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China	
PROJECT TITLE:	CFC-12 to HCFC-22 Plant Conversion at Shanghai Chlor-Alkali Chemical Co.	
BUDGET:	Capital Cost:	US $8.935 million
	Operational Cost:	US($2.566 million)
	Total:	US $6.369 million
INCREMENTAL COSTS:	US $6.369 million	
ODS PHASE-OUT:	Substitute for 7000 tonnes per year of CFC-12	
COST EFFECTIVENESS:	US $0.94/kg of ODP phased out	
PROJECT DURATION:	2.5 years	
IMPLEMENTING AGENCY:	The World Bank	
NATIONAL COORDINATING AGENCY:	National Environmental Protection Agency and Ministry of Chemical Industry	
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _	

SECRETARIAT'S COMMENTS

1. This proposal is submitted to the Committee for "preliminary, provisional review with regard to methodology and assumptions for calculating incremental costs". However, the World Bank is requesting permission to proceed with further development of the project and for resolution of the outstanding differences between the Bank and the Chinese authorities regarding calculation of project incremental costs.

2. A technical review is included in the project summary.

3. The Secretariat reviewed the project summary taking into consideration the Indicative List of Categories of Incremental Costs, Decisions IV/30 and V/8 of the Meeting of the Parties, Executive Committee guidelines, and China's Country Programme.

4. Based on the Secretariat's review, pertinent comments were communicated to the World Bank, to which the Bank responded.

5. The project is proposing to replace the existing production of CFC-12 (capacity of 7000 metric tonnes per year) with new production facilities to produce 5000 metric tonnes of HCFC-22 per year at Shanghai Chlor-Alkali Chemical Co. The World Bank estimated the incremental costs of the project to be US $6.369 million.

6. Consideration of this project should be taken within the context of three additional projects listed in China's Country Programme for the production of HCFC-22 at an additional estimated cost of US $5 million.

7. The project eligibility is not in doubt. However, it should be considered within a strategy for the chemical production sector in order to avoid the possibility of double counting, redundancies and future liability to the Fund since HCFC-22 is a controlled transitional substance.

SECRETARIAT'S RECOMMENDATIONS

1. Based on the above, the following recommendations are proposed for consideration of the Executive Committee:

(a) To indicate to the Government of China that conversion of CFC-12 to HCFC-22 is a legitimate activity under the Multilateral Fund; however, given the special nature and size of the chemical production sector in China, the Executive Committee will authorize the implementing agencies to work with the Government of China to elaborate an integral strategy for a phase-out in the ODS production sector in China.

(b) To request the implementing agencies to work with the Fund Secretariat, with the possible collaboration of some ODS producers in Article 5 countries, to recommend to the Executive Committee before its next meeting specific policy guidance and a credible methodology of calculating incremental costs.

(c) To defer a decision on permission to proceed on the submitted proposal until (a) and (b) above are addressed.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China		
PROJECT TITLE:	a)	Application development for conversion of compressor manufacturing to HFC-134a rotary compressor designs at Shanghai Refrigerator Compressor Co. Ltd.	
	b)	Engineering assistance for conversion of refrigerator manufacture to HFC-134a refrigerant with rotary compressors at Shanghai Shangling General Refrigerator Factory	
	c)	Engineering assistance for conversion of refrigerator manufacture to HFC-134a refrigerant with Tecumseh designed HFC-134a compressors at Hua Yi Electrical Appliance General Co.	
	d)	Engineering assistance for conversion of refrigerator manufacture to a ternary blend refrigerant (MP-39) using conventional compressors at Shanghai Shanglu Electrical Appliances Co. Ltd.	
	e)	Engineering assistance for conversion of refrigerator manufacture to use of HFC-152a refrigerant using conventional compressors at Wanbao Electric Appliance Industrial Corp.	
	f)	Engineering assistance for conversion of refrigerator manufacture to HFC-152a/HCFC-22 blended refrigerant in conventional compressors at Chang Ling (Group) Co. Ltd.	
BUDGET:	(Table attached)		
INCREMENTAL COSTS:	a)	US $1,400,000	(100 tonnes of ODS phase-out)
	b)	US $1,570,000	(108 tonnes of ODS phase-out)
	c)	US $1,442,000	(60 tonnes of ODS phase-out)
	d)	US $1,010,000	(70 tonnes of ODS phase-out)
	e)	US $1,360,000	(80 tonnes of ODS phase-out)
	f)	US $860,000	(70 tonnes of ODS phase-out)

COST EFFECTIVENESS[1]:	a)	N/A
	b)	US $14.5/kg
	c)	US $24.0/kg
	d)	US $14.4/kg
	e)	US $17.0/kg
	f)	US $12.3/kg

PROJECT DURATION: Implementation of each of the above projects will be done in two phases over a 2 year-period.

IMPLEMENTING AGENCY: The World Bank

NATIONAL COORDINATING AGENCY: National Environmental Protection Agency (NEPA)

TECHNICAL REVIEW COMPLETED: YES _X_ NO _

SECRETARIAT'S COMMENTS

1. All six projects are to be implemented in two phases. The first phase is for engineering, product development and testing under local conditions, and the second phase is for full conversion to a technology using a substitute.

2. Although there are 70 domestic refrigeration production lines and 16 compressor producers in China, five of the six projects account for 27 per cent of the actual 1993 refrigerator production in China as reported by the World Bank.

3. All six projects are in line with China's Country Programme. They may be viewed as demonstration projects to evaluate CFC-12 conversion technologies to HFC-134a, HFC-152a and two blends.

4. Five projects have technology transfer agreements and five projects request additional funds for training.

5. Shanghai Refrigerator Compressor Co. Ltd. (Project a)) will continue the production of CFC-12 compressors until HFC-134a compressors achieve market penetration. This project amounts to increase in capacity for an undetermined period of time.

6. Phase I of Hua Yi project (project c)) has been completed. The World Bank has requested 15 per cent contingency cost for all activities.

7. All projects are requesting testing equipment beyond the existing base line.

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[1] Determined as the ratio of incremental costs to the estimated annual saving of ODP ($/ODP$_{kg}$).

8. However, it should be noted that all 5 refrigerator projects do not propose testing associated with non-CFC blown insulating foam. In the event that this testing will be done at a later stage, additional testing equipment would certainly be requested.

9. Only the capital costs of the projects are requested. An order of magnitude for incremental operating cost is estimated to range from US $1.3 million to US $3.3 million. Incremental operational costs are expected to be requested separately in the future.

10. Shanghai Shangling General Refrigerator Factory (Project b)) is requesting a service truck at a cost of US $100,000 to service the new HFC-134a refrigerators. The incrementality of this cost item is in doubt.

11. None of the five refrigerator production projects (b-f) mentions whether the existing CFC-12 lines will be scrapped, modified or converted. A decision in this regard will impact the calculation of the incremental costs of each of these projects.

12. From comparison with similar projects approved by the Executive Committee, the number and cost of test equipment is very high.

13. All six projects include up to US $30,000 for the preparation of a feasibility report after the completion of Phase I.

14. All six projects were reviewed by an independent reviewer. The World Bank has responded to comments provided by the Fund Secretariat.

SECRETARIAT'S RECOMMENDATION

The Secretariat recommends approval of all six projects on the following conditions:

1. The projects will form the basis of a sectoral strategy to phase out CFCs in some 86 related enterprises/lines in China. The strategy should include phase out of CFCs in insulating foam.

2. Testing of appliances must be rationalised. Either the testing equipment requested in these projects should be used for the other enterprises or centralized testing centres should be established within 4-5 existing R & D institutes.

3. Incremental operating costs of the six projects should be accurately estimated.

4. Incremental capital costs should be in line with similar projects already approved by the Executive Committee.

5. Based on the above, the World Bank should submit revised costs of all six projects as pertinent.

PROJECT COST

	Shanghai Refrigerator Compressor Co.	Shanghai Shangling General Refrigerator Factory	Hua Yi Electrical Appliance General Co.	Shanghai Shanglu Electric Appliances Co.	Wanbao Electric Appliance Industrial Corp.	Chang Ling (Group) Co.
	US $	US $	US $	US $	US $	US $
Unit production	550,000	480,000	200,000	270,000	180,000	397,000
Capital costs Phase I	1,130,000	920,000	575,000	540,000	520,000	645,000
Capital costs Phase II	230,000	600,000	825,000	440,000	800,000	335,000
Total Project Cost	1,360,000	1,520,000	1,400,000	980,000	1,320,000	980,000*
Financial Agent Fee	40,000	50,000	42,000	30,000	40,000	30,000

* Chang Ling (Group) Co. will self-finance US $150,000.

PROJECT COVER SHEET

COUNTRY OR REGION:	China
SECTOR COVERED:	Primary Sector: Solvents
ODS CONSUMPTION IN AFFECTED SECTORS	3306 tonnes of ODP in 1991
PROJECT TITLE:	ODS - FREE CLEANING EQUIPMENT MANUFACTURING CENTER FOR PHASING OUT ODS CONSUMING SOLVENTS ACROSS CHINA
PROJECT DURATION:	Two years from funding availability
PROJECT IMPACT:	Rapid and accurate replication and placement of non-ODS technologies as they are transferred from developed countries to China.
PROPOSED BUDGET:	Total Proj Expense : US $1,446,542 **Requested funding: US $ 524,734**
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	NEPA THROUGH MEI

PROJECT SUMMARY

The China Country Programme addresses the rapidly growing solvent sector by employing a strategy of subsectoral demonstration projects, followed by replication. With an estimated 3000 lines consuming ODS in cleaning processes throughout China, the China Country Programme has included an Equipment Manufacturing plan to minimize the phase out cost.

It is the intent of this project to install manufacturing capability for ODS -free cleaning equipment in No. 2 Institute. ODS-Free Equipment manufacturing at this site will replace equivalent ODS equipment manufacturing capacity currently scattered across China.

PROJECT OF THE GOVERNMENT OF CHINA

ODS - FREE CLEANING EQUIPMENT MANUFACTURING CENTER FOR PHASING OUT ODS CONSUMING SOLVENTS ACROSS CHINA

1.Project Objective

The objective of this project is to provide for cost effective installation of replacement cleaning lines across China by manufacturing and then offering low cost, no-ODS cleaning equipment to Chinese firms
The project will use demonstrated technology and equipment and will demonstrate that the replication of ODS free cleaning processes can be accomplished at considerable savings to the Multilateral fund.

2.Sector Data

The Cina Country rrogramme states that total 1991 ODS consumption in China was 48,239 tonnes with an ODP (ozone-depleting potential) value of 60,352 tonnes. China has forecast that unconstrained ODS consumption would by year 2010 result in ODS consumption of 229,318 tonnes with a ODP value of 292,714 tonnes with resulting severe damage to the global ozone layer.

ODS consumption in the solvents sector in 1991 amounted to 4,947 tonnes with a combined ODP value of 3,306 tonnes. This combination reflects the weighted average of a 0.8 ODP value for CFC-113 (91%) and a 0.1 ODP value for methyl chloroform (9%). There are 3,200 middle and small-sized enterprises using ODS-based cleaning processes in China at present. With unconstrained consumption, ODS consumption in this sector by year 2010 would reach 53,571 tonnes growing at over 14% per annum over the period 1991-2010. It is thus critical that ODS consumption in this sector be reduced as soon as possible. This is technologically feasible since alternative processes exist. The main issue is to determine, and then deploy, the cleaning processes, or alternative technologies, most feasible for the many different factory applications throughout China.

3. Background

3.1 Sectoral Needs and Strategy

A major, high growth area in China is the solvents sector, as described above. China has defined its strategy in its Country Programme, and is in the process of implementation of each of the elements of that strategy. Key demonstration projects in each of several major applications, or subsectors, followed by rapid deployment and replication of the demonstrated technology, is deemed necessary for successful completion of the solvents sector overall strategy. For rapid deployment and replication to be successful, i.e.,a cost effective phase out, two additional elements are deemed essential, both of which have also been described as part of the CP solvent sector strategy:

a) An equipment manufacturing line to produce cleaning equipment for the replication in an economical, expeditious manner.

b) An Applications Deployment Center (ADC) for evaluating the cleaning process options for the replication plants, where samples from the factories will be cleaned in various processes, and the appropriate process and equipment specified for those applications.

In China, with such a significant number of enterprises spread over such a vast geography, with a significant language barrier in the ordering and installation of equipment - especially in the remote areas, the process of phase out on a plant by plant basis could be very inefficient and therefore, costly. China has existing CFC solvent equipment manufacturing capacity that is dispersed across China. China Electrical Engineering Design Institute (CEEDI) estimates that the number made is between 200 and 300 per year, depending on the ratio of batch and continuous units made. Just under two hundred additional are imported per year. The CFC based equipment manufactured across China today, essentialy as an "ad hoc" product, is made to meet local needs and generally does not adhere to international guidelines as to to emission control, solvent containment, freeboard, etc. It is normally custom made by many various machine manufacturing factories which are engaged in production of other, non-solvent, various general equipment products. The new replacement technology machines will be dealing with flammable and harsh/corrosive chemicals, and adherence to international guidelines is felt to be an essential need.

It is the intent of this project to set up an equipment manufacturing line in China that will eliminate virtually all of the aforementioned

barriers to an efficient and cost effective phase out of ODS in the solvent sector. China is committed to the plan that, when the equipment manufacturing line is brought on line, then the equivalent CFC equipment manufacturing in the various factories will cease, and there is expected to be no Incremental costs associated with the replacement of this capacity. Thus the CP strategy for a cost effective and efficient phase out can be achieved.

3.2 Enterprise Background

No. 2 institute has the expertise and the capacity, and also necessary means of studying and making cleaning systems, to satisfy various needs of the enterprises. It is believed to be the correct choice to set up the equipment manufacturing line in No. 2 institute.

No.2 institute is located in Heping South Road, Hexi District, Taiyuan City, about 5 kms away from downtown. Taiyuan City has all convenient means of communication and transportation. The institute occupies a total area of 95,000m2 and has sufficient water and power supply. Being the premier electronic process technology institute in electronics industry, the institute is mainly engaged in process technology development and electronics industrial process management. It was founded in 1962 and, during the past 30 years, has brought to market hundreds of research outcomes in the fields of automation technology, PC application, precision machining techniques, thermal processing, electronic assembly process, powder metallurgical technology and metal surface denaturation, etc..

In the 60's, it developed the first wave soldering machine and the first manufacturing line for producing C-type ferrite-core and Ta capacitor, followed by production lines of magnetic-rod loudspeaker as well as a semiautomatic line for B/W TV sets. In the 80's, it was assigned the research work of chip component mounting and soldering technology and equipment, and turned out a number of high-tech results represented by laser soft brazing machine and process, impurity alarm in cleaning process and an IR reflow machine, opening new prospects in the area of SMT technology for China.

The institute covers a wide area - 9.6 hectares with dozens of one-floor buildings and several multi-storey buildings. The manufacturing line will be located on the first floor of No. 8801 Building, a new five story structure with a building area of 6,463m2,

located northwest of the main entrance and now under construction.

The institute now has:

staff	703
in which technical personnel	321
(including senior engineers 63)	
key equipment	95pcs
key instrument	370pcs
mini-computer	20
mobile vehicles	25
books and reference materials	25,000volumes
site ground area	95,000m2
building area	27,000
original value of fixed assets	RMB 13,980,000

4. Project Description

As mentioned above, the first floor of a newly finished building will be converted to include a cleaning equipment manufacturing line that is capable of fabricating 6 types of cleaning system - ultrasonic, centrifugal, brush, spray and immersible and associated accessories and both in-line and batch systems of each type. The line should have a capacity of 300 batch units manufactured per year. With this capacity, it will take 8 years to fuifill the overall objective of conversion of China to non-ODS processes.

It has been decided that the batch system will be the typical product as there are more medium-size and small-size firms than large ones, while the in-line system will be also necessary to satisfy large firms' needs. In this aspect, the overseas mature water spray type in-line system will be in the first place for consideration.

batch system	270pcs
in-line system	10pcs (equivalent to 30 batch units)

The line will include sheet cutting, flattening, pressing, sheet bending, coldworking, benchworking, welding, surface treatment and assembly in conjunction with in-process inspection.

The process flow will be as follows: preparation - sheet cutting - machining -
inspection - surface treatment (electroplating, painting , etc) - inspection -

assembly (mounting and wiring) - on-line unit debugging -perforcemance test - packing & storage

5. Technology

The plant will use standard metal working and equipment fabrication techniques. Work areas within the manufacturing shop, to be set up, are as follows: benchworking,metalworking, machining, welding, surface preparation and coating, and the assembly area - which will consist of electric wiring, test and debugging, final assembly, and packing.

There is a significant amount of equipment already available at the institute which can be utilized for the purpose of the additional manufacturing line. It is estimated that the project would utilize 22 pieces of equipment from the Institute, but would require the addition of new pieces, many of them to be imported.

The institute, at present, has a 2t steam boiler and 2 hot water heating boilers with a capacity of 250Kcal/h each, which will be the source of hot water (95-70!f) supply to the new building. No.8801 Building will have 216m2 of air-conditioned area where t=20degrees, +/-1, RH=60%, +/-5% and mechanical exhaust system and scrubber will be installed.

The existing water source is sufficient to supply the max. 4.3m3/h additional consumption. There will be waste treatment plant or recycling unit for the effluent discharged from cleaning system debugging procedure.

Existing compressors supply compressed air at the point-of-use. The compressor in the painting area has enough spare capacity to satisfy 0.3m3/min in the new painting area. And a new compressor will be installed in the new building to meet 7.8m3/min consumption of the line.

The installed power capacity will be 310KW for the power consumed. There will be both radial and trunk systems for power distribution. There will be a separate feed line for power supply and lighting.

The equipment to be produced will utilize proven and credible international equipment technology and design, and will be based upon agreements with foreign equipment makers for the use of their technology.

6. Project Costs

The detail of the investment cost is described below. The investment cost requested of the Multilateral Fund has been determined to be US $524,734. The investment cost of the remainder of the project, to be bourne by the Government of China has been determined to be $US 921,808. There are no costs included in this project for patents or agreements, other than the technology transfer costs.

6.1 Some Explanations

1) The foreign exchange rate will be 1US$ to RMB 8.7, as issued by the State Foreign Currency Administration.
2) The imported equipment will be at CIF price and be exempted from duties and taxes on added value pursuant to certain rules. But the local support cost in RMB such as company commission, banking charges and local transport expenses and miscellaneous expenses shall be included.
3) The local source equipment will be priced with reference to ex-factory price with 6% of transport and miscellaneous expenses.
4) The installation cost for foreign and local source equipment will be separately calculated and cover both installation and debugging as well.
5) Building engineering cost is estimated for converting an area of 1,436 m2 while and external construction cost covering piping and cabling ,etc. is estimated at RMB 150,000.
6) The charges for feasibility study and design will be as stipulated in " The Charging Criteria for Engineering Design" issued by the State Planning Commission in 1984.
7) The additional power capacity required will be 240KVA and Taiyuan City regulates RMB 290/KVA for the additional power demand.
8) Insurance expense for construction period shall be 0.35% of the total cost of construction, equipment procurement and installation.
9) The cost for trial run, hospitality, office and domestic appliance shall be borne by the owner.
10) Cost for preparation work shall be 10% of the total investment both in US$ and RMB.
11) Calculation's indicated a sum of RMB 176,000 of the interest of loan in construction period,the yearly interest rate being 10.98%.

6.2 Project Economics

Annex 1 contains the list of equipment needed for the project. Annex 2 contains the project calculations, showing total project costs as well as the breakdown of the components and also the split between the MLF and the Government of China. Annex 3 shows the calculation basis for determining the cost of manufacture, the price comparisons between international and

local production, the profit to be deducted from the project, and the net calculations showing the basis for the request to the Multilateral Fund.

8. **Financing Plan**

From the MLF	$ 524,734
From Chinese Government	$ 921,808
TOTAL	$1,446,542

9. **Environmental, Health and Safety**

In debugging operations, city water will be used. The few printed circuit boards cleaned in debugging will have minimal impact on waste water effluent concentrations as they join the other site efluent streams. In any event, where organics or alkaline cleaning agents are used, the former will be recycled inside the area, while the latter will be treated in an enclosed system to minimize the discharge. Organic fumes released in the painting area are anticipated to be minimal. Water based acrylics will be investigated. To minimize noise in the fabrication areas, low noise equipment will be given priority in the selection process, and vibration isolation mountings will be specified as preferred. Illumination of 150 - 300Lx will be provided in compliance with national rules. Housings, covers, and wire guards will be installed on all drives, and reliable grounding will be installed throughout the manufacturing area.

Fire protection and explosion proof design will be initiated in the coating area. Indoors there will be a security pipeline, hydrant, and portable dry powder extinguishers placed appropriately throughout the area. Outdoors, there will be a water supply pipeline, an encircling access road for fire engine response, and a fire engine available with water delivery capability of 25 L/sec.

10 **Project Impact**

As a result of this project, Number 2 Institute will address the needs of the Country of China for

1. rapidly producing and distributing standard cleaning equipment, based on non-ODS cleaning technology, thereby overcoming the substantial infrastructural difficulries associated with distribution throughout the

various provinces

2. training indigenous users in the startup and operation of the equipment, thereby overcoming the difficult language problem
3. providing high quality, low cost equipment at a substantial savings to both the country and to the Multilateral Fund. The phase out plan is that, in 3 years, approximately 800 enterprises will be converted to non-ODS processes. Thus in the 3 year period, the project is expected to avoid an approximate cost of US$ 52 million to be requested from the Multilateral Fund.

	EQUIPMENT REQUIREMENTS							
				MLF	MLF		CHINA	TOTAL
Item no.	Item	qty		$ US	As RMB		RMB	RMB
1	NC Sheet shear	1		38000	330600			330600
2	Levelling Machine	1		22000	191400			191400
3	CNC Turret punch	1		275000	2392500			2392500
4	NC Programming system	1		38000	330600			330600
5	4 Bar Universal hydraulic press	1		12000	104400			104400
6	High speed hydraulic press	1		23000	200100			200100
7	Angle cutter/Iron worker	1		18000	156600			156600
8	NC Sheet bender/ tube bender	1		100000	870000			870000
9	Spot welder	1			0		40000	40000
10	40 Ton Hydraulic bending brake	1		50000	435000			435000
11	Single phase rectifier DC welder	1			0		32000	32000
12	Parts / tools grinding machine	1		43000	374100			374100
13	Spray coating equipment	1		140000	1218000			1218000
14	Welding defect detector	1		9000	78300			78300
15	Universal tool microscope	1		5000	43500			43500
16	Aqueous cleaning prototype	1		80000	696000			696000
17	Metal parts	1		80000	696000			696000
	TOTAL			933000	8117100		72000	8189100

	PROJECT CALCULATIONS							
				MLF	MLF		CHINA	TOTAL
				$ US	As RMB		RMB	RMB
1	BUILDING CONSTRUCTION							
	Conversion of Bldg						718000	718000
	outside engineering						150000	150000
	subtotal						868000	868000
2	EQUIPMENT							
	imported			933000	8117100			8117100
	Company commission			14000	121800			121800
	banking charges			4700	40890			40890
	local transport			23300	202710			202710
	local						72000	72000
	transport						4300	4300
3	INSTALLATION							
	imported			24400	212280			212280
	local						3000	3000
4	TOOLS AND FURNITURE						50000	50000
5	OTHER							
	Contractor mgt						150000	150000
	technology transfer and training			20000	174000			174000
	startup test fabrications			28000	243600			243600
	local training						100000	100000
	FSD preparation			8000	69600			69600
	Design			16500	143550			143550
	Contingency			107190	932553		211530	1144083
	Grand TOTAL			1179090	10258083		2326830	12584913
							$TOTAL =	1446541.7

CAPACITY - UNITS/YEAR

			INT'L PRICE	LOCAL PRICE	SAVINGS/YR
BATCH UNITS	270		70,000	5977	64,023
IN - LINE UNITS	10		110,000	15586	94,414
		AVG	71429	6320	65,108

ESTIMATE OF MFG COSTS (1000) RMB

RMB VALUE 8.7

MAJOR MATERIALS	5348
SUPPORT MATLS	4350
PACKING MATLS	240
LABOR	648
FUEL & UTILITIES	731
OVERHEAD	2282
TOTAL	**13599**

AVG COST/UNIT (RMB	48568	=13,599,000/280
AVG COST/UNIT ($)	5583	
AVG PRICE ($)	6320	
AVG PROFIT, $	738	
AVG PROFIT, RMB	6418	
PROFIT/YR, $	$206,552	---------- THIS IS THE PROFIT USED TO CALCULATE
GROSS PROFIT/YR, I	1797000	THE NET BENEFITS PER YEAR
TAXES	413310	
NET PROFIT	1383690	

USE PROFIT FROM CALCULATIONS ABOVE

REQUEST TO MLF	$1,179,090		
4 YEARS PROFIT =	$654,356	---------- net present value of 4 years' profit = 4 X (0.792) X	206552
NET GRANT =	$524,734		

TOTAL PROJECT CAPITAL REQUIRED, $US	1446542
TOTAL MLF GRANT REQUESTED, $US	524734

GLOBAL CENTRE FOR PROCESS CHANGE
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W. G. Kenyon
Tel: 302-652-5597
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TO: C. J. NORRIS (UNDP) DATE: 10 FEB., 1994

FROM: W. G. KENYON (CONSULTANT)

SUBJECT: PROJECT TECHNICAL REVIEW

I have reviewed the Solvent Project, "ODS-Free Cleaning Equipment Manufacturing Center for Phasing Out ODS Consuming Solvents Across China" prepared by CEEDI, MEI and UNDP personnel.

Technical Soundness

This project is designed for rapid, successful, cost effective deployment of non-ODS cleaning equipment throughout China after evaluation of the various alternatives. The vast geographic area of China, combined with multiple languages, makes the ordering and servicing of equipment from external vendors difficult. Local manufacture of proven equipment designs, both batch and in-line, will provide rapid deployment of non-ODS equipment in the solvent sector throughout China, while providing trained personnel for troubleshooting and maintenance. Close cooperation with the Applications Development Center will enable rapid publication and deployment of training materials and manuals to ensure meeting the phase out goals in the Country Programme. Since it is essential that proven designs be employed, maximum success will be achieved if the proposed Project Site (#2 Institute) engages in close cooperation with a developed nation equipment manufacturer with industry-proven designs.

Safety

The manufacture of cleaning equipment requires many standard procedures for cutting, bending and welding sheet metal and piping. In addition, electrical wiring, plumbing operations and painting must be carried out. Safe practice procedures for all of these operations are readily available, especially from the more heavily regulated developed countries. It is expected that such safe practices will be followed, especially if they are part of the workmanship standards supplied by one or more of the developed countries equipment manufacturers. Equipment for the use of semi-aqueous technology employs hydrocarbon substances which have flammability or combustibility potential. The use of established equipment designs ensures that the appropriate safeguards are designed into the PRC-manufactured equipment. Thus, chemical misting will be controlled or blanketed, depending on the equipment design.

Environmental

"Wet testing" of each piece of equipment is required prior to shipment to the point of use. This is accomplished by actually running the chemistry in the cleaning equipment and cleaning the parts to be manufactured. Thus waste streams will be generated which must be treated on site. It is the evaluator's understanding that aqueous treatment is already available at the #2 Institute site. In addition, the site meets all applicable workplace regulations for light and ventilation.

Aqueous technology has the potential for the detergents to complex with the heavy metal components in the removed flux residues or with the the non-electronics parts being cleaned. Semi-aqueous solvents are hydrocarbons; they are normally incinerated for disposal. They also have VOC potential. While VOCs are not regulated in developing countries, they may be a future concern.

Cost Effectiveness

The project addresses cost effectiveness, pointing out the unique opportunity for local equipment manufacture at the #2 Institute Project Site to simultaneously accelerate the phase-out in China while potentially saving the MLF a projected USD 100,000,000. From an investment standpoint, less than USD 2,000,000 in capital investment will produce more than USD 50,000,000 return in 3 years. This savings can be used to accelerate ODS phase-outs in other developing countries who perhaps do not have the manufacturing base and central planning advantages possessed by China.

Recommendations

It is recommended that this project be approved with the stipulation that (at least initially) proven equipment designs from developed country sources be manufactured, thus maintaining the momentum of the ODS phase-out.

PROJECT COVER SHEET

COUNTRY:	The People's Republic of China
PROJECT TITLE:	Zhongshan Fine Chemical Aerosol Filling Center (CFC-12 Substitution Project)
SECTOR COVERED:	Aerosol
ODS USE IN SECTOR:	CFC-12 consumption was 9420 tons in 1992
PROJECT IMPACT:	Phase out CFC-12 6,590 tons annually in 1996.
PROJECT DURATION:	2 years
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	US$ 8.359 million Capital Costs US$ 6.759 million incremental recurrent savings
PROPOSED OTF FINANCING:	US$ 1.6 million
IMPLEMENTING ENTERPRISE:	Zhongshan Fine Chemical Industrial Limited
COORDINATION NATIONAL BODY:	National Environment Protection Agency
IMPLEMENTING AGENCY:	World Bank

PROJECT SUMMARY

The project converts aerosols with 100% CFC propellants to non CFC. Dimethyl Ether (DME) was selected as propellent, due to non availability of clean LPG in Guangdong Province. After project completion, output of DME will be 5000 tons annually, which can substitute for 6590 tons CFC. This project is listed in China's ODS CP, and will be carried out during 1994/95. In foreign aerosol industry, except for LPG, DME is in the second position for substitution for CFC and technology is available. The enterprise plans to take available technology of making DME by methanol from South-West Research Institute. Based on facilities for making DME, the project can not only meet requirements of conversion of enterprise itself, but also serve local small enterprises in can-filling lines with competitive low costs by establishing aerosol filling center. Thus it will promote substitution CFC throughout southern China, and reduce CFC losses prevelant in many small existing fillers. For those enterprises with modern filling facilities, the enterprise can supply suitable DME at a low price. DME manufacturing facilities will be in Zhongshan city. According to CP, estimated consumption of CFC-12 used in China aerosol industry will be 23,600 tons in 1996, by implementation of this project, consumption of CFC-12 will be reduced by about 25-30% in 1996.

TECHNICAL ASSESSMENT: The project has been reviewed and supported by the Bank's alternate OORG technical reviewer, Harry McCain. His comments are attached.

PROJECT OBJECTIVES.

Project objectives include: 1) setting up facilities for manufacturing 5000 tpy DME; 2) setting up aerosol filling center, with capacity of 35 million cans/year; and 3) phasing out about 6,900 tpy CFC use in aerosol industry.

SECTOR BACKGROUND

China's aerosol industry developed late, its products are now only about 1% in the world, but with a population of 1.1 billion people there is a huge potential market. Along with the boost of domestic economy, demand have been increasing rapidly in recent years. National consumption of CFC propellant was 7090 tons in 1991, and increased to 9720 tons in 1992. According to CP, in case of no substitution, consumption will increase to 23,580 tons in 1996. To meet requirement of environment protection, CFC substitution and conversion engineering of aerosol industry in China now becomes a top priority. This project along with previously approved projects in Shanghai and Tiangjing, will account for about 80% of projected consumption. There are 56 factories which produce aerosols in Guangdong Province, with CFC consumption of 3,620 tons in 1992. According to investigation, the consumption in Guangdong will reach to more than 6,000 tons in 1996. Most of these aerosol factories will be supported by the southern filling center.

ENTERPRISE BACKGROUND

Zongshan Fine Chemical Industrial Limited (Zongshan) is a comprehensive state-owned enterprise which deals mainly with aerosol products, aerosol cans (including valves) and fine chemical products. The enterprise owns a net fixed asset of US$ 7.6362 million, and in 1992 its gross industrial output is US$64.2735 million. The project sponsor is a 100% state-owned enterprise.

The enterprise has developed aerosol products since 1982. In 1992, the annual output of aerosols reached 48.8 million cans, which was about thirty percent of national output. There are more than twenty kinds of products spreading widely in domestic market. In 1992, the consumption of CFC-12 was 2250 tons, in which about 70% is hairsprays and air fresheners. There is an aerosol technology developing centre in the enterprise as the scientific research organization to develop new products, while the manufacturing technologies mainly developed by the enterprise itself.

PROJECT DESCRIPTION

This project covers the facilities for making 5000 tons DME from methanol annually, an aerosol filling center of 35 million cans annual filling capacity, and a set of public utilities of water, electricity, steam, cool and compressed air. Accessory equipments include warehousing, distribution, transportation, quality control, fire control systems of DME. The enterprise has signed an agreement on technology of making DME by methanol with South-West Research Institute of the Ministry of Chemical Industry to take over its scientific research result and designs for this project. By using this technology, the conversion of methanol can reach 70%, the purity of DME can reach more that 99%,

which approaches the foreign technical level of the same product. The finished product of separated and refined DME can have a purity of over 99.9%, thus suitable to be used as aerosol propellant. The preliminary design of DME facilities has passed provincial evaluation, the construction design is also nearly completed. There are altogether 81 sets of equipments under the design, of which 17 sets are standard type, 62 sets are non-standard type, and 2 sets are specified equipments. Technology and equipment are from China, the main hardware of computer system shall be imported from USA and Japan. DME output of the facility is 5000 tons annually, of which 3094 tons shall be applied to fill 35 million cans of aerosols. Among them, the enterprise itself will turn out 20 million cans, the remaining 15 million cans will be for other enterprises. The remaining 1906 tons of DME will be sold to other companies.

In order to phase out all CFC uses in the company, there are five automatic filling lines and four semi-automatic filling machines to be retrofitted. However, in this project, only the investment required for retrofitting three automatic filling machines (each with capacity of 40—50 cans per minute) and two semi-automatic filling machines (each with 10 cans/minute) is included. The investment needed for the other equipment will be solved by the company themselves as a constriction for the world ozone layer protection programme. The content of retrofitting includes the installation of gassing room in accordance with the fire proof requirement, the installation of safety devices as detection, ventilation, alarming and fire extinguishing etc. Besides those, all gaskets are to be changed to suit the DME characteristics as well as power and lighting to be retrofitted in accordance with safety standards. This project is to be situated in Qiwan District, east of Zhongshan City.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION

LPG is more frequently used in aerosols than other CFC alternatives for its reasonable price and easy source of supply. However, in Guangdong province, the investigation shows that LPG is not so satisfactory as to both its quality and quantity. In respect of quality, the total sulphur and sulphur as thiols within local LPG are respectively about 200ppm and 20ppm. It also contains ethylene and many kinds of bad smell impurities, making it hard to take normal refining process to get the ideal result; in respect of quantity, in contrast with one million tons of annual practical demand of LPG for civil usage, LPG annual output of two main refineries of the province cannot yet reach 200,000 tons, which is a big shortage in quantity. It is noted that LPG in neighbor provinces is also insufficient. The local price of imported refined grade LPG in effect reaches high to RMB 8,000 per ton, and the supply is not stable.

With the exception of LPG, DME stands in the second place in quantity as the aerosol CFC alternative. The world's annual output of DME exceeds 170,000 tons, among which nearly half are supplied to the aerosol industry. DME is applied in aerosols with the evident advantages as follows:

1) Since DME and water are highly miscible, it is easy to develop water based products to decrease VOC value for purpose of environmental protection.
2) To decrease flammability of aerosols by increasing its water content.

3) DME is soluble in either polar or non-polar solvent, so it is ideal to be used in multi-component formula to increase product quality. Supply of methanol is locally available, thus since local supply of LPG is difficult, it's feasible to base the project on DME.

Zhongshan , sponsor of this project, has been in the field of developing and producing fine chemical products for 28 years. The project adopts transferred technology of making DME from methanol by South-West Research Institute of Ministry of Chemical Industry to turn out DME of aerosol use purpose. DME purity of finished product is to be not less than 99.9%, with impurities methanol less than 200 ppm, water less than 200 ppm and thiols less than 1ppm. Under present production scale, it is estimated that the enterprise can already make small benefit on a selling price of RMB 7,500 Yuan (a bit lower than price of imported refine grade LPG). Thus the project is feasible in view of economy and technology. The project is an effective way for Guangdong province to improve its circumstance of LPG shortage by using DME as CFC propellent alternative. By the time the project put into operation, it will complement and support the LPG-use filling centers in Shanghai and Tianjin.

PROJECT COST

Capital Costs. The investment cost is US$8.359 million, according to detailed investment cost in annex A),

Incremental Costs. The project will generate revenue, and the operating costs and benefits have been taken into consideration in determining incremental costs. Given the profit of the substitution as given in the feasibility report (Appendix B), and estimation of cost, tax and profit of different products (Appendix C in feasibility report), discount rate of 12%, construction period of two years and economic lifetime of 10 years, the internal rate of return can be calculated. The internal rate of return is calculated, respectively, without any grant (FRR of 8.3%) and with a grant of US$ 1.6 million to give a FRR of 12% as shown in annex B. The project shows a net value of US$ 6.759 million within its lifespan on 10 years. Thus, the incremental costs for the project is equal to:

Capital costs	US$ 8.359	million
Net presentvalue of operating benefits		US$ 6.759 million
Incremental costs	US$ 1.6	million

FINANCING PLAN

ODS investment cost of the project is US$ 8.359 million, plus the interest of US$ 0.5973 million during construction (interest rate is 9.696), total investment shall be US$8.9563 million, including US$1.934 million in direct foreign exchange.

The total investment of US$ 8.359 million is to be collected by three ways: US$1.600 million for OTF grant, US$ 0.684 million raised by the enterprise itself, and US$ 6.075 million from domestic loan. As to the domestic loan, The People's Construction Bank of China, Zhongshan Branch has already promised to

provide an initial amount of US$3.932 million for this project. Additional loans will be obtained and confirmed during subproject appraisal by the FA.

PROJECT Management

The National Bureau of Environment Protection will act as the project supervisor. Zhongshan Fine Chemical Industrial Limited is responsible to carry out this project. The South West Research Institute of the Ministry of Chemical Industry shall provide technical support. Implementation will take two years.

PROJECT BENEFITS

1) DME manufacturing facility with DME capacity of 5,000 tons/annum, and annual ODS reduction of 6,590 tons;

2) The filling center can eliminate environmental pollution caused by heavy leakage of small enterprises due to their backward equipment, and save significant expenditure for small enterprises' conversion to non CFC propellant.

Unit Abatement Costs: = US$ 0.1/kgODS/annum

Annex A

List of Investment Costs

Exchange Rate: US$ 1 = RMB 5.85 RMB 10000.00 unit US$ 1000.00

Item	RMB		Foreign Currency		Total	
	RMB	Convertto US$	US$	Convert to RMB	RMB	Convert to US$
Civil Works						
Land preparation	316.0	540			316.0	540
Civil construction	396.0	677			396.0	677
Public utilities						
Utilities	188.1	322			100.1	322
Boiler	62.4	107			62.4	107
Cooling Station	55.0	94			55.0	94
DME equipments						
Equipment	1154.2	1973			1125.1	1973
Instruments	10.00	17	332	194.2	204.2	349
Conversion of aerosol filling system						
3 sets of autofilling lines			622	363.9	363.9	622
2 sets of filling machines			105	61.4	61.4	105
Liquid product formulating						
Tanks for storage	22.0	38			22.0	38
Tanks for formulating	12.5	21			12.5	21
Measuring, filtering appliances, etc.	8.5	15			8.5	15
DME storage and distribution						

Main equipment, pipes, electric apparatus	286.9	490			286.9	490
Conveying system, instruments, valves			207	121.1	121.1	207
Transportation appliance						
DME truck(3)	131.0	224			131.0	224
Methanol truck (6)	36.0	62			36.0	62
Crane (2)	6.0	10			6.0	10
Cargo truck (2)	6.0	17			10.0	17
Bus (1)	25.0	43			25.0	43
Lab QC Apparatus						
Corrosion test & auxiliary instruments			90	52.7	52.7	90
Other quality test instruments	12.0	21			12.0	21
Safety facilities						
Safety equipment	25.0	43	140	81.9	106.9	183
Water spray system (2)	42.0	72			42.0	72
Transportation expenses for equipment import						
Overseas transportation			96	56.2	56.2	96
Domestic transportation	45.0	77			45.0	77
Installation & Commissioning						
Installation	226.0	386			226.0	386

Commissioning by foreign experts			60	35.1	35.1	60
Running test & training	32.0	55	30	17.6	49.6	85
Engineering Costs						
Design & Technical Assistance	100.8	172			100.8	172
Project management	65.0	111			65.0	111
Sub-total	3267.9	5586	1682	984.2	4252.2	7269
Other costs						
Floating rate 5%	163.4	279	84	49.2	212.6	363
Unpredicted expense 10%	326.8	559	168	98.4	425.2	727
Total	3758.1	6424	1934	1131.8	4890.0	8359

annex B

Calculation of Grant Amount to Yield 12% FRR

(1) Without grant

Unit: US$000.00

Year	Investment Cost	Grants	Sales Revenue	Sales Tax	Operation Cost	Operation Benefit	Net Cash Flow
1	3760.7	0	0	0	0	0	(3760.7)
2	4598.3	0	0	0	0	0	(4598.3)
3	0	0	26860.7	4728.9	22717.9	(578.1)	(578.1)
4	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
5	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
6	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
7	0		38383.8	6755.7	30089.9	1538.1	1538.1
8	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
9	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
10	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
11	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
12	(1003.1)	0	38383.8	6755.7	30089.9	1538.1	2541.2

Notes:

1. Sales revenue = revenue of products filled for the enterprise + revenue of products filled for other enterprises + revenue of DME product for sale.
2. Sales revenue = quantity for market x selling price of each part.
3. Selling price of each part is in table 2-4 of Appendix C-2.
4. Operation cost = sales total cost - depreciation cost

(2)with grant Unit: US$ 000.00

Year	Investment Cost	Grants	Sales Revenue	Sales Tax	Operation Cost	Operation Benefit	Net Cash Flow
1	3760.7	721.4	0	0	0	0	(3039.3)
2	4598.3	878.6	0	0	0	0	(3719.7)
3	0	0	26868.7	4728.9	22717.9	(578.1)	(578.1)
4	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
5	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
6	0	00	38383.8	6755.7	30089.9	1538.1	1538.1
7	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
8	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
9	0	0	38383.8	6755.7	30089.9	15538.1	1538.1
10	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
11	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
12	0	0	38383.8	6755.7	30089.9	1538.1	2541.2

Unit Abatement Costs: Unit abatement costs is calculated as follows:

$$A = \frac{C(F) = (OC - OS/R)}{ODP}$$

Within the formula

(1) C(F)—annual investment cost

When investment cost = US$ 8.359 million, economic lifetime= 1- years, discount rate=1296:

C(F)=8359.0 x 0.1770= US$ 1,479.5 million

(2) OC—OS/R—the revenue in the first year of full operation

In this project, OC—OS/R= US$o.8026 million

(3) ODP—annual ODS reduction under full operation expressed on ODP

In this project, ODP=6590 tons

$$A = \frac{1479.5 - 802.6}{6590}$$

= US$ 0.1/kgODS/annum

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November 22, 1993

TO : Jessica Poppele — FAX: 202-477-5752
Ozone Ops Coordinator-Asia
Global Environment Coordination
Room S2-113 / Dept. 655-37

COPY TO : Tom Waltz — FAX: 202-522-3258
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Montreal Protocol

FROM : Harry B. McCain

SUBJECT : **China Aerosol Project**
China Aerosol Industry Southern Filling Center Project
(Zhongshan Fire Chemical Industrial Limited Aerosol CFC-12 Substitution and Conversion Engineering)

- **SCOPE**

The project under review covers the development of technology for CFC-12 phaseout of 6,590 tons annually (equivalent to 6,590 tons annually ODS use in sector reduced) in the aerosol sector.

- **RECOMMENDATION**

The project is supported. Dimethyl ether (DME) is a valid alternative propellant to CFC in the aerosol industry.

- **RELEVANCE AND ADEQUACY OF INFORMATION PROVIDED**

Information provided is comprehensive, complete and well set out to the standards in keeping with producing aerosol grade DME which will serve the Chinese aerosol industry well.

Exception: Under "List of Investment Costs", item 7, "Transportation appliance, DME truck $274,000 U.S.":

A new truck (tractor) and tank (trailer) for DME use in the U.S. costs $130,000 delivered in the U.S. Therefore, the presented cost of $274,000 U.S. seems very high indeed and should be reconsidered.

- **TECHNICAL SOUNDNESS**

The report is very extensive and well presented. However, the technical information concerning the catalytic dehydration of methanol and the specific use consideration for DME are implied rather than presented in detail. One must perceive this report as a report primarily on costing, and one must assume that the technical know-how for producing DME and using DME is well understood by Zhongshan Fire Chemical Industrial Limited.

It is stated in the report that the source of methanol is locally available. More detail is needed here. Is the local source basic, i.e., is it manufactured locally or is it imported and distributed locally?

Methanol is a world commodity whose price can fluctuate greatly depending on worldwide demand. If methanol is not manufactured locally, it is then subject to these price changes and can greatly affect the end cost of DME. Therefore, one must insure that the local source of methanol, in what one assumes to be the Guangdong Province, is basic.

- **LESSONS FROM EXPERIENCE**

The Project Accomplishment Schedule, 24 months total, is very optimistic. Forty eight months would be a more accurate figure. Example: Building construction and equipment purchase and manufacture was given six months for completion. However, there is a major chemical company in the U.S. with an excellent reputation, basic in methanol with a catalytic dehydrator for methanol in place, that has been trying for three years to produce high quality DME and are to date unsuccessful. Producing DME is not their problem; producing no-odor, high-purity DME is. Therefore, one must surely be prepared for significant delays in the production of DME in China.

- **ENVIRONMENTAL ISSUE**

This project when completed will phase out 6,590 tons of CFC-12 annually (equivalent to 6,590 tons annually ODS use in sector reduced).

SAFETY ISSUES

The safety issues regarding DME have been addressed in the report. Special considerations for handling which include electrical equipment and the aggressive solvent characteristics of DME on elastomers were considered.

- **COST EFFECTIVENESS**

The project is very cost effective at a UAC of $0.1 USD/Kg/annum. This figure may rise if project accomplishment schedule is extended beyond the present two year estimate.

- **OTHER**

None

Project Cover Sheet

Country:	People's Republic of China
Project Title:	CFC-12 to HCFC-22 Plant Conversion
Sector Covered:	Chemical Production
Project Impact:	Reduce 7,000 tons per year CFC-12. Increase HCFC-22 5,000T/Y. ODP reduction 6,750T/Y
Project Duration:	2.5 years
Project Economic Life:	10 years
Total Project Costs:	US$ 8.935 million
Proposed OTF Financing:	US$ 6.369 million (see below)
Implementing Enterprise:	Shanghai Chlor-Alkali Chemical Co.
Coordinating Agency:	NEPA/Ministry of Chemical Industry
Implementing Agency:	World Bank

Project Summary. This project will simultaneously close an existing CFC-12 plant with rated capacity of 7,000 tpy at Shanghai Chlor-Alkali Chemical Co (SCAC) and replace it with a plant with rated capacity of 5,000 tpy HCFC-22. Existing infrastructure will be kept. Technology and key equipment will be imported. ODP reduction will be 6,750 tpy. This project reflects the Chinese Government strategy in CP to phase out ODS, which is: conversion from using ODS products to ODS substitutes should be carried out smoothly by adopting from high ODP substances, to low ODP substances, and then to substances without ODP. China has chosen HCFC-22 as an important transitional substance.

The project is being submitted to MPEC at this stage for preliminary , provisional review with regard to methodology and assumptions for calculating incremental costs. There is disagreement between SCAC/MCI and Bank on assumptions that determine incremental costs, mainly on foregone production level of CFC 12, production buildup of HCFC 22 and base year for discounting. SCAC assumes higher levels of CFC 12 production foregone, lower production of HCFC 22, discounts all recurring costs and benefits streams to the same year; each leading to higher incremental costs. SCAC's calculation of incremental costs are presented herein as an alternate and advice from MPEC is being solicited on how to resolve the differences.

Technical Assessment: A preliminary technical review has been undertaken by the OORG reviewer, Mike Harris, and project is provisionally supported as presented. Feasibility report will be revised once firms bids are received and recalculate capital costs and incremental costs. OORG comments will be taken into consideration when project is resubmitted to MPEC for funding.

Project Objectives. The project objectives are to reduce annual production capacity of 7,000 tons of CFC-12, and simultaneously increase HCFC-22 production capacity of 5,000 tpy to ensure that HCFC 22 product will be available as a CFC substitute, in line with China's ODS CP strategy. If demand for HCFC-22 grows rapidly as projected in the CP, similar projects can be carried out in other plants.

Sector Background. Currently, there are about 38 CFCs production facilities in China. These enterprises are comprised of 13 large-scale state-owned enterprises and about 25 small-scale collective enterprises. In 1991, total production capacity was about 47,000 tons, including 7,000 tpy CFC 12 at SCAC. Production capacity is expected to increase to about 74,000 in 1994 due to several ongoing expansion projects that are being completed. They all employ domestic, liquid phase technology, to produce CFCs with raw materials purchased from domestic sources. However, most plants are not "swing" plants and can only produce one type of CFC. The current CFC production capacity in China cannot meet the demand of CFC 11 and 113, but there is an excess of CFC 12 capacity. Imported CFCs have occupied a large portion in CFC consumption market, but that is expected to decrease rapidly over the next 2-3 years. In 1991, total output of CFC-12 was 21,900 tons. The imported amount was 1,100 tons and consumption was 23,000 tons. Unconstrained CFC market is forecast to be 45,900 tons in 1996; 65,100 tons in 2000; 95,900 tons in 2005, and 138,500 tons in 2010.

Enterprise Background. SCAC is a large chemical producer in Shanghai, with production facilities dating back to the mid 1960s; that have been continually modernized and expanded since that time. SCAC was restructured as a separate entity in 1992. Registered capital for the company amounts to 832 million RMB. In 1991, SCAC had the largest CFC-12 production plant in China, with a rated capacity of 7,000 tpy CFC 12. (In 1884 , there are two plants larger.) Its total output in 1991 was 5,350 tons (highest production for any year), which was one-fourth of total national output in 1991. However, raw material supply was a major constraint and SCAC commissioned a 10,000 tpy CTC plant in 1993 to remove the bottleneck. However, there is an emerging overall surplus of CFC 12 capacity in China and the impact on output from SCAC in terms of assessing future CFC 12 production levels is difficult to quantify.

Project Description. This project will adopt imported technology to produce HCFC-22. Currently, HCFC-22 production at home and abroad all adopt the liquid-phase halogen exchange process, which uses hydrogen fluoride (HF) and chloroform ($CHCl_3$) as a catalyst. Domestic techniques, due to reactions taking place in lower pressures, having higher consumption of raw materials, power and catalysts, larger discharges of wastes and by-products. Foreign technology, due to higher reaction pressure, has lower consumption and less discharge of wastes and by-product HCl. Design will be provided by foreign contractors and detail designs will be carried out by domestic contractors. The HCFC-22 plant is made up of raw material supply, reaction and stripping, HF removal and drying, product separation and rectification, and packaging system. Key equipment,piping and instruments, will be imported and other equipment and materials will be furnished by domestic suppliers. There are about 140 total pieces of equipment HCFC-22 production process, of which, 29 pieces will be imported and 19 pieces will be from original CFC-12 plant. The project will be implemented within existing battery limits of CFC-12

production plant that will be razed and same site will be used to erect the HCFC 22 plant. The office, analysis room, maintenance workshop and other installations of original CFC-12 plant will be used in the project. The raw materials of HCFC-22 production, with exception of chloroform and sulphuric acid, will be provided by raw material supply system of the CFC-12 plant. Utilities and waste water treatment will also be from original CFC-12 system.

Rationale for CFC Substitute Choice. Demand for products made of ODS in China is far from being satisfied before 2010. Reductions of ODS production and consumption should not harm normal industrial and consumer demands for such products. Thus the conversion should be carried out smoothly by adopting from high ODP substances, low substances, to substances without ODP. To speed up phaseout process in the current circumstances of unfully-developed technique to produce non-ODS substitute, China is going to choose transitional substances specified in MP, especially HCFC-22 as the important transitional substance in ODS phaseout process. Concerning demand for ODS substitute, strategy of Chinese government is to mainly base upon development of domestic production. Meanwhile ODS reduction should be carried out simultaneously with ODS substitute production to meet domestic consumption. Developing production capacity of HCFC-22 is imperative, so that State Plan can be carried out. No ideal substitute has been found which can completely replace CFC-12. Substitutes with zero ODP value such as HFC-134a and HFC-152a require high investment for capital construction, high selling price, and also have problems such as greenhouse effect and high energy consumption of HFC- 134a and inflammability of HFC-152a. China is a developing country, lacking capital and techniques. It is impossible to complete development of ODS substitute with zero ODP value and provide enough ODS substitute with zero ODP value as required in such a short time under Chinese conditions. Currently, there are still some binary and trinary combination substitutes in transitional substitutes developed both at home and abroad. Most of these contain HCFC-22. Thus, development of HCFC-22 production capacity has advantages for application of binary and trinary combination substitutes.

ODP value of HCFC-22 is only 5% of that of CFC-12. With mature production process and low investment costs, unit ODS reduction cost would be lower and profit would be higher. The price of HCFC-22 is only 1.5 times of that of CFC-12, much lower than HFC-134a, so that HCFC 22 can be easily used by the consumer. According to the State Plan, requirement of HCFC-22 for projects of small commercial compressor can be over 2,400 tpy CFC substituted.

Project Costs and Incremental Costs.

Incremental costs are based on compensation for premature closure of the existing CFC 12 unit and incremental costs for the new HCFC 22 unit as shown below (calculated at US$ = RMB 5.37):

HCFC 22 Unit

Capital costs for new plant	US$ 8,935,000
Net incremental recurring benefits:	-US$ 5,041,000
Incremental costs due to HCFC 22 production	US$ 3,894,000

CFC 12 unit

Incremental costs from foregone production of CFC 12 would be added to the above figure to arrive at the net incremental costs for the project as a whole, as shown below. There is disagreement between the Bank and SCAC on some of the assumptions that determine incremental costs, with the main difference in level of foregone production for CFC 12, production buildup of HCFC 22 and base year for discounting. Calculations are in annexes 2 and 3 and summarized below, in US$ millions:

	SCAC Calculation	Bank Calculation
Capital Costs	8.935	8.935
Incremental Costs HCFC 22	- 5.041	-5.661
Incremental Costs Lost CFC12	+5.020	+3.095
net overall incremental costs	8.914	6.369

Proposed OTF Grant: US$ 6.406 million (to be recalculated once final project capital estimates are available and assumptions are agreed). Please note that the above figure is based on Bank assumptions as noted above. SCAC figures give US$ 8.914 as shown above and in annexes 2 and 3.

Unit Abatement Costs: to be determined

Financial and Economic Analysis: To be determined at appraisal.

Financing Plan: to be determined

Project Implementation. This project will be undertaken by the enterprise. A foreign company will provide technology and basic design. The engineering design of this project will be undertaken by the design department of SCAC with the assistance of local engineering firms. Construction will be also be handled by local firms. Construction time is 2 1/2 years and shown in the schedule on the following page. The CFC 12 unit will be closed after the first 6 months to give a 2 year period when the factory will have no sales revenue of CFC 12 nor HCFC 22. This 2 year period contributes tothe high incremental costs shown above.

Project Benefits

Direct Effects. When the project begins implementation, the domestic production capacity of CFC-12 will be reduced by 7,000 tpy. When the project has been completed, i.e HCFC-22 has been put into operation, HCFC-22 can be supplied with 5,000 tpy, and ODP reduction is 6,750 tpy. Indirect Effects. If demand for HCFC-22 grows rapidly, similar projects can be carried out in other plants.

Task	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Basic Design	xxx	xx x								
Detailed Design			xx x	xxx	xxx					
Equipment Purchasing		xx x	xx x	xxx	xxx	xx x				
Construc-tion					xxx	xx x	xxx	xxx	xxx	xxx
Training								xx	xx	
Test Run										xx

Unit Abatement Cost:

$$A=ODP = \frac{C(F) + (OC-OS)}{}$$

where UAC = Unit abatement costs, $/kgODP/year

C = ODS reduction investment cost, including all initial one time costs such as technology and training

F = Capital recovery factor; the annualized capital cost charges, discounted at a standard rate of 10% per year over the economic life of the investment

OC= Annual incremental operating costs in the first year of full operation

OS= Annual incremental operating savings (OS) in the first full year of full operation

ODP= Annual ODS reduction at the first year of full operation expressed in ODP units

Calculation of C(F)

The annualized investment costs consider the total investment plus the amount of interest that would be repaid over the life of the project if the investment were a loan (the investment is a grant) and if the loan were repaid in equal installment.

Result: to be determined after final capital costs and incremental costs are determined

Annex 1 Capital Costs ($1,000)

Item	Home	Abroad	Subtotal
A. Equipment Cost of which a-f	687.8	2,925.0	3,612.8
(a) Feedstock System	(116.1)		
(b) Reaction & Stripping system	(88.4)		
(c) De-HF Drying System	(58.1)		
(d) Separating & Rectifying System	(80.2)		
(e) Tail Gas Treatment & HCL System	(54.3)		
(f) Packing System	(290.7)		
B. Civil Construction	453.1		453.1
C. Equipment Installation	1,065.1		1,065.1
D. Design/Technology	177.2	1575.0	1752.2
E. Training	60.2	68.6	128.8
F. Commissioning (of which a-c)	646.9	240.6	887.5
(a) Equipment	(10.3)	(224.0)	(234.3)
(b) Trail Tests	(174.6)		(174.6)
(c) Others[1]	(409.9)	(15.8)	(425.7)
G. Working Capital	140.6		140.6
H. Contingency	332.0	600.0	932.0
Subtotal	3562.9	5409.2	8972.1
Residual Equipment Value	37.2	-	37.2
Total	3525.7	5409.2	8934.9

Note:

1. The cost of others in startup includes:
   a. Feasibility study fee, amounting to US$ 52,630 have been deleted.
   b. Domestic costs for imported part (including fee for foreign trade formalities, banking and finance, customs supervision and administrative formalities, and domestic transportation), amounting to US$ 147,000 and inspection fee for imported equipment, amounting to US$ 29,250.
   c. Management of project implementing company, amounting to US$ 185,820.
   d. Project insurance, amounting to US$ 23,520.
   e. Translation and copy for materials and drawings form home and abroad, amounting to US$ 40,050.

Annex 2

Review of Incremental costs for China- SCAC HCFC 22 Project

The Bank review of the SCAC HCFC 22 Project based on revised proposal from SCAC (fax dated December 21,1993.) will consist of:

a) technical review including costs of HCFC 22 project; and

b) financial and economic analysis of eligible incremental costs for closure of CFC 12 unit and for construction of HCFC 22 unit. For purpose of this initial review (costs in US$ millions):

Capital costs	$8.9879
Minus feasibility study fees	.0530
Net capital cost	8.9349

(However, capital costs will change once firm estimates are available after receipt of bids.)

As the Bank has agreed with SCAC and MCI, incremental costs should be based on a six year period for foregone profits on CFC 12 closure and a 10 year economic life for the HCFC 22 unit; price and cost data should based on 1991 figures; and a 12% p.a. discount rate used. (Even though the Bank has agreed on the above assumptions, the Bank does not have precise guidelines from MPEC on assessing incremental costs for production sector and any of these above assumptions could be questioned by MPEC.)

As discussed with SCAC in Shanghai in December, the Bank does not agree with the production levels for both HCFC 22 and for CFC 12 on which the incremental costs as calculated by SCAC are based. The combination of low HCFC 22 production and high CFC 12 production overstates the incremental costs. There is also a difference in calculation methodology. The Bank calculation of incremental costs based on SCAC production level for HCFC 22 and CFC 12 as shown in SCAC's Annex 2 shows an incremental cost of:

Capital costs for HCFC 22 unit	$US 8.935 million
Net inc. benefits from HCFC 22 production	-$US 5.041 million
Net inc. costs from lost CFC 12 production	$US 4.007 million
Net incremental costs	$US 7.901 million

The above figures are discounted to 1997 for the HCFC 22 component and to 1995 for the CFC 12 component. The SCAC figure for incremental costs is US$ 8.860 million, discounted to 1995 for both HCFC 22 and CFC 12. The difference between the SCAC figure and the Bank figure is due to the different base years for discounting. Since the CFC 12 plant closes in 1995 its incremental cost should be discounted to that year. Since the HCFC 22 unit starts operating in 1997, the operating costs and benefits should be discounted to 1997 to determine the incremental costs for that unit. Thus, SCAC has not used the

correct years for discounting.

However, there are additional differences in determining the base line for calculating incremental costs that need to be considered. A more consistent and reasonable basis for calculating incremental costs, considering both performance of SCAC and domestic demand for CFC 12, would be the production levels in tons per year listed below under "Bank." The SCAC production buildup is shown below and in annex 3 for comparison:

Year	CFC 12 production		HCFC 22 Production	
	Bank	SCAC	Bank	SCAC
1995	6000	6000	0	0
1996	6000	6000	0	0
1997	6000	6500	3000	3000
1998	6000	6500	4000	3500
1999	6000	7000	5000	4000
2000	6000	7000	5000	4500
2001	0	0	5000	5000
2002	0	0	5000	5000
2003	0	0	5000	5000
2004	0	0	5000	5000
2005	0	0	5000	5000
2006	0	0	5000	5000

The main difference in incremental costs will be the different assumptions by SCAC and the Bank in buildup of production for HCFC 22 and foregone CFC 12 production level, and discounting HCFC 22 to 1997 and CFC 12 to 1995.

Incremental costs calculated on above "Bank" basis will be:

capital costs for HCFC22 unit	$US 8.935 million
net incremental benefits from production of HCFC 22	-$US 5.661 million
net incremental costs from lost CFC 12 production	$US 3.095 million
net incremental costs	$US 6.369 million

The SCAC HCFC 22 Project is being submitted to MPEC for review and preliminary decision and guidance on the several assumptions and methodology. The Bank recommendation is be to base the incremental costs on the Bank suggested production buildup or a preliminary funding level for incremental costs of US$ 6.369 million. (Please keep in mind that the incremental costs will change when the capital costs figures are revised.) SCAC calculated incremental costs of US$ 8.859 million with the main differences due to the different assumptions as discussed above. MPEC should take both figures into consideration in arriving at a recommended methodology and assumptions for determining eligible incremental costs.

Annex 3 - Breakdown of Incremental Benefits (SCAC Assumptions)
(US$= RMB 5.7)

Year	CFC-12			HCFC-22			Incremental Benefits
	Sale Price Unit (US$) *	Total Annual Produc -tion (Units)	Annual Sales (US$ 1,000)	Sale Price Unit (US$) *	Total Annual Produc-tion (Units)	Annual Sales (US$ 1.000)	US$ 1.000)
1995	1347.4	6000	8084				-8084
1996	1347.4	6000	8084				-8084
1997	1347.4	6500	8757.43	2017.5	3000	6052.5	-2704.93
1998	1347.4	6.500	8757.43	2017.5	3500	7061.3	-1696.13
1999	1347.4	7.000	9431.8	2017.5	4000	8087	-1361.8
2000	1347.4	7000	9431.8	2017.5	4500	9078.75	-353.05
2001				2017.5	5000	10087.5	10087.5
2002				2017.5	5000	10087.5	10087.5
2003				2017.5	5000	10087.5	10087.5
2004				2017.5	5000	10087.5	10087.5
2005				2017.5	5000	10087.5	10087.5
2006				2017.5	5000	10087.5	10087.5

NPV = 3394.75
i = 12%

* Factory price in 1991

OORG - Production Sector

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Cover Note

Tom: please find attached a revised version of the Technical Opinion on the SCAC 22 project. Passing via my home this weekend I have found in my mail some suggested amendments to the SCAC 22 TO from one of my experts. I append a revised version in case it is still not too late to use it instead of the original. The problem is that everyone is so overloaded that my internal deadlines are not always met!

PS. I also found in my mail a cheque in respect of the hours worked in the UK. We're now up-to-date on historical travel expenses and remuneration. Thank you for your help.

Kind regards

Shanghai Chlor-Alkali Chemical Co Ltd (SCAC) - CFC-12 to HCFC-22 Conversion

Recommendation

The project should be conditionally approved. At this stage a political decision is required and the proposal as it stands is of sufficient merit to deserve moving to the next stage. Further information required includes (priority items only):

(a) Process flow diagram and details of existing CFC-12 plant for comparison, to improve calculation of incremental cost, and to underpin the CFC-12 production estimates.
(b) Explanation of the need for some 45 process equipment items (from a total of 142) not found on some other operational developed world HCFC-22 plants.
(c) A preliminary hazard study (HAZOP-1 or similar).
(d) Explanation of the unusual yields (low for HCFC-22, high for HCl) and high reliability (95% - despite several years of low occupacity) stated for the process.
(e) Quality (eg F' content) of HCl by-product, its value and markets.
(f) Description of controls on emissions of HFC-23, a very powerful global warming gas.

Relevance and adequacy of information provided

The main items of information required are provided, except for the major items listed above. It should be noted that a major and complex chemical process project of this nature cannot be adequately assessed in an opinion of this length, and that a large amount of further specific information would be required for a capital proposal in the private sector. However, much of this information will be both commercially sensitive and very specific to the particular plant and the particular technology supplier. No two HCFC-22 plants are the same, not least because each exists in a unique infrastructure of other plants and processes. So far as is possible, the chosen technology (which will differ in important detail from supplier to supplier) should be as close to the operating experience of SCAC in their existing fluorocarbon operations - to maximise re-use of equipment, and to facilitate the changeover to HCFC-22.

Much more detail will be required before final approvals are given to the specific project, but the information available (plus that requested above) suffices for an initial 'permission to proceed to the next stage'.

Technical soundness

The technology considered involves the conversion of a liquid-phase (assumed) CFC-12 plant to a liquid-phase HCFC-22 plant and is generically the only reasonable approach. Large differences exist as to options for the detailed implementation of this conversion. The merits of each option will depend on the choice of technology supplier *vis-à-vis* the details of the existing equipment and infrastructure. The technology is very well established and is commercially ready for transfer to an LDC. The technical risks involved are low (as to the technology) and normal (as to implementing the technology on site and within the domestic infrastructure).

Lessons from experience

This is a largely conventional project of a kind which is often undertaken for commercial reasons, regardless of environmental concerns about CFCs. In the developed world, there has been considerable movement from CFC-12 to HCFC-22 in important refrigeration applications (eg food chain refrigeration)

for well-established technical reasons. By the same token, the downstream technology to use the HCFC-22 product is well-established and available.

Environmental issues

The key environmental issue is the view of the ECMF as to the desirability of funding a conversion from a CFC to an HCFC given that the Copenhagen Amendments to the Protocol call for, an albeit long-term, phase-out of HCFCs in the developed world. Decision V/8 of the Parties at their 5th meeting in Bangkok (1993) requested "each Party ... to give consideration in selecting alternatives ... to economic aspects ... taking into account ... all interim steps leading to final ODS elimination". The ECMF may feel that they wish to consider the costs of eventual replacement of this new HCFC-22 plant by a non-ODS production facility. The other major issue is the emission of HFC 23 from the process. No mention is made of provision for its control, monitoring or minimisation - nor recognition that the problem exists. HFC 23 is a persistent greenhouse gas with a GWP in excess of 12 (relative to CFC 11) and an atmospheric lifetime of over 300 years. Emissions are likely to exceed 250 tonnes/year unless tightly controlled - equivalent to 750 te/yr of CFC-12 or 12,000 te/yr of HFC 134a in GWP terms.

Safety issues

In all fluorocarbon plants, HF is an important feedstock and a very hazardous material unless properly handled and controlled. There are also safety aspects to the composition of the mixture in the main reactor vessel (R201) where special provision needs to be made to keep water levels low (to avoid aqueous HF), and to avoid the formation of "magic acid" ($HSbF_6$) both of which will lead to severe corrosion. There are doubts as to the fail-safe operation of the vent scrubber (T502) in the event of chlorine break-through in that no caustic absorption system is provided. These issues need addressing at the next stage.

Cost-effectiveness

The overall capital cost of the project is of the right order of magnitude at $8.86 million. However, from the information provided, a cost estimate cannot be made to an accuracy of better than ± $2 million. Much depends on the detailed sizing of the process vessels, and the extent to which items may indeed be re-used. Detailed process diagrams would be required for this, and will depend on the detailed choice of technology and supplier. At this stage there is little purpose in attempting to refine or further validate the cost-estimate. This must be done at the pre-sanction stage on the basis of detailed design, drawings and sizings.

One general point must be made: some four dozen or so of the major items of equipment on the flowsheet are *not* used on at least one major operational developed world plant. While a case could be made that perhaps eight to ten of these are desirable, there seems no good reason for the remainder. As equipment items are not individually costed, it is not possible to state the capital saving implicit - but it could be on the order of $300-400k.

Other

A significant factor in calculating the incremental cost is the value of foregone CFC-12 sales. This is based on annual production of 7,000 te (nameplate capacity of the latest plant expansion in 1990/91). Yet the plant has never operated above 5,350 tpa, and only at about 3,500 tpa in the last two years (1992/3) - apparently because of CTC feedstock shortages. It remains to be seen whether the plant is capable of 7,000 tpa operation (equivalent to a surprising 95% reliability). It might also be asked why investments were made in expanding CFC-12 capacity in 1990/91 and CTC capacity in 1991/94 even though China indicated in mid-1990 its intention to ratify the Montreal Protocol, and actually ratified in mid-1991. These recent investments in the production of CFC-12, and its feedstock CTC, have increased the incremental costs of the project - which could otherwise have been based on 1989/90 CFC-12 production/sales levels of some 3,750 te/yr saving some $5M/year (undiscounted).

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER PROJECT COVER SHEET

COUNTRY	The People's Republic of China	
SECTORS COVERED	Domestic Refrigeration	
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)	
PROJECT TITLE	Application development for conversion of compressor manufacturing to HFC-134a rotary compressor designs.	
PROJECT DURATION	2 years	
PROJECT IMPACT	Indirect - 100 MT CFC-12	
PROJECT BUDGET	Incremental Capital Cost - Phase 1	$ 1,130,000
	Incremental Capital Cost - Phase 2	$ 230,000
	Incremental Operating Cost	$ 0
	Total Project Cost	$ 1,360,000
PROPOSED OTF GRANT[1]	$1,400,000	
IMPLEMENTING ENTERPRISE	Shanghai Refrigerator Compressor Co. Ltd.	
IMPLEMENTING AGENCY	The World Bank	
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)	

PROJECT SUMMARY

This project will result in the annual production of up to 500,000 high efficiency rotary HFC134a compressors to supply the needs of the Shanghai Shangling General Refrigeration Factory and others as they introduce HFC134a refrigerant into their line of refrigerators. Technology will be obtained from Mitsubishi (Japan) under the terms of an existing technology transfer agreement. In Phase 1 of the project, detailed engineering, product development and lab and field testing of 1000 units produced under factory conditions, will be conducted to define firm project scope and costs for full conversion of the factory output to HFC134a refrigerant during Phase 2. The results of Phase 1 will be compared with similar projects using alternative refrigerants before proceeding with Phase 2. Net incremental operating costs for the conversion will be defined during Phase 2 and presented in a separate Phase 3 project at a future date. A separate project will be defined for replacement of CFCs used in refrigerator insulating foam, pending definition of the best available technology.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 15% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVES

The objective of this project is to provide an indigenous source of Mitsubishi HFC134a rotary compressors for use with new model refrigerators based on HFC134a refrigerant at Shanghai Shangling General Refrigerator Factory.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992

(metric tons)

	CFC-11	CFC-12
Insulating Foam - New Refrigerators	4600	
Refrigerant - New Refrigerators		950
Refrigerant - Service Old Refrigerators		500
Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term. Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

The Shanghai Refrigerator Compressor Co. Ltd (SRC) factory is located in Shanghai and supplies a variety of refrigerator compressors to Shanghai Shangling Refrigerator Co. Ltd., China Industry Co. Ltd., Shanghai Shanglu Electrical Appliances Co. Ltd., and Beijing Xue Hua Electrical Appliances Group. In 1993, 550,000 compressors were produced (Table 3), about 10% of China's total requirement.

SRC has 2600 employees including 260 professional engineers. In addition to refrigerator compressors, SRC also makes air conditioning compressors and other refrigerating equipment.

Table 3
Actual and Forecast Refrigerator Compressor Production at Shanghai Refrigerator Compressor Co.

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Compressors Produced (000 Units)	350	420	470	550	800	850	950	1100

PROJECT DESCRIPTION.

The project will convert manufacturing of domestic refrigerator compressor manufacture from CFC12 designs to an newly developed rotary compressor suited to HFC134a refrigerant at Shanghai Refrigerator Compressor Co.
The project will be conducted in 2 Phases.

Phase I Engineering, product development and testing under local conditions to integrate new Mitsubishi technology and to establish basic data for full conversion of the factory to make the new rotary compressors.

Phase II Full conversion of the SRC factory to Mitsubishi HFC134a rotary compressor designs.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY:

HFC134a has been accepted worldwide as the principal replacement for CFC12 refrigerant in domestic refrigerators. Its thermodynamic properties are similar to CFC12, it is non-flammable, non-toxic, and has a zero ODP. SRC's program to convert their manufacturing facility to HFC134a designs, with the assistance of Mitsubishi, has made it the leading candidate for continued development of this technology.

PROJECT COST

The total project cost is estimated to be $1,360,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation,currency fluctuations, and other unforseen costs.
A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An order of magnitude estimate of these costs is US$2,000,000 for the first four years of operation, discounted at 10%. If these costs are passed on to the users of SRC compressors, the net incremental operating costs for OTF fund will be negligible.

UNIT ABATEMENT COST (UAB)

Not applicable to compressors manufacture as CFC phaseout is determined to be as a result of appliance manufacture.

PROPOSED OTF GRANT

The proposed OTF grant request is US$1,400,000 is based on 100% Chinese ownershhip of Shanghai Refrigerator Compressor Co. Ltd. and covers the incremental capital costs for Phases 1 and 2 of the project ,

including a 15% contingency cost and a 3% fee for the financial agent administering the project.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

SHANGHAI REFRIGERATOR COMPRESSOR PROJECT COST SUMMARY

CAPITAL COSTS	US$
Phase I -	
Technology Transfer Fee	475
Calorimeter	200
Noise and Vibration Sensors & Instruments	50
Data Logger	180
Components for 1000 Compressors (@ US$35 per compressor)	35
Training of Technicians in Japan	20
Foreign Consultations	20
SUB-TOTAL	980
Phase I I	
Oil Charging System	150
Operator Training at SRC	30
Installation and Commissioning	20
SUB-TOTAL	200
Contingency (15%)	180
TOTAL CAPITAL COSTS	1,360

Annex B

SHANGHAI REFRIGERATOR COMPRESSOR IMPLEMENTATION SCHEDULE[2]

	From	To
Phase 1		
Purchase Equipment for Test Manufacture	1Q94	3Q94
Modify Production Line for Test Manufacture	1Q94	2Q94
Train Technical Personnel	1Q94	2Q94
Make 1000 New Rotary Compressors	2Q94	2Q94
Test Compressors	3Q94	3Q94
Prepare Phase 2 Feasibility Study	3Q94	3Q94
Phase 2		
Purchase and Install New Equipment	3Q94	4Q94
Train Operators and Mechanics	3Q94	3Q94
Startup	4Q94	4Q94
Acheive Full Production Rate	1Q95	1Q98

[2] Project schedule assumes ECMP approval of project during 1Q94.

Annex C

TECHNOLOGY TRANSFER AGREEMENT

On November 23, 1993, Shanghai Refrgerator Compressor Company and Mitsubishi Electric signed an agreement for transfer of technology for manufacture of rotary compressors suitable for use of HFC134a.

The terms and conditions of this agreement include the following:

10 year term
4 compressor models
Annual update of latest Mitsubishi improvements on the 4 models
Designs modified to meet Chinese Standards
Technical assistance provided by Mitsubishi on request

The technology fee is 53,000,000, denominated in Japanese Yen (equiv. US$475,000)

Designs	20,000,000
Process Technology	25,000,000
Testing Technology	8,000,000

Conversion of Compressor Manufacturing from CFC-12 to HFC-134a at Shanghai Refrigerator Compressor Factory

Project Proposal by The World Bank, January 1994

ⓘ

Scope

The scope of this project is to convert the production of rotary compressors from CFC-12 to HFC-134a. Assistance is provided from a developed country manufacturer (Mitsubishi, Japan).

Recommendation

Approval

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a first instance some questions were asked which were satisfactorily answered, so altogether sufficient information for a judgment is present.
The project proposal itself does not contain all relevant information.

Technical soundness

This project has a sound technical basis. The technology transfer from Mitsubishi, Japan is essential. An adequate technology transfer can be expected also due to successful cooperation between the two companies in previous projects.

Lessons from experience

not applicable

Environmental and safety issues

HFC-134a is an acceptable way to reduce CFC-12 consumption.

Cost-effectiveness

No incremental operational costs are claimed in this phase. In a future phase it must be decided who can claim for operational costs, the compressor producer or the users. The costs being claimed are reasonable and in line with similar projects.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 09

Supplemental Comments of 6 China Refrigerant Projects
Overall Assessment

Shanghai Refrigerator Compressor Factory
HFC134a Mitsubishi Rotary Compressors

1. The Shangling and Shanghai Compressor projects will rely heavily on Mitsubishi for technology. As can be seen in the project summary discussion on Technology Transfer, the agreement cost Shangling about $6,000,000 and includes full designs for 2 non-CFC model refrigrators based on their rotary compressors. The technology agreement for compressors is an additional $430,000.

2. The basic questions posed to Shangling and Shanghai Compressor wer, "is Mitsubishi producing similar refrigerators and compressors in Japan today?" "Is the technology commercially proven?" Shangling will consult with Mitsubishi and prepare a formal response for inclusion in the feasibility studies for Shangling and Shanghai Compressors.

3. We felt that the original quote of $375,000 for a calorminete was too high and $200,000 was agreed to for the project.

4. Overall Assessment - the project feasibility study is adequate. The project scope definition and costs is comparable to other similiar projects which have been reviewed and approved. The support of Mitsubishi is essential for project success. Clarification of the state of HFC134a rotary compressor development in Japan is needed to resolve outstanding questions on commerciality of the technology.

5. Recommendation - OORG to support the 2 projects (Shangling and Shanghai Compressor) on the basis that the Shangling project is included in the China CP Action Plan and the data is needed to assist selection of the best refrigerator/compressor technology for broad application in China. The Shangling project would be moot without approval of the Shanghai Compressor project. As HFC134a technology is currently the world standard CFC12 replacement, China must fully understand the impact of this technology on their industry to remain competitive in the world markets, particularly if they choose to adopt a different technology.

To: Miss Helen Chan Fax: 1-202-477-1273
From: Shanghai Refrigerator Compressor Co.Ltd.

Additional Remarks For SRC Project

1. Noise and Vib ration equipment

As the pressure ratio of suction to discharging and oil circuit are different between HFC134a and CFC12 during compressor running, so noise and vib ration of compressor is also different.

1). Noise is tested after the equipment filled with HFC134a reach a steady running. But the existing equipment in the company is only suit for CFC12, so it can not be used for HFC134a.

2). Noise equipment is placed in the noise elimination room. Another noise elimination room will be set up necessarily for HFC134a compressor, so the equipment will be set up at the same time.

3). The CFC12 compressor will be produced for several years, it is impossible to remove the existing CFC12 system. So the noi se and vib ration equipments for both CFC12 and HFC134a will be existed simultaneously for several years.

2. The basis of 35 USD per compressor (for 1000 compressors)

In fact the cost of existing CFC12 compressor in the company is 39 USD (the domestic sale price is 49 USD, which can not be compared with the nationaol price). For trial production, the cost will be higher than 40 USD (including some special reasons, such as material, higher reject rate and design fee, etc.). So the company will bear some portion of cost by itself except 35 USD per comperssor applied from The World Bank.

SHANGHAI REFRIGERATOR COMPRESSOR CO., LTD.

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER PROJECT COVER SHEET

COUNTRY	The People's Republic of China	
SECTORS COVERED	Domestic Refrigeration	
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)	
PROJECT TITLE	Engineering Assistance for Conversion of Refrigerator Manufacture to HFC-134a refrigerant with Rotary Compressors.	
PROJECT DURATION	2 years	
PROJECT IMPACT	108MT CFC-12	
PROJECT BUDGET	Incremental Capital Cost - Phase 1	$ 920,000
	Incremental Capital Cost - Phase 2	$ 600,000
	Incremental Operating Costs	0
	Total Project Cost	$ 1,520,000
PROPOSED OTF GRANT[1]	$1,570,000	
IMPLEMENTING ENTERPRISE	Shanghai Shangling General Refrigerator Factory (SSGRF)	
IMPLEMENTING AGENCY	The World Bank	
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)	

PROJECT SUMMARY

This project will lead to replacement of CFC-12 refrigerant in household refrigerators manufactured by Shanghai Shangling General Refrigerator Factory with HFC-134a . In Phase 1 of the project, detailed engineering, product development and lab and field testing of 500 units produced under factory conditions, will be conducted to define firm project scope and costs for full conversion of the factory output to HFC134a refrigerant during Phase 2. The results of Phase 1 will be compared with similar projects using alternative refrigerants before proceeding with Phase 2. Net incremental operating costs for the conversion will be defined during Phase 2 and presented in a separate Phase 3 project at a future date. A separate project will be defined for replacement of CFCs used in refrigerator insulating foam, pending definition of the best available technology.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 15% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVE

The objective of this project are to establish a phased introduction of proven and useful technology for HFC-134a refrigerant in rotary compressors in China. The results of this project will be evaluated and considered for adoption by similar refrigerator operations in China.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992

(metric tons)

	CFC-11	CFC-12
Insulating Foam - New Refrigerators	4600	
Refrigerant - New Refrigerators		950
Refrigerant - Service Old Refrigerators		500
Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term.

Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

SSGRF produces refrigerators, air conditioners, microwave ovens and other domestic appliances. The factory is located in the Pudong special development area of Shanghai and covers 17,000 sq. meters. The location entitles the company to import foreign made components duty free.

A total of 2600 employees are engaged in refrigerator production on one production line imported from Mitsubishi (Japan). The line is capable of producing 500,000 refrigerators annually based on 2 shift operation. Eight models are produced with about 1% exported.

In 1992, Shangling produced 11% of the refrigerators sold in China. Actual and forecast production are illustrated in Table 3 for the period 1990-1997

Table 3
Actual and Forecast Refrigerator Production at SSGRF

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Refrigerators Produced (000 Units)	280	320	360	480	520	600	600	600

SSGRF first produced refrigerators designed by Mitsubishi in 1986 and subsequently developed its own designs based on use of Mitsubishi designed rotary compressors produced by the Shanghai Refrigerator Compressor Company(SRCC). Since 1991, SSGRF has been engaged on a collaborative venture with SRCC to produce a prototype HFC134a refrigerator equipped with a rotary compressor. This work has been supported by the Power Machinery Engineering Department of Xi'an Jiaotong University, Shanghai Research Institute of General Machinery and Shanghai Organic Chemical Research Institute.

Work completed to date includes the following:

- O Performance and material compatibility testing with HFC134a in SRCC rotary compressors.
- O Identification and testing of suitable lubricants
- O Lab testing of SSGRF refrigerators equipped with the SRCC rotary compressors.

In March 1993, Mitsubishi signed an agreement with SSGRF to support the full development of refrigerator circuit designs for 4 refrigerator models (2 CFC and 2 non-CFC models). This agreement includes provision of drawings and manufacturing procedures, a parts schedule, assistance with achieving quality control, and testing of SSGRF's test manufactured refrigerator units The agreement includes technology transfer for both CFC and non-CFC refrigerators (Annex C).

PROJECT DESCRIPTION.

The project will accomplish phaseout of CFC12 used as refrigerant in domestic refrigerators produced by SSGRF in two phases.

Phase I Engineering, product development and testing under local conditions to establish basic data for full conversion to HFC-134a and for comparison with results of similar programs using alternative refrigerants.

Phase II Full conversion of the SSGRF facilities to HFC-134a refrigerant

During Phase 1, over 500 refrigerators will be produced under factory conditions to prove the viability of refrigerant circuit designs provided by Mitsubishi. Testing facilities to be installed at SSGRF will include a controlled ambient test room and a data acquisition system for monitoring refrigerator performance under test conditions. Consultations will be arranged with local and foreign experts to instruct SSGRF engineers and technicians in the design, testing and manufacturing procedures for non-CFC refrigerants. At the conclusion of Phase 1, a feasibility study will be prepared for full conversion of refrigerator manufacturing at SSGRF to the use of HFC-134a refrigerant with a rotary style compressor. Based on the feasibility study results, a detailed cost estimate will be prepared and project planning will be revised to accomodate Phase 1 findings before commencing with Phase 2.

Phase 2 will implement the full conversion of SSGRF refrigerator facilities to HFC134a refrigerant over a period of 4 years.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

HFC134a has been accepted worldwide as the principal replacement for CFC12 refrigerant in domestic refrigerators. Its thermodynamic properties are similar to CFC12, it is non-flammable, non-toxic, and has a zero ODP. SSGRF's program to develop the use of HFC134a in refrigerators of its design, with the assistance of Mitsubishi, has made it the leading candidate for continued development of this technology for comparison with other technolgies as defined in the China Country Program.

PROJECT COST

The total project cost is estimated to be $1,520,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation, and other unforseen costs.
A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An OTF grant request will be made based on Phase 2 results. An order of magnitude estimate of these costs is US$3.300,000 for the first four years of operation, discounted at 10%.

UNIT ABATEMENT COST (UAB)

$13.48 per kg CFC-12

PROPOSED OTF GRANT

The proposed OTF grant request is US$1,570,000 is based on 100% chinese ownershhip of SSGRF and covers the incremental capital costs for Phases 1 and 2 of the project , including a 15% contingency cost and a 3% fee for the financial agent administering the project.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal.

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

SHANGHAI GENERAL REFRIGERATOR FACTORY
PROJECT COST SUMMARY

	(000US$)
Phase I -	
Controlled Ambient Test Room	70
Data Acquisition System	57
Technology Transfer Agreement	430
Test manufacture 500 Refrigerators (@US$ 160 per unit)	80
Testing of Trial Manufactured Units	33
Consulations and Training	100
Feasibility Study Preparation	30
SUB-TOTAL	800
Phase I I	
Refrigerant Charging Machine	50
Leak Detectors & Instruments	60
80 Vacuum Pumps for In-Line Testing	110
Calorimeter for Quality Control	200
Sprecial Service Unit for HFC134a Refrigerators	100
SUB-TOTAL	520
Contingency (15%)	200
OTAL INCREMENTAL CAPITAL COST	1,520

Annex B

IMPLEMENTATION SCHEDULE[2]

	From	To
Phase 1		
Install Test Room and Data System	3Q94	4Q95
Train Technicians and Engineers	1Q94	2Q94
Test Manufacture 500 Refrigerators	3Q94	3Q94
Conduct Lab Tests	4Q94	3Q95
Conduct Field Tests	1Q95	3Q95
Prepare Feasibility Study	2Q95	2Q95
Phase 2		
Convert Manufacturing to HFC-134a	4Q95	4Q97

[2] Project schedule assumes ECMP approval of project during 1Q94.

Annex C

TECHNOLOGY TRANSFER AGREEMENT

On March 18, 1993, Mitsubishi Electric Corporation and Shanghai Shangling General Refrigerator Factory (SSGRF) concluded a technical collaboration agreement for manufacture of refrigerators by SSGRF in China. Under the terms of this agreement, Mitsubishi will provide SSGRF with technical support for manufacturing 2 CFC models as well as designs, drawings and specifications for manufacture of 2 non-CFC refrigerator models in SSGRF facilities. Testing of non-CFC refrigerators by Mitsubishi is also included.

The agreement will be valid for 7 years and requires a payment of 640,000,000 japanese yen on the following payment schedule.

1993 - 40,000,000
1994 - 70,000,000
1995 - 90,000,000
1996 - 110,000,000
1997 - 110,000,000
1998 - 110,000,000
1999 - 110,000,000

As the agreement covers technical support for CFC and non-CFC foams and refrigerants, the portion applicable to various activities was estimated as follows:

85% to support existing CFC refrigerator manufacture.
7.5% to support technology transfer for non-CFC refrigerants.
7.5% to support technology transfer for non-CFC refrigerator foam.

The portion of the technology transfer agreement attributable to refrigerant circuit design for HFC-134a refrigerant in this project is therefore 48,000,000 yen (US$430,000)

Conversion of Refrigerator Manufacturing from CFC-12 to HFC-134a at Shanghai Shangling General Refrigerator Factory (SSGRF)

Project Proposal by The World Bank, January 1994

③

Scope

The scope of this project is to replace CFC-12 by HFC-134a in the Shanghai Shangling refrigerator factory. This is a proven technology and back up is provided from a developed country manufacturer (Mitsubishi Japan).

Recommendation

Approval

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a second stage, after a preliminary review, a satisfactory response was given to outstanding issues by the Shangling company. Altogether sufficient information for a judgment is present.
The project proposal itself does not contain all relevant information.

Technical soundness

This project has a sound technical basis. The technology transfer from Mitsubishi, Japan is essential. Rotary compressors will be obtained from the Shanghai Refrigerator Compressor Company who request for funding itself and is also supported by Mitsubushi, Japan. It can be expected that the technology transfer will be adequate and that the project can be completed successfully.

Lessons from experience

not applicable

Environmental and safety issues

HFC-134a is an acceptable way to reduce CFC-12 consumption.

Cost-effectiveness

No incremental operational costs are claimed in this phase. Therefore no cost-effectiveness can be discussed.
The costs being claimed are reasonable and in line with similar projects.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 09

Supplemental Comments of 6 China Refrigerant Projects
Overall Assessment

Shangling
HFC134a Refrigerators using Mitsubishi Rotary Compressors

1. The Shangling project will rely heavily on Mitsubishi for technology. As can be seen in the project summary discussion on Technology Transfer, the agreement cost Shangling about $6,000,000 and includes full designs for 2 non-CFC model refrigrators based on their rotary compressors. There os a separate technology agreement for compressors between Shanghai Compressor Factory and Mitsubishi. We debated how much of the technology transfer agreement cost shoud be allocated to this project and concluded 7.5% on the basis that $430,000 would be in line with similar agreements elsewhere. Transfer of technology from Mitsubishi has started.

2. The basic question posed to Shangling was, "is Mitsubishi producing similar refrigerators in Japan today?" "Is the technology commercially proven?" Shangling will consult with Mitsubishi and prepare a formal response for inclusion in the feasibility study.

3. Two cost items in Phase 2 were extensively discussed - a calorimeter and a service unit. The calorimeter is claimed to be necessary to assure quality control of incoming compressors from Shanghai Refrigerator Factory. I questioned if this was really necessary. We also felt that the original quote of $375,000 was too high and $200,000 was agreed to for the project.
Shangling have a policy of servicing all of the refrigerators they produce. They state the $100,000 service facility in Phase 2 is to provide the necessary capital equipment to permit servicing of the HFC134a refrigerators that they will produce as well as the CFC12 units still in service.

4. The work plan does focus on the "Criteria" for appliance development. There was considerable debate on the 48 degree temperature which was specified for the controlled ambient test. (This same question arose from Hua Yi, Wanbao, Chang ling, and Shanglu). The claim is that 48 degrees is to hot for the refrigerators made in China -- their National Standard for testing is 32 to 38 degrees depending on model type. Kuijpers has been requested to review this issue and advise if lower temperatures can be accepted for meeting the "Criteria".

5. Overall Assessment - the project feasibility study is adequate. The support of Mitsubishi is essential for project success. Clarification of the state of HFC134a rotary compressor development in Japan is needed to resolve outstanding questions on commerciality of the technology.

6. Recommendation - OORG to support the project on the basis that it is included in the China CP Action Plan and the data is needed to assist selection of the best refrigerator technology for broad application in China. As HFC134a technology is currently the world standard CFC12 replacement, China must fully understand the impact of this technology on their industry to remain competitive in the world markets, particularly if they choose to adopt a different technology.

To: Helen Chan 海伦·陈
World Bank 世界银行
Washington, U.S.A 美国华盛顿
Fax: 001-202-477-1273

From: Chen Lingxiang 陈令祥
Shanghai Shangling General Refrigerator Factory
Shanghai, China 中国上海上菱电冰箱总厂
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Tel: 901-8621-885-7888

Further Explanation For Some Quotation under the Project of Conversion of Refrigerator Manufacturing from CFC-12 to HFC-134a at Shanghai Shangling General Refrigerator Factory (SSGRF)

1. In China, it has become a custom that a quality test of some or all of the products should be carried out before they used upon new products, although those tests have been made by the manufactures before the products get to the market.

The calorimeter for compressor owned by Shanghai Refrigerator Compressor Co., Ltd.. is used to its limit, so it is impossible for the equipment to be used by SSGRF anymore.

Furthermore, the calorimeter for compressor using CFC-12 can not be used for compressor with HFC-134a. In this case, a new calorimeter for compressor must be bought to ensure the quality of the HFC-134a refrigerator.

2. It is indicated in the provisions of the technical contract signed between Shangling and Mitsubishi that

(1) The cost of sending Japanese technicians to China, including the cost of technical guide and traffic, should be paid by Shangling.

a. Payment to every Japanese technician for everyday is 50,000 yen.

b. Traffic fee for every technician every tour is 170,000 yen.

It takes a Japanese technician US$ 500 a day and US$ 60,000 altogether for three persons in 40 days.

(2) Payment for the cost of sending Chinese technicians abroad to receive technical training. It is estimated of as much as US$ 40,000 for three persons in 44 days abroad, if every one takes US$ 300 per days.

All this money is exclusive of the total technical contract cost of 640 million yen. Shangling must pay this US$ 100,000 (US$ 60,000 + US$ 40,000) extra expenses.

3. In our project feasibility study, we have explained that service becomes more and more important for the refrigerator manufactory in China. The existing service system can only service CFC-12 refrigerators but not HFC-134a ones. On the other hand, becauses the existing service system isn't adapted HFC-134a, it can't service CFC-12 refrigerators and HFC-134a ones alternately. Thus, in order to ensure the service of both Shangling CFC-12 refrigerators and HFC-134a ones, we wish this investment can be supported by OORG.

4. In SSGRF, there are two test production phases before a new model put into operation. One is model test phase, it uses to check whether the performance of the new refrigerator achieves the goal of design. The other is test production, it uses to check whether the equipment and technological process are adapted to production. When test production, the equipment and instruments invested must be adjust and tested. So the producing line can't run normally and Shangling will exert a tremendous influence on the profit. On the base of two days calculating, Shangling will suffer heavy losses of 700,000 yuan (US$80,000). That means US$ 160 per refrigerator.

In fact, this expense is cost of test production.

THE MONTREAL PROTOCOL ON
SUBSTANCES THAT DEPLETE THE OZONE LAYER
PROJECT COVER SHEET

COUNTRY	The People's Republic of China	
SECTORS COVERED	Domestic Refrigeration	
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)	
PROJECT TITLE	Engineering Assistance for Conversion of Refrigerator Manufacture to HFC134a Refrigerant with Tecumseh designed HFC134a compressors.	
PROJECT DURATION	2 years	
PROJECT IMPACT	60 MT CFC-12	
PROJECT BUDGET	Incremental Capital Cost - Phase 1	$ 575,000
	Incremental Capital Cost - Phase 2	$ 825,000
	Incremental Operating Cost	$ 0
	Total Project Cost	$1,400,000
PROPOSED OTF GRANT[1]	$1,442,000	
IMPLEMENTING ENTERPRISE	Hua Yi Electrical Appliance General Company	
IMPLEMENTING AGENCY	The World Bank	
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)	

PROJECT SUMMARY

This project will convert the existing CFC12 refrigerator line to HFC134a refrigerant using new reciprocating compressors manufactured by Hua Yi in a new facility. Retroactive financing of Phase 1 of the project (detailed engineering, product development and lab and field testing of 500 units produced under factory conditions) is being requested. A firm project scope and detailed costs for full conversion of the factory output to HFC134a refrigerant was made at the conclusion of Phase 1. Net incremental operating costs for the conversion will be defined during Phase 2 and presented in a separate Phase 3 project at a future date. A separate project will be defined for replacement of CFCs used in refrigerator insulating foam, pending definition of the best available technology.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 15% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVES

The objectives of this project are to establish a phased introduction of technology for use of HFC134a in domestic refrigerators equipped with new reciprocating compressors and produced by Hua Yi. The project will develop reliable data for comparison with other refrigerant projects . The results of this project will be evaluated and considered for adoption by similar refrigerator operations throughout China.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992

(metric tons)

	CFC-11	CFC-12
Insulating Foam - New Refrigerators	4600	
Refrigerant - New Refrigerators		950
Refrigerant - Service Old Refrigerators		500
Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term. Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

Hua Yi Electrical Appliance General Co. is located in Jingdezhen and produces household electric appliances, air conditioners and freezers. A total of 510 employees are engaged in refrigerator production on one production line imported from Merloni (Italy) in 1985. The line is capable of producing 300,000 refrigerators annually based on 2 shift operation. Sixteen models are produced with export of about 10% of the refrigerators produced..

In 1992, Hua Yi produced 6% of the refrigerators sold in China. Actual and forecast production are illustrated in Table 3 for the period 1990-1997

Table 3
Actual and Forecast Refrigerator Production at Hua Yi

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Refrigerators Produced (000 Units)	120	150	200	200	200	200	250	300

PROJECT DESCRIPTION.

The project will accomplish phaseout of CFC12 used as refrigerant in domestic refrigerators produced by Hua Yi in two phases.

Phase I Engineering, product development and testing under local conditions to establish basic data for full conversion to HFC134a refrigerant has been completed. A feasibility study for full conversion of Hua Yi refrigerator manufacturing to HFC134a has also been completed.

Phase II Full conversion of the Hua Yi factory to HFC134a refrigerant

During Phase 1, 4000 refrigerators have been produced under factory conditions to prove the viability of manufacturing refrigerators safely and reliable under local conditions. Five models were fully tested by Kirby(Austrailia) and permission to proceed with full scale production was granted. At the conclusion of Phase 1, a feasibility study was prepared for the full conversion of Hua Yi refrigerator manufacturing and is being used to guide project completion.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY:

HFC134a has been accepted worldwide as the principal replacement for CFC12 refrigerant in domestic refrigerators. Its thermodynamic properties are similar to CFC12, it is non-flammable, non-toxic, and has a zero ODP. Hua Yi has completed startup of a compressor manufacturing line to produce HFC-134a compressors based on Tecumseh designs. These compressors are to used to make new HFC134a model refrigerators, with the assistance of Kirby (Australia). Hua Yi experience with startup and operations during 1994 will provide valuable data for continued development of this technology and for comparison with other technolgies as defined in the China Country Program.

PROJECT COST

The total project cost is estimated to be $1,400,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation,currency fluctuations, and other unforseen costs.
A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An OTF grant request will be made based on Phase 2 results. An order of magnitude estimate of these costs is US$6,300,000 for the first four years of operation, discounted at 10%.

UNIT ABATEMENT COST (UAB)

$41.33 per kg CFC-12

PROPOSED OTF GRANT

The proposed OTF grant request is US$1,442,000 is based on 100% Chinese (state) ownershhip of Hua Yi and covers the incremental capital costs for Phases 1 and 2 of the project , including a 15% contingency cost and a 3% fee for the financial agent administering the project.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

HUA YI
PROJECT COST SUMMARY

	(000US$)
Phase I -	
Technology Transfer Fee	300
Testing of Refrigerators by Kirby	10
Training of Engineers	66
Preparation of Feasibility Study	30
Test Manufacture of 510 Refrigerators (@ US$185 per unit)	94
SUB-TOTAL	500
Phase I I	
3 Refrigerant Charging Machines	195
4 Halogen Leak Detectors	28
30 Vacuum pumps	72
2 Vacuum Dehydrators	200
1 Helium Leak Detector	90
Controlled Ambient Test Room	100
Operator and Mechanic Training	35
SUB-TOTAL	720
Contingency (15%)	180
TOTAL CAPITAL COSTS	1,400

Annex B

HUA YI
IMPLEMENTATION SCHEDULE[2]

	From	To
Phase 1 (complete)		
Test Manufacture 4000 refrigerators	3Q93	1Q94
Prepare Feasibility Report for Phase 2	3Q93	4Q93
Phase 2		
Purchase and install equipment for mass production of HFC134a refrigerators	1Q94	3Q94
Startup	3Q94	4Q94
Achieve full phaseout of CFC12 refrigerant	4Q94	4Q94

2 Project schedule assumes ECMP approval of project during 1Q94.

Annex C

TECHNOLOGY TRANSFER AGREEMENT

On 15 June 1992, Hua Yi Electric Appliance General Co signed an agreement with James N. Kirby Pvt. Ltd. for transfer of technology with which to develop a HFC134a refrigerator.

the memorandum of understanding for this agreement covered three elements:

Technical assistance for developing HFC134a refrigerators	US$300,000
Testing of HFC134a compressors withHua Yi cabinets	US$ 10,000
Training of Hua Yi Technical Personnel	US$ 66,000

Conversion of Refrigerator Manufacturing from CFC-12 to HFC-134a at Hua Yi Refrigerator Company

Project Proposal by The World Bank, January 1994

⑤

Scope

The scope of this project is to convert the Hua Yi refrigerator factory from CFC-12 to HFC-134a. The selected technology is a proven technology and a partner in the developed world (Kirby, Australia) assists in the conversion process. This project is in an advanced state as Hua Yi already produced 4000 appliances with HFC-134a. Part of the funding requested can be considered retroactive financing.

Recommendation

Approval, see remarks below.

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a second stage, after a preliminary review, supplementary information was given by Hua Yi. Altogether sufficient information for a judgment is present.
The project proposal itself does not contain all relevant information.

Technical soundness

This project has a sound technical basis. The Hua Yi company has already performed a pilot production using HFC-134a with successful results. The compressors applied are produced by the Hua Yi company itself which started HFC-134a compressor production in May '93. Compressor manufacturing technology was obtained from Kirby, Australia. The status of the compressor production is such that a reliable supply for the refrigerator project can be assumed.

Lessons from experience

not applicable

Environmental and safety issues

HFC-134a is an acceptable way to reduce CFC-12 consumption.

Cost-effectiveness

No incremental operational costs are claimed in this phase yet. Therefore no cost-effectiveness can be discussed.
The costs claimed are high but reasonable and in line with similar projects.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 09

Supplemental Comments of 6 China Refrigerant Projects

Overall Assessment

Hua Yi
HFC134a Refrigerators - Kirby Technology

1. The work plan does focus on the "Criteria" for appliance development. There was considerable debate on the 48 degree temperature which was specified for the controlled ambient test. (This same question arose from Wanbao, Chang Ling, Shangling, and Shanglu). The claim is that 48 degrees is to hot for the refrigerators made in China -- their National Standard for testing is 32 to 38 degrees depending on model type. Kuijpers has been requested to review this issue and advise if lower temperatures can be accepted for meeting the "Criteria".

2. Hua Yi has produced over 4000 refrigerators to date in proving the manufacturing technology obtained through Kirby. Testing work on these units has led Kirby to grant approval to proceed with full scale production. Consequently, Phase 1 is complete and the funding request is for RETROACTIVE financing of the cost of the work that otherwise would have been funded through the OTF.

3. The project feasibility study is complete and thorough and will be in hand by Jan 22.

4. Hua Yi was requested to prepare a separate project proposal to cover their HFC134a compressor plant incremental costs. Hence, costs and discussions relative to the compressor plant are not included in this project summary.

5 Overall Assessment - The project is well prepared and has no significant flaws.

6 Recommendation - (O)ORG to support the project on the basis that the work included in the project is more than 50% complete and is well supported by international technology suppliers (Kirby-Tecunseh) and the project it is included in the China CP Action Plan. Data from the Hua Yi is needed to assist selection of the best refrigerator technology for broad application in China.

DATE: FEB.7,1

SUPPLEMENT STATEMENT TO THE FEASIBILITY STUDY ON CONVERSION OF REFRIGERATOR MANUFACTURE FROM CFC-12 TO HFC-134A AT HUA YI REFRIGERATOR FACTORY

According to the comments made by Mr.Janssen,M.J.P.(OORG) Feb.2,1994, we prepared the supplement statement as follows:

1. In October,1991, Hua Yi Electrical Appliance General Compa signed with James N. Kirby Pty. Ltd. a contract that introdu manufacture technology and production line of new reciprocati compressor applying HFC-134a from Tecumseh Product Company (t U. S.A.). The installation and testing of imported equipment beg in May of 1993, and in the September first batch of new compress were assembled with imported pump kits. By the end of last year, a the erection and testing of production lines have been completed ar 5000 finished products came out of the lines. Now the new plant h been put into production. The plnning capacity in 1994 shall b 400, 000, half of which are used to match the refrigerator produce at Hua Yi and the remaining half will be exported to internationa market such as Netherland and Turkey and so on. Reliability test fc HFC-134a compressor had been done by Kirby, please see details i Annex 1.

2. The capacity of Hua Yi's project is 300,000 instead of 200,000. A ambient controlled test room and vacuum dehydrator are necessary t be set up and purchased in order to guarantee the product quality, because moisture absorption of HFC-134a is very high and it shoul be much more strictly to HFC-134a than to CFC-12 in respect o residue moisture and and contamination.

3. Unit price of USD185 claimed for 510 refrigerators is the E Factory Price. Actually, the production cost of one refirgerator (the cost of raw material and components) is USD172. Though i looks higher than traditional product, some of the main parts shoul be replaced and cost much more than before, for example HFC-134a, new compressor and special dryer and etc...By the end of last year, 4000 HFC-134a refrigerators have been produced by Hua Yi and bee put into demostic market for trial sales. Hua Yi put forward request of OTF grant for only 510 refrigerators which amounts to b USD94, 000, after Mr.Charles Catanach kindly advised that it is no suitable to exceed the figure of 510 in Hua Yi's proposal fo refrigerator test manufacture. If possible, Hua Yi sincerely hop MPEC could consider the test manufacture fee as per actual figure o 4000.

4000.

4. The quotation of USD90,000 for helium leak detector includes th cost of recovery system. Helium leak detector model no.ECOTE500 i made by Leybold Ltd.(Germany), it costs about USD35, 000/set. Please see details in Annex 2.

Should you have any question need our explaination durin the project review and appraisal, please do not hesitate to advis us as soon as possible.

Hua Yi Electrical Appliance General Company

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER PROJECT COVER SHEET

COUNTRY	The People's Republic of China	
SECTORS COVERED	Domestic Refrigeration	
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)	
PROJECT TITLE	Enginnering Assistance for Conversion of Refrigerator Manufacture to a Ternary Blend Refrigerant (MP-39) using conventional compressors.	
PROJECT DURATION	2 years	
PROJECT IMPACT	70 MT CFC-12	
PROJECT BUDGET	Incremental Capital Cost-Phase 1	$ 540,000
	Incremental Capital Cost-Phase 2	$ 440,000
	Incremental Operating Costs	$ 0
	Total Project Cost	$ 980,000
PROPOSED OTF GRANT[1]	$1,010,000	
IMPLEMENTING ENTERPRISE	Shanghai Shanglu Electrical Appliances Co. Ltd.	
IMPLEMENTING AGENCY	The World Bank	
NATIONAL COORDINATING AGCY	National Environmental Protection Agency (NEPA)	

PROJECT SUMMARY

This project will lead to replacement of CFC-12 refrigerant in household refrigerators manufactured by Shanglu to a blended refrigerant consisting of HCFC22 and HFC152a. Technology has been developed in cooperation with DuPont China Limited and the Shanghai General Mechanical Institute. In Phase 1 of the project, detailed engineering, product development and lab and field testing of 500 units produced under factory conditions, will be conducted to define firm project scope and costs for full conversion of the factory output to HCFC22/HFC152a/HCFC124 ternary blend refrigerant (MP-39) during Phase 2. The results of Phase 1 will be compared with similar projects using alternative refrigerants before proceeding with Phase 2. Net incremental operating costs for the conversion will be defined during Phase 2 and presented in a separate Phase 3 project at a future date. A separate project will be defined for replacement of CFCs used in refrigerator insulating foam, pending definition of the best available technology.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

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[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 15% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVES

The objectives of this project are to establish a phased introduction of technology for use of HCFC22/HFC152aHCFC124 ternary blend refrigerant (MP-39) in domestic refrigerators produced by Shanglu as to develop reliable data for comparison with other alternative refrigerants . The results of this project will be evaluated and considered for adoption by similar refrigerator operations in China.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992

(metric tons)

	CFC-11	CFC-12
Insulating Foam - New Refrigerators	4600	
Refrigerant - New Refrigerators		950
Refrigerant - Service Old Refrigerators		500
Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term. Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

Shanghai Shanglu Electrical Appliances Co. Ltd. is located in Shanghai on the site of the former Shanghai Refrigerator factory and was set up in 1979. A total of 2,238 employees are engaged in production of refrigerators, freezers, and other household appliances. There are 4 refrigerator lines capable of producing 400,000 refrigerators on a two shift basis. Three primary models are produced with export of about 5% of the refrigerators produced..

In 1992, Shanglu produced 7% of the refrigerators sold in China. Actual and forecast production are illustrated in Table 3 for the period 1990-1997

Table 3
Actual and Forecast Refrigerator Production at Shanglu

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Refrigerators Produced (000 Units)	160	185	220	270	320	400	500	500

PROJECT DESCRIPTION.

The project will accomplish phaseout of CFC12 used as refrigerant in domestic refrigerators produced by Shanglu in two phases.

Phase I Engineering, product development and testing under local conditions to establish basic data for full conversion to HCFC22/HFC152/HCFC124a (MP-39) ternary blended refrigerant and for comparison with results of similar programs using alternative refrigerants.

Phase II Full conversion of the Shanglu factory to MP-39 refrigerant

During Phase 1, 500 refrigerators will be produced under factory conditions to prove the viability of manufacturing refrigerators safely and reliable under local conditions. At the conclusion of Phase 1, a feasibility study will be prepared for full conversion of refrigerator manufacturing at Shanglu using MP-39 refrigerant. Based on the feasibility study results, a detailed cost estimate will be prepared and project planning will be revised to accomodate Phase 1 findings before commencing with Phase 2.

Phase 2 will implement the full conversion of Shanglu refrigerator facilities to MP-39 refrigerant

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

While HFC134a has been accepted worldwide as the principal replacement for CFC12 refrigerant in domestic refrigerators, alternative refrigerants have found application in China where indigenous sources of HFC134a refrigerant and polyolester lubricant are not available.

One such alternative under consideration is the use of blended refrigerants which can function effectively in conventional CFC12 style refrigerator compressors. The HCFC22/HFC152a (binary blend) and MP-39 (ternary blend) are a leading condidates because standard CFC-12 compressors can be used without design modifications and because of a slight improvement in energy efficiency when compared to CFC12 at the same conditions in an identical compressor. Shanglu has pioneered the development of MP-39 application in China and is well positioned to implement the project successfully.

PROJECT COST

The total project cost is estimated to be $980,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation,currency fluctuations, and other unforseen costs.
A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An OTF grant request will be made based on Phase 2 results. An order of magnitude estimate of these costs is US$2,000,000 for the first four years of operation, discounted at 10%.

UNIT ABATEMENT COST (UAB)

$13.19 per kg CFC-12

PROPOSED OTF GRANT

The proposed OTF grant request is US$1,010,000 is based on 100% chinese ownershhip of Shanglu and covers the incremental capital costs for Phases 1 and 2 of the project , including a 15% contingency cost and a 3% fee for the financial agent administering the project.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

SHANGHAI SHANGLU ELECTRICAL APPLIANCES
PROJECT COST SUMMARY

	(000US$)
Phase I -	
Technology Transfer Fee	100
Refrigerant Charging Machine	60
Oil Charging Machine	70
Process Control Instruments	79
Data Logging Facility	50
Components for 510 refrigerators (@ US$161/unit)	82
Refrigerator Testing Cost	8
Training & Technology Study in US	21
SUB-TOTAL	470
Phase I I	
4 Refrigerant Charging Machines	240
2 Oil Charging Machines	140
SUB-TOTAL	380
Contingency (15%)	130
TOTAL CAPITAL COSTS	980

Annex B

SHANGHAI SHANGLU ELECTRICAL APPLIANCES
IMPLEMENTATION SCHEDULE[2]

	From	To
Phase 1		
Compressor Tests with MP-39	2Q93	4Q93
Test Manufacture 10 MP-39 Refrigerators (5 Hua Guang;5 Yuan Dong Compressors)	2Q94	2Q94
Controlled Ambient Tests	2Q94	2Q94
Prepare Report for Expert Review	3Q94	3Q94
Test Manufacture 500 MP-39 Refrigerators	4Q94	4Q94
Prepare Feasibility Report for Phase 2	4Q94	4Q94
Phase 2		
Purchase and install equipment for mass production of MP-39 refrigerators	1Q95	2Q95
Startup	2Q95	2Q95
Achieve full phaseout of CFC12 refrigerant	3Q95	4Q95

[2] Project schedule assumes ECMP approval of project during 1Q94.

Annex C

TECHNOLOGY TRANSFER AGREEMENT

On 18 January 1994, Shanglu signed an agreement with Du Pont China Limited, for transfer of technology with which to convert Shanglu CFC12 household refrigerator manufacturing facility to use of DuPont MP39 refrigerant (a HFC152a/HCFC22/HCFC124 ternary blend) The memorandum of understanding for this agreement covered three elements:

Application Technology	US$ 63,000
Technical Evaluation of Components	US$ 20,000
Training, Consultation and Expense	US$ 17,000

The materials required for the Phase 1 testing program will be provided free of charge by DuPont.

Conversion of Refrigerator Manufacturing from CFC-12 to MP-39 at Shanghai Shuanglu Electrical Appliances (SSEA)

Project Proposal by The World Bank, January 1994

Scope

This project aims at the conversion from CFC-12 to MP-39 at the Shuanglu refrigerator factory. MP-39 is a ternary blend (ODP 0.03) developed by Du Pont. The application of MP-39 has been investigated by the Shuanglu company itself in cooperation with the Shanghai General Mechanic Institute.

Recommendation

Approval, provided the limited test series on 10 appliances planned at the start of the project will be completed successfully.

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a second stage, after a preliminary review, additional information was given including the full feasibility report and details of the agreement with Du Pont. Al this information together forms sufficient basis for a judgment.
The project proposal itself has serious shortcomings considering relevant information.

Technical soundness

Up to now, the Shuanglu company performed only a limited amount of test work applying the MP39 alternative (on one appliance only) and relies therefore strongly on the Du Pont company. Du Pont has a vast experience in applying this blend which experience is transferred following the technology transfer agreement signed by both parties.
A test series on a limited number of appliances (10) is planned at the start of the project where durability and performance must be demonstrated before starting the pilot production of 500 appliances.
There is no cooperation with the compressor manufacturers. In fact tests are planned with compressors from two different suppliers. Therefore no guarantee of that side can be expected.
As in fact indicated by the Shuanglu company itself, the status of the technology is not so advanced that the pilot production of 500 appliances can be started at once, but a limited test series is planned before.

Lessons from experience

not applicable

Environmental Issues

The MP39 blend still has a low ODP but is an acceptable transitional substance to reduce the CFC-12 consumption.

Safety issues

MP39 is not flammable nor toxic and is classified as a safe refrigerant.

Cost-effectiveness

No incremental operational costs are claimed in this phase yet (the claim is that the blend is cheaper and will remain cheaper than HFC-134a). Therefore no cost-effectiveness can be discussed.
Though MP39 is supposed to be a cheap and easy transition substance still considerable costs originate from the conversion process. For the Shuanglu project this is mainly due to the necessity of new refrigerant charging stations (as for HFC-134a) and to the installation of oil-charging machines for the new alkyl-benzene oil (which the compressor manufacturers cannot charge). *The fact that a new oil is used was not even mentioned in the project proposal.* Other costs claimed are reasonable. Summarizing, the total costs claimed for this project are lower than for comparable HFC-134a projects but not to the order which might be expected.

Other

In the project summary it is stated that after phase 1 (pilot production and field test of 500 appliances) the results will be compared with similar projects before proceeding to phase 2. However, it is doubted whether this procedure is very realistic. Already in phase 1 large investments are made, maybe not specifically in hardware but in technology development, transfer, training etc. Another aspect is the funding itself. The question is: would this company be funded again for conversion to HFC-134a if after phase 1 it appears that the blend alternative is not so successful ? In other words, once the decision is made for funding this alternative, it is a final decision.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 10

Supplemental Comments of 6 China Refrigerant Projects

Overall Assessment

Shanghai Shanglu
DuPont MP39 Blend

1. Test work at Shanglu includes one model BCD-185 refrigerator at Shanglu which has been running since August 1992 on MP39 (so far there have been no problems, however, critical measurements on compressor wear have not been made by Shanglu); first stage efficiency test (MP39 power consumption 5% higher than CFC-12); capacity test (MP39 7% higher than CFC-12); pull down test (MP39 pull down speed slightly faster than CFC12). While test work shows no real problems, additional supporting test work needs to be revealed through the technology supplier to demonstrate the viability of this technology over a suitable range of operating conditions.

2. Shanglu did not provide quotations for major equipment. There is a possibility that they may have these before the January 22 when I leave China. I plan to visit their factory on the 22nd and will expect them to have more quotes at that time.

3. Shanglu have not provided details of their technology agreement but agreed to do so before Jan 22nd. Shanglu was also requested to provide an updated version of their Feasibility Study on the 22nd.

4. The work plan which Shanglu developed is somewhat optimistic but does focus on the "Criteria" for appliance development. There was considerable debate on the 48 degree temperature which was specified for the controlled ambient test. (This same question arose from Wanbao, Chang Ling, Shangling, and Hua Yi). The claim is that 48 degrees is to hot for the refrigerators made in China -- their National Standard for testing is 32 to 38 degrees depending on model type. Kuijpers has been requested to review this issue and advise if lower temperatures can be accepted for meeting the "Criteria".

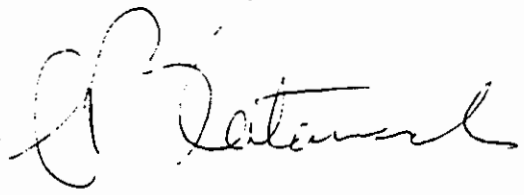
5. The assumption was made that since Shanglu will purchase standard compressors containing standard mineral oil, and that the purpose of Phase I is to test manufacturing under local conditions, the Shanglu project must only meet the "Criteria" for Testing of Appliances (but not those Criteria for Compressor Manufacture)(This is a key point for the Wanbao, Shangling, Chang Ling projects as well). Compressor testing is to be done by compressor manufacturers (e.g. Shanghai Compressor,Hua Yi) as necessary to meet the compressor "Criteria"

6. A major issue to be resolved for the Shanglu project is the proof of compressor testing with MP39 under refrigerator conditions. Shanglu does not have this experience yet. DuPont, as the primary supplier of technology for this project, should be requested to provide documentation of testing work with MP39 which meet the "Criteria" requirements. Since the "Criteria" are primarily designed to prove manufacturing procedures, it would appear that a revision or addendum to the "Criteria" should be developed for consideration not only on the Shanglu project but also for the Wanbao and Chang Ling projects.

7. The issue of refrigerant cost does not appear to be significant. Apparently, the prices for HFC152a, HCFC22, and HCFC124(imported) will all be the same in the future and will be about 2x those for CFC12 today but $1-2 per kg below HFC134a. This means that blends will be competitively priced. As demand increases, local blending facilities will be created to reduce shipping costs.

8. Overall assessment - MP39 technology has the potential to be a low cost and quick way to phaseout CFC12 in refrigerator manufacture because: MP39 can be used in the same compressor as CFC12, energy efficiency is slightly (2-3%) better; MP39 is non-flammable; ICI makes a competitive product; transformation of manufacturing only requires improved blend handling and testing facilities for quality control. MP39 is also a possible retrofit for repair of old refrigerators once CFC12 supplies dry up.The major fault at this time is the limited testing work which has been performed to assure commercial viability.

9. Recommendation - Strengthen technology agreement. Request strong support from DuPont, possibly including financial and technical support of Phase 1. Upgrade documentation of prior testing, quotations etc. prior to project submission to ECMF. OORG to support the project on the basis that it is included in the China CP Action Plan and the data is needed to assist selection of the best refrigerator technology for broad application in China.



TO: GENERAL ASSOCIATION OF LIGHT INDUSTRY

CC: NATIONAL ENVIRONMENT PROTECTION AGENCY

RE: MP39 CONVERSION PROJECT

IN RESPONSE TO THE OORG COMMENTS OF FEB. 2 ON THE PROPOSED PROJECT FOR CONVERSION OF REFRIGERATOR MANUFACTURE FROM CFC12 TO MP39 AT SHANGHAI SHUANGLU ELECTRICAL APPLIANCE (SSEA), FOLLWING WRITEUP ARE TO ADDRESS THE CONCERNS AND ISSUES:

MP39 AS A NEAR DROP-IN REFRIGERANT ALTERNATIVE TO CFC12 IS IDENTIFIED BY ASHRAE STANDARD 34 WITH ASHRAE REFRIGERANT NO. 401A AND SAFETY CLASSIFACTION A1/A1. IT IS ALSO LISTED IN U.S EPA "SNAP" PROGRAM AND HAS BEEN INCREASINGLY APPLIED IN RETROFITTING EXISTING SYSTEMS REFRIGERATED BY CFC12 IN U.S., AUSTRILIA, AND AND OTHER ASIA PACIFIC COUNTRIES.

WE AWARED AS EARLY AS JUNE 1992, DUPONT HAD WORKED WITH BEIJING HOUSEHOLD ELECTRICAL APPLIANCE RESEARCH INSTITUTE (BHEARI), FORMER MINISTRY OF LIGHT INDUSTRY(MLI) DESIGNATED NATIONAL CENTRE FOR HOUSEHOLD REFRIGERATOR TESTING AND QUALIFICATION, INITIATED TEST OF USING MP39 ON THREE CHINA STANDARD REFRIGERATORS (BRAND "ZHONGYI" BCD182) WITH NO OPTIMIZATIONS. THE CONCLUSION INDICATES "MP39 REFRIGERATOR DULY MEETS THE STATE STANDARD GB 8059.2 UNDER THE CRITERIAS FOR COOLING (PULL DOWN) SPEED, ENERGY CONSUMPTION, FREEZER/FRESHER TEMP. NOISE, VIBARATION ETC." (TEST REPORT ARE AVAILABLE).

ON AUG. 1992, WE WORKED WITH SHANGHAI MACHNICAL RESEARCH INSTITUTE UNDER DUPONT SPECIALISTS ON SITE GUIDANCE, RETROFITTED A STANDARD SHUANGLU REFRIGERATOR. THE OPERATION PERFORMANCE IS ALMOST IDENTICAL TO THE TRIAL RUN AT BHEARI. THE TEST WAS AGAIN RUN WITHOUT ANY OPTIMIZATION BUT WITH COMPARABLE PERFORMANCE TO THE ORIGINAL CFC12 SYSTEM.

VIEWING THE APPLICATION TECHNOLOGY PROCEDURES/PROCESS OF MP39 AS ALTERNATIVE ON EXISTING CFC12 CONSUMING REFRIGERATORS DEVELOPED BY DUPONT AND DOMESTRATED ON OUR PREDOMINENT NATIONAL STANDARD REFRIGERATORS, WE PURSUED FURTHER TO COOPERATE WITH DUPONT AND HAVE BEEN ASSURED BY DUPONT WITH TECHNICAL ASSISTANCE AND SUPPORT COMMITTED TO FACILITATE OUR CONVERSION THROUGHOUT THE PROJECT IMPLEMENTATION PERIOD. THEREFORE, MP39 APPLICATION TECHNOLOGY INCLUDING RETROFITTING EXSITING SYS., MODIFICATION AND OPTIMIZATION, RECOVERY AND SERVICE TECHNOLOGY ARE NECESSARY.

USING MP39 AMONG OTHER THINGS LIKE SAFETY, COMPATIBILITY, STABLITY, IS ITS EXCEPTIONAL ADVANTEGY THAT COMPRESSOR CAPACITY RELIABILITY AND DURIBILITY ARE MAINTAINED. THIS IS BECAUSE ESSENTIAL THERMAL PHASICAL PROPERTY AND PRESSURE OF MP39 IS ALMOST PRECISE TO CFC12 AND THE TYPICAL TEST CONDUCTED PASSED 500 HOURS DURABILITY TEST IN SMALL HERMETIC COMPRESSORS AS WELL AS HIGH PRESSURE COMPRESSORS IN U.S. DEMOSTRATED ALSO BY OUR RETROFITTED REFRIGERATOR THAT HAS BEEN RUNNING NORMALLY UP TO DATE SINCE AUG. 1992. WORLDWIDE, IT IS PRACTICALLY PROVED BY MANY SYSTEMS NOW REFRIGERATED USING MP39, INCLUDING DUPONT, COPLAND, TRANE, COCA COLA, MCDONALD

THE MONTREAL PROTOCOL ON
SUBSTANCES THAT DEPLETE THE OZONE LAYER
PROJECT COVER SHEET

COUNTRY	The People's Republic of China	
SECTORS COVERED	Domestic Refrigeration	
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)	
PROJECT TITLE	Engineering Assistance for Conversion of Refrigerator Manufacture to use of HFC-152a Refrigerant using conventional compressors.	
PROJECT DURATION	2 years	
PROJECT IMPACT	80 MT CFC-12	
PROJECT BUDGET	Incremental Capital Cost - Phase 1	$ 520,000
	Incremental Capital Cost - Phase 2	$ 800,000
	Incremental Operating Cost	$ 0
	Total Project Cost	$1,320,000
PROPOSED OTF GRANT[1]	$1,360,000	
IMPLEMENTING ENTERPRISE	Wanbao Electrical Appliance Industrial Corporation	
IMPLEMENTING AGENCY	The World Bank	
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)	

PROJECT SUMMARY

This project will phase out chlorofluorocarbons (CFC's) used in household refrigerators manufactured at the Wanbao Electrical Appliance Industrial Corporation. The project comprises two phases and will convert the production line to refrigerators using HFC-152a as the new refrigerant. The first phase will provide for product development using CFC alternatives and will identify all equipment and process changes needed to implement the alternative technology. Part of this phase associated with the use of an alternative refrigerant is already under way. The project is based on a collaboration between the Power Engineering Department of Xi'an Jiaotong University, the Shanghai Jiaotong University, and the Wanbao company.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

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[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 15% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVES

The objectives of this project are to phase out CFC-12 through use of HFC152a in household refrigerators produced at Wanbao and to develop reliable data for comparison with other phaseout alternatives. The project provides for the purchase of equipment and the training necessary to facilitate an effective transition to HFC-152a refrigerant.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992
(metric tons)

	CFC-11	CFC-12
Insulating Foam - New Refrigerators	4600	
Refrigerant - New Refrigerators		950
Refrigerant - Service Old Refrigerators		500
Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term.

Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

The Wanbao company is located in Guangzhou, Guangdong province. There are 1,800 employees in this company of whom about 200 are technicians. It first produced refrigerators in 1980 with the models from Acma in Singapore and Hitachi in Japan, but has subsequently developed its own designs. It has up to now used domestically produced compressors.

Wanbao Group has a number of subsidiaries. Most of them are located in Guangzhou, Guangdong province. As a group corporation, it produces regrigerators, freezers, air conditioners, compressors, washing machines, rice cookers and other electrical appliances. It has six refrigerator production lines. These are capable of producing 1,200,000 refrigerators in two shifts. Approximately 40% of production is exported (80% of all refrigerators exported from China). Most are sold in the USA with a significant number sold in France. Wanbao's share of the domestic market is about 5%. This project is to convert one of Wanbao's 6 production lines (400,000 units per year capacity on 2 shift opertion) to HFC152a refrigerant. All such refrigerators are for domestic use only.

Table 3
Actual and Forecast Refrigerator Production at Wanbao

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Refrigerators Produced (000 Units)	360	300	250	180	250	300	350	400

For the past three years Wanbao and Xi'an Jiaotong University have been engaged on a collaborative venture to develop a refrigerator using HFC-152a. Energy savings in the region of 5% compared to an identical model CFC-12 refrigerator can be achieved with minimal changes made to the refrigeration circuit. The following items of work have been completed and a report is being prepared for evaluation by an independant expert:

*Appliance testing of 20 refrigerators
*Compatibility testing of lubricants, drier and compressor materials.
*A batch of 120 refrigerators using HFC-152a has been made and sold into the market. After 1 year there has been no negative feedback.

The project will consist of finalising the transition to CFC-free technology for mass production. Wanbao will purchase extra charging stations and safety equipment. HFC-152a is moderately flammable. The safety equipment is required for monitoring concentration levels and safe handling and storing of HFC-152a. Safety considerations also demand that the production line be modified to avoid inadvertant HFC152a combustion. Underwriters' Laboratories (UL) have tested Wanbao refrigerators. Their informal report is that these will satisfy UL 250. A draft proposal for "A2" category (covering HFC-152a) refrigerant use in domestic refrigerants has been prepared by them.

PROJECT DESCRIPTION.

The project will accomplish phaseout of CFC12 used as refrigerant in domestic refrigerators produced by Wanbao in two phases.

Phase I Engineering, product development and testing under local conditions to establish basic data for full conversion to HFC-152a and for comparison with results of similar programs using alternative refrigerants.

Phase II Full conversion of the Wanbao factory to HFC-152a refrigerant

Phase 1

During Phase 1, compressor oil testing studies will be completed and the condensor,evaporator and capillary tubes will be redesigned to achieve optimum performance with HFC152a. A test manufacturing run of 500 prototype refrigerators will be made to prove the viablility of the refrigerant circuit designs and the manufacturing process. Existing test facilities will be used for local testing. The USEPA will provide special assistance for testing the safety of the manufactured units in the US. The remaining refrigerators will be subjected to field tests. Consultations will be arranged with local and foreign experts (Underwriters Laboratory) to train Wanbao engineers and technicians in safe handling practices and facilities for use of HFC152a in the factory. At the conclusion of Phase 1, a feasibility study will be prepared for full conversion of refrigerator manufacturing at Wanbao to the use of HFC-152a. Based on the feasibility study results, a detailed cost estimate will be prepared and project planning will be revised to accomodate Phase 1 findings before commencing with

Phase 2

Phase 2 will implement the full conversion of Wanbao refrigerator facilities to HFC152a refrigerant over a period of 4 years.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY:

The use of HFC-152a refrigerant in domestic refrigerators is a domestic Chinese development. Theoretical predictions that energy savings could be achieved by comparison with CFC-12 systems have been borne out by test results. Independent laboratory tests corroborate Wanbao's tests which showed a 5% improvement in energy efficiency associated with the use of HFC-152a vs CFC-12. Other principal reasons for using this blend are as follows:

*HFC-152a is readily available in China

*Only minor modifications need be made to the circuit of a CFC-12 refrigerator for it to be used, and it is compatible with mineral oil lubricants and standard compressor materials.

*It possesses zero ODP and a low GWP (.055 to .068).

*Being a domestic Chinese development, replication to other enterprises once the technology is proved will be considerably cheaper than piecemeal importing of foreign HFC-134a technology.

PROJECT COST

The total project cost is estimated to be $1,320,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation,currency fluctuations, and other unforseen costs.
A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An OTF grant request will be made based on Phase 2 results. An order of magnitude estimate of these costs is US$1,400,000 for the first four years of operation, discounted at 10%.

UNIT ABATEMENT COST (UAB)

$10.29 per kg CFC-12

PROPOSED OTF GRANT

The proposed OTF grant request is US$1,360,000 is based on 100% Chinese ownershhip of Wanbao and covers the incremental capital costs for Phases-1 and 2 of the project , including a 15% contingency cost and a 3% fee for the financial agent administering the project.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

WANBAO
PROJECT COST SUMMARY

	(000US$)
Phase I	
Compressor Testing	12
Purchase Safety and Process Equipment for Test Manufacture Run	
1 Refrigerant Charging Machine	100
2 Halogen Leak Detector	82
2 HFC152a Monitor/Alarm system	16
1 Vacuum Pump	9
Ventilation equipment	47
Explosion Proofing	22
Fire Fighting Facilities	21
Test Manufacture 500 HFC152a Refrigerators (@$180 per unit)	90
Prepare Test Reports and Feasibility Study	30
Safety Training for Technical Staff	21
SUB-TOTAL	450
Phase I I	
Additional Manufacturing Equipment	
1 Refrigerant Charging Machine	100
2 Halogen Leak Detector	82
13 HFC152a Monitor/Alarm system	104
1 Vacuum Pump	9
Ventilation equipment	95
Explosion Proofing	44
Fire Fighting Facilities	45
Conveyor	141
Safety Training for Operators and Mechanics	56
Overseas - Consultations and Inspection	24
SUB-TOTAL	700
Contingency (15%)	170
TOTAL CAPITAL COSTS	1,320

Annex B

WANBAO
IMPLEMENTATION SCHEDULE[2]

	From	To
Phase 1		
Compressor Tests with HFC152a	1Q94	2Q94
Prepare Report of Test Work to date for Expert Review	1Q94	2Q94
Purchase Safety and Process Equipment for Test Manufacturing	2Q94	3Q94
Safety Training for Technical Staff	2Q94	3Q94
Test Manufacture 500 HFC152a Refrigerators	2Q94	3Q94
Prepare Feasibility Report for Phase 2	3Q94	3Q94
Phase 2		
Purchase and install equipment for mass production of HFC152a refrigerators	4Q94	2Q95
Safety Training for Operators and Mechanics	2Q95	4Q95
Startup	2Q95	2Q95
Achieve full phaseout of CFC12 refrigerant	---	4Q95

[2] Project schedule assumes ECMP approval of project during 1Q94.

Conversion of Refrigerator Manufacturing from CFC-12 to HFC-152a at Wanbao Electrical Appliance Corporation

Project Proposal by The World Bank, January 1994

⑥

Scope

The scope of this project is to convert one of the Wanbao production lines to the application of HFC-152a thereby eliminating CFC-12. The products are planned to be used in the domestic market only. The technology for this alternative has been developed by the Wanbao company itself in cooperation with the Xi'an Jiaotong University.

Recommendation

Approval

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a second stage, after a preliminary review, supplementary information was given by the Wanbao company. Altogether sufficient information for a judgment is present. *The project proposal itself does not contain all relevant information.*

Technical soundness

The Wanbao company has chosen an alternative which is not being applied elsewhere and therefore had to do its own development in cooperation with the Xi'an Jiatong University. No real cooperation with a compressor manufacturer is reported. Extensive tests with ~~the blend~~ 7124 are being reported (among them a successful field test of 120 appliances) and possible problems have been addressed like the application of mineral oil [1]. The information supplied gives confidence that the status of the technology is advanced enough to start a pilot production.

Lessons from experience

not applicable

Environmental issues

HFC-152a is an acceptable way to reduce CFC-12 emission.

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[1] It is stated that evaporators/condensers are going to be redesigned to get optimal performance with HFC-152a. However, the tests performed up to now were carried out with the current design. Due to the low solubility of HFC-152a in mineral oil the oil return from the circuit is more criticial than for CFC-12. Due to this aspect redesigns of the evaporator/condenser could be dangerous and must be done with care.

Safety Issues

HFC-152a is flammable and therefore special provisions need to be made to the production line. Standard and guidelines are in development. Safety in servicing is addressed and included in training programs.

Cost-effectiveness

No incremental operational costs are claimed in this phase yet (they must be lower than for HFC-134a projects). Therefore no cost-effectiveness can be discussed.
The costs claimed for safety measures in the production lines are reasonable (approximately 400,000 USD plus additional training). Due to the characteristics of the local production line extra indirect safety costs originate (in this case the addition of a conveyer of 141,000 USD). Further costs claimed are reasonable and in line with similar projects.
The total cost of the HFC-152a project is very similar to the costs of HFC-134a projects mainly due to the safety investments which are counterbalanced by the technology transfer fee in HFC-134a projects.

Other

In the project summary it is stated that after phase 1 (pilot production and field test of 500 appliances) the results will be compared with similar projects before proceeding to phase 2. However, it is doubted whether this procedure is very realistic. Already in phase 1 large investments are made, maybe not specifically in hardware but in technology development, transfer, training etc. Another aspect is the funding itself. The question is: would this company be funded again for conversion to HFC-134a if after phase 1 it appears that the HFC-152a alternative is not so successful ? In other words, once the decision is made for funding this alternative, it is a final decision.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 10

Supplemental Comments of 6 China Refrigerant Projects

Overall Assessment

Wanbao
HFC152a Refrigerators

1. Wanbao has conduced a limited number of tests with HFC152a and expects to complete testing by June 1994. (The test runs started in June 1990).They also have made 120 refrigerators which are now about 1 year into their field test. Wanbao does not have external technology support but feels confident that their expertise in the field should be adequate as there are no changes needed in compressor design to accomodate HFC152a. They will simply use a slightly larger compressor than they would have used ordinarily to compensate for a 10% loss in cooling capacity. (This of course adds to the incremental operating cost)

2. Test data included in the feasibility study have shown no degradation of mineral oil when compared to a CFC12 unit under the same conditions. HFC152a, however, is significantly less soluble than CFC12 in the oil (1-1.5% vs 4.4%)

3. Wanbao have considered using PAG lubricants but see no advantage over mineral oil at this time. Test work has all been done with mineral oil in compressors from both Wanbao and Tianjin Haihe.

4. Wanbao plan to modify their condensors and evaporators to optimize the refrigerant circuit. Testing to date has been on older designs. It was suggested that the trail run of 500 refrigerators be made with the newly designed condensors and evaporators.

3. The Feasibility Study is well prepared but is missing a reasonable quotation for a refrigerant charging machine. The quote they did have was 3X that for charging non-flammable refrigerants. This appeared excessive and they will get a new quote. As a temporary measure, the price of a charging machine for "flammable" HFC152a was estimated at $100,000. Suggested alternative vendors were given to Wanbao, but it will take 1-2 weeks to get revised quotations.

5. The work plan does focus on the "Criteria" for appliance development. There was considerable debate on the 48 degree temperature which was specified for the controlled ambient test. (This same question arose from Hua Yi, Chang Ling, Shangling, and Shanglu). The claim is that 48 degrees is to hot for the refrigerators made in China -- their National Standard for testing is 32 to 38 degrees depending on model type. Kuijpers has been requested to review this issue and advise if lower temperatures can be accepted for meeting the "Criteria".

6. The cost to make refrigerator manufacture safe for handling flammable refrigerants is a significant factor in the cost of capital equipment, training of technical staff, training of operators and mechanics and timing project implementation. I do not think that these questions are fully appreciated by anyone at the present time. We should anticipate a rather slow project implementation.

7. As more different refrigerants are added to the "suite" of refrigerants in use in China, the question of refrigerator service will become acute. China will need to develop appropriate standards for identification of what type ("class") of refrigerant is in use and what servicing procedures should be used.

8. Wanbao has indicated project support will be obtained from the USEPA and UL. My information suggests that this support will be limited to testing some of the early Wanbao refrigerator production to receive safety approval for sales in the US. Currently, about 80% of their exports are to the US.

9. Oveall Assessment - The project is well prepared and documented (with the exception of the refrigerant charging machine quote) Prior testing work is barely adequate in the absence of an international technology supplier. The work plan meets the "Criteria" for testing appliances.

10. Recommendation - Ammend documentation of prior testing, quotations etc. prior to project submission to ECMF. OORG to support the project on the basis that it is included in the China CP Action Plan and the data is needed to assist selection of the best refrigerator technology for broad application in China.

TO: WORLD BANK (001-202-477-1273)
ATTN: MS HELEN CHAN

CC: NEPA (01-8328013)
ATTN: 雍永智 (大气处ODS办)

FROM: WANBAO
FAX: 86-20-4413034
DATE: FEB 8,1994

RE: CLARIFICATION OF WANBAO PROJECT

Comments from OORG noted. Below is our clarification.

1. Wanbao Group has about 20 subsidiaries. Its product lines include many kinds of household appliances with the refrigerator capacity of 1,200,000 units. The production line to be converted for using HFC-152a has a capacity of 400,000 units in 2 shifts. (Therefore the production capacity in the project summary should be corrected as 400,000 units. All description and figures in the FS and PS are for the excuting subcompany only except otherwise specified.) Other 2 production lines are in another subsidiary which produces fridges mainly for export. This latter company has discussed with Electrolux for the conversion of 134a technology because its large numbers of fridges are exported to the USA. But this latter project has not decided yet. Besides, there are other 3 factories producing fridges of them 2 has temporaryly stopped operating.

Wanbao group invested a lot of money in other products in recent years that caused reduction of fridge output. Another reason for fridge output reduction is the decrease of domestic market demand. Wanbao group strategically scheduled more fridges for export to compensate domestic maeket demand. But these export fridges are made in another sobcompany. Wanbao's (this project) actual production in 1993 is in 1 shift only for above reasons.

2. Wanbao has conducted a lot of tests with 152a. Some test reports given by independent laboratories are attached to FS. Up to now we are not quite clear on the point of "expert review", on what level that the experts are considered to be qualified, international, national, provincial or other? We need indication about this. We think most fundamental tests has been conducted and we are aware that some more additional tests need be condudcted in the future, which are described in FS and PS.

3. It is ture that redesigning of condensors and evaporators is not certainly necessary. Our tests are based on unmodified condensors/evaporators and nearly satisfied results have been obtained. Yet the performance of HFC-152a is not exactly the same as that of CFC-12. If we modify the condensors/evaporators, more favorable results may possibly be obtained, especially in the aspect of energy saving. We think energy saving is very important

to customers.

4. There will be a marking on the cabinet indicating the refrigerant used in the unit and guideline will be given to the service men. These will be included in training program. Standards for application of 152a will be developed when implementing the project.

5. The export fridges are made by another subcompany of the group which is considering to convert to 134a technology for the reason of USA market. The 152a project is to make fridges mainly for domestic market. The deadline for comments on UL draft proposal is May 5, 1993, thus we think the UL draft proposal has now become effective (not quite sure, will check). However, even more flammable hydrocarbons are considered to be used as refrigerant, we think the less flammable HFC-152a will eventually be sure to be accepted. And we undertake the fridges using 152a will first get approval by UL if we want them to be exported to USA.

6. The safety measures are key points of the project. We think higher costs on safety measures than other projects are reasonable. On the other hand, the technical transfer costs of the project are less than other projects. And the incremental operating cost of the project is less, too.

7. The quotation we have got for charging machines is USD 439,000 for 2 (USD 219,500 for each). We noticed that the price is higher than that of ordinary ones. It was said that this is because of 152a's flammability that the machines suitable for 152a have not been existing and many modifications have to be done. We will, however, inquire other companies to seek less-expensive ones, and are very much interested in if the World Bank Consultants or OORG could help us to find the machines with lower price. At the moment, we assume that they could be found with the price of USD 100,000 for each and USD 200,000 for two.

8. To use 152a as non-ODS refrigerant is mainly developed by our own. We have invested a lot of resources and conducted many tests on this project. We are also aware that there are still a lot of work need to be done. But as an enterprice, we could not afford to do everything on our own. We need support from outside. We need to be clear if MPEC will sopport the projexct developed by our own.

9. Feasibility Study (revised on Jan 28, 1994) on both paper and disk has been submitted to World Bank, which we think has been well received. We think you will know more detailed situation about this project when you read it.

Thanks and Best Regars

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER PROJECT COVER SHEET

COUNTRY	The People's Republic of China		
SECTORS COVERED	Domestic Refrigeration		
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)		
PROJECT TITLE	Engineering Assistance for Conversion of Refrigerator Manufacture to HFC152a/HCFC22 Blended Refrigerant in Conventional Compressors		
PROJECT DURATION	2 years		
PROJECT IMPACT	70 MT CFC-12		
PROJECT BUDGET	Incremental Capital Cost - Phase 1	$	645,000
	Incremental Capital Cost - Phase 2	$	335,000
	Incremental Operating Cost	$	0
	Total Project Cost	$	980,000
PROPOSED OTF GRANT[1]	$ 860,000		
IMPLEMENTING ENTERPRISE	Chang Ling (Group) Co. Ltd.		
IMPLEMENTING AGENCY	The World Bank		
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)		

PROJECT SUMMARY

This project will lead to replacement of CFC-12 refrigerant in household refrigerators manufactured by Chang Ling with a blended refrigerant consisting of HFC152a and HCFC22. Technology has been developed locally in cooperation with Xi'an Jiaotong University. In Phase 1 of the project, detailed engineering, product development and lab and field testing of 500 units produced under factory conditions, will be conducted to define firm project scope and costs for full conversion of the factory output to HFC152a/HCFC22 blended refrigerant during Phase 2. The results of Phase 1 will be compared with similar projects using alternative refrigerants before proceeding with Phase 2. Net incremental operating costs for the conversion will be defined during Phase 2 and presented in a separate Phase 3 project at a future date. A separate project will be defined for replacement of CFCs used in refrigerator insulating foam, pending definition of the best available technology.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

[1] The OTF grant is based on 100% Chinese ownership. A 3% financial agent fee and a 15% contingency is included in the estimates of incremental capital costs. Chang Ling will self finance $150,000 of Phase 2 the capital cost for plant renovations.

PROJECT OBJECTIVES

The objective of this project is to establish a phased introduction of technology for use of HFC152a/HCFC22 blended refrigerant in domestic refrigerators produced by Chang Ling. The results of this project will be evaluated and considered for adoption by similar refrigerator operations.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992

(metric tons)

	CFC-11	CFC-12
Insulating Foam - New Refrigerators	4600	
Refrigerant - New Refrigerators		950
Refrigerant - Service Old Refrigerators		500
Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term. Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

Chang Ling (Group) Co. Ltd. is located in Baoji city in a large military complex which produces household electric appliances, textile, military and domestic electronics. It is a large company with 4 research institutes and 1525 engineers and technicians.

A total of 1,200 employees are engaged in refrigerator production on one production line imported from Merloni (Italy) in 1987. The line is capable of producing 400,000 refrigerators annually based on 1 shift operation. Thirty models are produced with export of about 3% of the refrigerators produced.

In 1992, Chang Ling produced 6% of the refrigerators sold in China. Actual and forecast production are illustrated in Table 3 for the period 1990-1997.

Chang Ling is committed to phaseout all CFCs used in refrigerator manufacture before 1997.

Table 3
Actual and Forecast Refrigerator Production at Chang Ling

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Refrigerators Produced (000 Units)	210	260	270	397	450	600	600	600

Since 1990, Chang Ling and Xi'an Jiaotong University have been engaged in a collaborative venture to develop a refrigerator based on HFC152a/HCFC22 refrigerant. Phase 1 type activities completed to date include: calorimeter testing of 9 compressors using the blend, appliance testing of 20 refrigerators, and compatibility testing of lubricants, driers and compressor materials. Advantages of the blended refrigerant were found to be minimal engineering changes to compressors and refrigerators and higher energy efficiency. Ongoing work is focused on optimization of the refrigerator-compressor system.

PROJECT DESCRIPTION.

The project will accomplish phaseout of CFC12 used as refrigerant in domestic refrigerators produced by Chang Ling in two phases.

Phase I Engineering, product development and testing under local conditions to establish basic data for full conversion to HFC152a/HCFC22 blended refrigerant and for comparison with results of similar programs using alternative refrigerants.

Phase II Full conversion of the Chang Ling factory to HFC152a/HCFC22 blended refrigerant

During Phase 1, 500 refrigerators will be produced under factory conditions to prove the viability of manufacturing refrigerators safely and reliable under local conditions. Technical collaboration will be sustained with Xi'an Jiaotong University. At the conclusion of Phase 1, a feasibility study will be prepared for full conversion of refrigerator manufacturing at Chang Ling using HFC152a/HCFC22 refrigerant. Based on the feasibility study results, a detailed cost estimate will be prepared and project planning will be revised to accomodate Phase 1 findings before commencing with Phase 2.

Phase 2 will implement the full conversion of Chang Ling refrigerator facilities to HFC152a/HCFC22 blended refrigerant

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

While HFC134a has been accepted worldwide as the principal replacement for CFC12 refrigerant in domestic refrigerators, alternative refrigerants have found application in China where indigenous sources of HFC134a refrigerant and polyolester lubricant are not available.
One such alternative under consideration is the use of blended refrigerants which can function effectively in conventional CFC12 style refrigerator compressors. The HFC152a/HCFC22 blended refrigerant is a leading condidate because of refrigerant availability at a resonable cost compared to CFC12 and because of a slight improvement in energy efficiency. Chang Ling has pioneered this application and is well positioned to implement the project successfully.

PROJECT COST

The total project cost is estimated to be $980,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation,currency fluctuations, and other unforseen costs. A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An OTF grant request will be made based on Phase 2 results. An order of magnitude estimate of these costs is US$1,300,000 for the first four years of operation, discounted at 10%.

UNIT ABATEMENT COST (UAB)

$ 9.87 per kg CFC-12

PROPOSED OTF GRANT

The proposed OTF grant request is US$860,000 is based on 100% Chinese (state) ownershhip of Chang Ling (Group) Co. Ltd. and covers the incremental capital costs for Phases 1 and 2 of the project , including a 15% contingency cost and a 3% fee for the financial agent administering the project. Chang Ling will self finance $150,000 of the Phase 2 costs covering plant renovations.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

CHANG LING
PROJECT COST SUMMARY

Phase I	(000US$)
Technology Transfer Fee	50
1 Refrigerant Charging Machines	75
Analytical and Special Test Equipment	75
Safety Control and Alarm Equipment	191
Blend Supply and Recovery Facility	36
Ventilation and Fire Safety Improvements	33
Test Manufacture of 500 Refrigerators (@US$ 160 per unit)	80
Preparation of Phase 2 Feasibility Study Report	20
SUB-TOTAL	560
Phase I I	
1 Refrigerant Charging Machine	75
Reorganization of Production Line including Ventilation and Fire Protection	175[2]
7 Halogen Leak Detectors	40
13 Blend Recovery Units	20
SUB-TOTAL	310
Contingency (15%)	110
TOTAL CAPITAL COSTS	980

[2] US$150,000 to be self financed by Chang Ling (Group) Ltd.

Annex B

CHANG LING
IMPLEMENTATION SCHEDULE[3]

	From	To
Phase 1		
Run compressor tests with Blends and performance tests on 20 refrigerators containing HFC152a/HCFC22 blend	1989	1Q91
Test Manufacture 500 Blend Refrigerators	2Q94	2Q94
Prepare Feasibility Study for Phase 2	3Q94	3Q94
Phase 2		
Purchase and Install equipment for mass production of Blend Refrigerators	4Q94	1Q95
Test Manufacture 2000 refrigerators on full scale production line	2Q95	2Q95
Increase Production Rate to achieve complete phaseout of CFC12 refrigerant use	4Q95	4Q96

[3] Project schedule assumes ECMP approval of project during 1Q94.

Annex C

TECHNOLOGY TRANSFER AGREEMENT

Chang Ling (Group) Co. Ltd. (formerly Shaanxi Refrigerator Factory)(Chang Ling)) and Xi'an Jiaotong University (XJU) have reached the following technical and safety system coordination agreement for producing refrigerators using HFC152a/HCFC22 blended refrigerant.

In a previous agreement (Dec. 26,1990) XJU transferred to Chang Ling technology applicable to use of the HFC152a/HCFC22 blend in refrigerator service. In this agreement XJU will provide additions technology and testing services to assist Chang Ling with the following activities:

Production of 500 refrigerators
Design of facilities for mass production
Safety analysis of project plans and facilities
Training of operators and mechanics

XJU will be responsible for ensuring the reliability and reasonability of all project plans.

A one time fee of $50,000 will be charged for the above services.

The term of the agreement will conclude in December 1995.

Conversion of Refrigerator Manufacturing from CFC-12 to HFC-152a/HCFC-22 blend at Chang Ling Refrigerator Company at Baoji

Project Proposal by The World Bank, January 1994

④

Scope

The scope of this project is to convert the Chang Ling household refrigerator factory from CFC-12 to the binary blend HFC-152a/HFCF-22 using conventional compressors. The technology for this alternative has been developed by the company in cooperation with the Xi'an Jiatong University.

Recommendation

Approval

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a second stage, after a preliminary review, supplementary information was given by the Chang Ling company. Altogether sufficient information for a judgment is present. *The project proposal itself does not contain all relevant information.*

Technical soundness

The Chang Ling company has chosen an alternative which is not being applied elsewhere and therefore had to do its own development in cooperation with the Xi'an Jiatong University. Also the compressor manufacturer (Yuan Dong Co., Xian) participated in this development and guarantees their CFC-12 compressors with the HFC-152a/HCFC-22 blend.
Extensive tests with the blend are being reported and possible problems have been addressed like the application of mineral oil and the higher discharge temperature. For the latter problem accelerated life time tests for the compressor are still being scheduled. The tests performed and information supplied gives confidence that the status of the technology is advanced enough to start a pilot production.

Lessons from experience

not applicable

Environmental issues

The blend HFC-152a/HCFC-22 still has a low ODP and is therefore a transitional substance only.

Safety issues

The blend applied is flammable and therefore special provisions need to be made to the production line.
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.

Cost-effectiveness

No incremental operational costs are claimed in this phase yet (they must be lower than for HFC-134a projects) Therefore no cost-effectiveness can be discussed.
The costs claimed for safety measures in the production lines are reasonable (approximately 400,000 USD). Also the other costs claimed are reasonable and in line with similar projects.

Other

In the project summary it is stated that after phase 1 (pilot production and field test of 500 appliances) the results will be compared with similar projects before proceeding to phase 2. However, it is doubted whether this procedure is very realistic. Already in phase 1 large investments are made, maybe not specifically in hardware but in technology development, transfer, training etc. Another aspect is the funding itself. The question is: would this company be funded again for conversion to HFC-134a if after phase 1 it appears that the blend alternative is not so successful ? In other words, once the decision is made for funding this alternative, it is a final decision.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 09

Supplemental Comments of 6 China Refrigerant Projects
Overall Assessment

Chang Ling
HFC152a/HCFC22 Binary Blend Refrigerant

1. Chang Ling has conduced extensivie tests with HFC152a/HCFC22 in cooperation with Xi'an Jiaotong Univ (XJU) starting in 1989. They claim the test work is now complete (3 years of data) but is all in Chinese. They are summarizing these tests for inclusion as an annex to their feasibility study. This will be in hand by Jan 22. The next step will be to make 500 refrigerators on their main manufacturing line for field testing. Chang Ling does not have external technology support but feels confident that their expertise in cooperation with XJU should be adequate as there are no changes needed in compressor design to accomodate the HFC152a/HCFC22 blend.

2. Chang Ling do not plan to modify their condensors and evaporators to optimize the refrigerant circuit. They are planning to evaluate a replacement for mineral oil as the discharge temperature for the blend is higher than that for CFC12 and oil degradation may result over a long period of time.

3. The work plan does focus on the "Criteria" for appliance development. There was considerable debate on the 48 degree temperature which was specified for the controlled ambient test. (This same question arose from Hua Yi, Wanbao, Shangling, and Shanglu). The claim is that 48 degrees is to hot for the refrigerators made in China -- their National Standard for testing is 32 to 38 degrees depending on model type. Kuijpers has been requested to review this issue and advise if lower temperatures can be accepted for meeting the "Criteria".

4. Even though the addition of HCFC22 to HFC152 reduced flammability, the binary blend which Chang Ling plan to use (80/20 HFC152a/HCFC22) is still flammable. The cost to make refrigerator manufacture safe for handling flammable refrigerants is a significant factor in the cost of capital equipment, training of technical staff, training of operators and mechanics and timing project implementation. I do not think that these questions are fully appreciated by anyone at the present time. We should anticipate a slower project implementation than has been suggested by Chang Ling.

5 Chang Ling is committed to a full phaseout of CFCs in their line of refrigerators by 1997. This is an admirable goal and deserves support, however, caution should be exercised on the flammability issue. Chang Ling will commit $150,000 of their funds to Phase 2 of this project to encourage its progress and support.

6 As more different refrigerants are added to the "suite" of refrigerants in use in China, the question of refrigerator service will become acute. China will need to develop appropriate standards for identification of what type ("class") of refrigerant is in use and what servicing procedures should be used.

7 Oveall Assessment - The project is well prepared and documented. The work plan meets the "Criteria" for testing appliances.

8. Recommendation - Ammend documentation of prior testing prior to project submission to ECMF. OORG to support the project on the basis that it is included in the China CP Action Plan and the data is needed to assist selection of the best refrigerator technology for broad application in China.

1. ChangLing's blend technology was approved by expert group organized by the related goverment scientific agency.
The English translation copy of "Evaluated Certificate of Science and Technology Achievement ofproject" are attached this time.
The chinese copy was involved in the feasibility study.

2. Yuan Dong compressor Manufacture Co. Xian, Shaanxi province, China, is the leading compressor supplier of Chang Ling.
According to the Goverment arrangement of Shaanxi Province, the two company cooperate on blend technology.
Yuan Dong Co. fully guarantee the Justification that its CFC-12 compressor directly use blend.

2.1 Yuan Dong Co. Xian.

2.1.1 Yuan Dong compressor range from 1/8HP to 1/3HP reciprocating type.

2.1.2 production capacity 650000sets/year.

2.1.3 Yuan Dong compressor QD62GA, QD75GA have been fully tested with using blend as refrigerant.
English translation copy of the test report are attached this time.

3. Higher discharge temperature, mineral oil

3.1 Discharge temperature
when use blend, compressor's dischargetemperature raises a little compared with that of using CFC-12.
Surpose the increase Δt

3.1.1 DUPONT CO. U.S.A report
Acconding DUPONT'S report(U.S.A), for SUVA MP39. Δt=+10℃ about and they claim that there is no problem for the compressor made within the nearest decade to do with.

3.1.2 our test report

The different of the compressor type, the different of the Δt.

ASPERA A1112A (Italy)	Δt=+8℃
QD75GA (Yuan Dong Co. Xian, China)	Δt=+5℃

3.1.3 Above all, we think it can be accepted.

3.2 Minezal oil

By fully tested, we are confident enough that exist compressor oil is compatible with blend. We have dismantled one prototype compressor that had run over one year, we find no change of its minenal oil, nor the compressor parts.

3.3 Accelerated Life time test

We schedule to carry out this test according to CRITERIA and compressor standard.

Start Date : 20/2/94
Duration : 2 months
Coooperator: Yuan Dong Co.
Xian Jiao Tong University

Yuan Dong's test reports of its CFC-12 compressor QD75GA directly use blend attached this time, the result is okay.

Refrigerator prototypes using blend have well operate for 3 years without any problem.

4. Flammability

In Appendix 2.f. of our feasibility study, there are full test reports to show blend's flammability being in safety level and weakest compared with HFC-152a's.

For single customer refrigerator using blend, flammability isn't exist.

4.2 Flammability Guidlines of blend using appliances and the way to distinguish them from others will be accordence with the National standard scheduled to he

made out by NEPA and NCLI. recently.

5. Investment

5.1 Background of the 160 USD/unit for 500 refrigerators.

5.1.1 In item 6.3 of feasibility study

6.3 500 sets refrigerator with blend: field test fee plus increamental cost of production are 20000 USD.

That is: 40 USD/unit

5.1.2 In item 6.4 of feasibility study

6.4 Techincal pzeparation fee, cost of prototypes, tset fee, designing feeof safety systemand cost for standard making out, totally: 60000 USD

That is: 120 USD/unit

5.1.3 40+120=160 USD/unit

5.2 Blend supply and recovery facility

5.2.1 In Item 5.1, NO.4 of feasibility study. we totally need is set recovery equipment.

For 500 blend refrigeafor test production, (phase I), only 2 set were needed. one for production line, the other for repairing center.

91500 USD/unit 2×1500=3000 USD

5.2.2 In item 5.3, NO.3

Micro-mass flow meter and pump set (supply pump) we need 4 sets

1. It was used to pump the HFC-152a and HCFC-22 into blend changing Machine accuratly and individually.
2. As one each changing machine for preduction lineand repairing line, and two supply pumps for each. so total 4 set were needed.
3. 8250 USD/set 4×8250=33000 USD

5.2.3 Total: 3000+33000=36000 USD

5.3 Special introduction

1. 160 USD/Unit for 500 refrigeration
2. 36000 USD supply and recovery facility

The above data were summarized by W.B. expert Mr.

PROJECT COVER SHEET

COUNTRY:	The People's Republic of China
PROJECT TITLE:	Zhongshan Fine Chemical Aerosol Filling Center CFC-12 Substitution Project)
SECTOR COVERED:	Aerosol
ODS USE IN SECTOR:	CFC-12 consumption was 9420 tons in 1992
PROJECT IMPACT:	Phase out CFC-12 6,590 tons annually in 1996.
PROJECT DURATION:	2 years
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	US$ 8.359 million Capital Costs US$ 6.759 million incremental recurrent savings
PROPOSED OTF FINANCING:	US$ 1.6 million
IMPLEMENTING ENTERPRISE:	Zhongshan Fine Chemical Industrial Limited
COORDINATION NATIONAL BODY:	National Environment Protection Agency
IMPLEMENTING AGENCY:	World Bank

PROJECT SUMMARY

The project converts aerosols with 100% CFC propellants to non CFC. Dimethyl Ether (DME) was selected as propellent, due to non availability of clean LPG in Guangdong Province. After project completion, output of DME will be 5000 tons annually, which can substitute for 6590 tons CFC. This project is listed in China's ODS CP, and will be carried out during 1994/95. In foreign aerosol industry, except for LPG, DME is in the second position for substitution for CFC and technology is available. The enterprise plans to take available technology of making DME by methanol from South-West Research Institute. Based on facilities for making DME, the project can not only meet requirements of conversion of enterprise itself, but also serve local small enterprises in can-filling lines with competitive low costs by establishing aerosol filling center. Thus it will promote substitution CFC throughout southern China, and reduce CFC losses prevelant in many small existing fillers. For those enterprises with modern filling facilities, the enterprise can supply suitable DME at a low price. DME manufacturing facilities will be in Zhongshan city. According to CP, estimated consumption of CFC-12 used in China aerosol industry will be 23,600 tons in 1996, by implementation of this project, consumption of CFC-12 will be reduced by about 25-30% in 1996.

TECHNICAL ASSESSMENT: The project has been reviewed and supported by the Bank's alternate OORG technical reviewer, Harry McCain. His comments are attached.

PROJECT OBJECTIVES.

Project objectives include: 1) setting up facilities for manufacturing 5000 tpy DME; 2) setting up aerosol filling center, with capacity of 35 million cans/year; and 3) phasing out about 6,900 tpy CFC use in aerosol industry.

SECTOR BACKGROUND

China's aerosol industry developed late, its products are now only about 1% in the world, but with a population of 1.1 billion people there is a huge potential market. Along with the boost of domestic economy, demand have been increasing rapidly in recent years. National consumption of CFC propellant was 7090 tons in 1991, and increased to 9720 tons in 1992. According to CP, in case of no substitution, consumption will increase to 23,580 tons in 1996. To meet requirement of environment protection, CFC substitution and conversion engineering of aerosol industry in China now becomes a top priority. This project along with previously approved projects in Shanghai and Tiangjing, will account for about 80% of projected consumption. There are 56 factories which produce aerosols in Guangdong Province, with CFC consumption of 3,620 tons in 1992. According to investigation, the consumption in Guangdong will reach to more than 6,000 tons in 1996. Most of these aerosol factories will be supported by the southern filling center.

ENTERPRISE BACKGROUND

Zongshan Fine Chemical Industrial Limited (Zongshan) is a comprehensive state-owned enterprise which deals mainly with aerosol products, aerosol cans (including valves) and fine chemical products. The enterprise owns a net fixed asset of US$ 7.6362 million, and in 1992 its gross industrial output is US$64.2735 million. The project sponsor is a 100% state-owned enterprise.

The enterprise has developed aerosol products since 1982. In 1992, the annual output of aerosols reached 48.8 million cans, which was about thirty percent of national output. There are more than twenty kinds of products spreading widely in domestic market. In 1992, the consumption of CFC-12 was 2250 tons, in which about 70% is hairsprays and air fresheners. There is an aerosol technology developing centre in the enterprise as the scientific research organization to develop new products, while the manufacturing technologies mainly developed by the enterprise itself.

PROJECT DESCRIPTION

This project covers the facilities for making 5000 tons DME from methanol annually, an aerosol filling center of 35 million cans annual filling capacity, and a set of public utilities of water, electricity, steam, cool and compressed air. Accessory equipments include warehousing, distribution, transportation, quality control, fire control systems of DME. The enterprise has signed an agreement on technology of making DME by methanol with South-West Research Institute of the Ministry of Chemical Industry to take over its scientific research result and designs for this project. By using this technology, the conversion of methanol can reach 70%, the purity of DME can reach more that 99%,

which approaches the foreign technical level of the same product. The finished product of separated and refined DME can have a purity of over 99.9%, thus suitable to be used as aerosol propellant. The preliminary design of DME facilities has passed provincial evaluation, the construction design is also nearly completed. There are altogether 81 sets of equipments under the design, of which 17 sets are standard type, 62 sets are non-standard type, and 2 sets are specified equipments. Technology and equipment are from China, the main hardware of computer system shall be imported from USA and Japan. DME output of the facility is 5000 tons annually, of which 3094 tons shall be applied to fill 35 million cans of aerosols. Among them, the enterprise itself will turn out 20 million cans, the remaining 15 million cans will be for other enterprises. The remaining 1906 tons of DME will be sold to other companies.

In order to phase out all CFC uses in the company, there are five automatic filling lines and four semi-automatic filling machines to be retrofitted. However, in this project, only the investment required for retrofitting three automatic filling machines (each with capacity of 40–50 cans per minute) and two semi-automatic filling machines (each with 10 cans/minute) is included. The investment needed for the other equipment will be solved by the company themselves as a constriction for the world ozone layer protection programme. The content of retrofitting includes the installation of gassing room in accordance with the fire proof requirement, the installation of safety devices as detection, ventilation, alarming and fire extinguishing etc. Besides those, all gaskets are to be changed to suit the DME characteristics as well as power and lighting to be retrofitted in accordance with safety standards. This project is to be situated in Qiwan District, east of Zhongshan City.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION

LPG is more frequently used in aerosols than other CFC alternatives for its reasonable price and easy source of supply. However, in Guangdong province, the investigation shows that LPG is not so satisfactory as to both its quality and quantity. In respect of quality, the total sulphur and sulphur as thiols within local LPG are respectively about 200ppm and 20ppm. It also contains ethylene and many kinds of bad smell impurities, making it hard to take normal refining process to get the ideal result; in respect of quantity, in contrast with one million tons of annual practical demand of LPG for civil usage, LPG annual output of two main refineries of the province cannot yet reach 200,000 tons, which is a big shortage in quantity. It is noted that LPG in neighbor provinces is also insufficient. The local price of imported refined grade LPG in effect reaches high to RMB 8,000 per ton, and the supply is not stable.

With the exception of LPG, DME stands in the second place in quantity as the aerosol CFC alternative. The world's annual output of DME exceeds 170,000 tons, among which nearly half are supplied to the aerosol industry. DME is applied in aerosols with the evident advantages as follows:

1) Since DME and water are highly miscible, it is easy to develop water based products to decrease VOC value for purpose of environmental protection.
2) To decrease flammability of aerosols by increasing its water content.

3) DME is soluble in either polar or non-polar solvent, so it is ideal to be used in multi-component formula to increase product quality. Supply of methanol is locally available, thus since local supply of LPG is difficult, it's feasible to base the project on DME.

Zhongshan , sponsor of this project, has been in the field of developing and producing fine chemical products for 28 years. The project adopts transferred technology of making DME from methanol by South-West Research Institute of Ministry of Chemical Industry to turn out DME of aerosol use purpose. DME purity of finished product is to be not less than 99.9%, with impurities methanol less than 200 ppm, water less than 200 ppm and thiols less than 1ppm. Under present production scale, it is estimated that the enterprise can already make small benefit on a selling price of RMB 7,500 Yuan (a bit lower than price of imported refine grade LPG). Thus the project is feasible in view of economy and technology. The project is an effective way for Guangdong province to improve its circumstance of LPG shortage by using DME as CFC propellent alternative. By the time the project put into operation, it will complement and support the LPG-use filling centers in Shanghai and Tianjin.

PROJECT COST

Capital Costs. The investment cost is US$8.359 million, according to detailed investment cost in annex A),

Incremental Costs. The project will generate revenue, and the operating costs and benefits have been taken into consideration in determining incremental costs. Given the profit of the substitution as given in the feasibility report (Appendix B), and estimation of cost, tax and profit of different products (Appendix C in feasibility report), discount rate of 12%, construction period of two years and economic lifetime of 10 years, the internal rate of return can be calculated. The internal rate of return is calculated, respectively, without any grant (FRR of 8.3%) and with a grant of US$ 1.6 million to give a FRR of 12% as shown in annex B. The project shows a net value of US$ 6.759 million within its lifespan on 10 years. Thus, the incremental costs for the project is equal to:

Capital costs	US$ 8.359	million
Net presentvalue of operating benefits		US$ 6.759 million
Incremental costs	US$ 1.6	million

FINANCING PLAN

ODS investment cost of the project is US$ 8.359 million, plus the interest of US$ 0.5973 million during construction (interest rate is 9.696), total investment shall be US$8.9563 million, including US$1.934 million in direct foreign exchange.

The total investment of US$ 8.359 million is to be collected by three ways: US$1.600 million for OTF grant, US$ 0.684 million raised by the enterprise itself, and US$ 6.075 million from domestic loan. As to the domestic loan, The People's Construction Bank of China, Zhongshan Branch has already promised to

provide an initial amount of US$3.932 million for this project. Additional loans will be obtained and confirmed during subproject appraisal by the FA.

PROJECT Management

The National Bureau of Environment Protection will act as the project supervisor. Zhongshan Fine Chemical Industrial Limited is responsible to carry out this project. The South West Research Institute of the Ministry of Chemical Industry shall provide technical support. Implementation will take two years.

PROJECT BENEFITS

1) DME manufacturing facility with DME capacity of 5,000 tons/annum, and annual ODS reduction of 6,590 tons;

2) The filling center can eliminate environmental pollution caused by heavy leakage of small enterprises due to their backward equipment, and save significant expenditure for small enterprises' conversion to non CFC propellant.

Unit Abatement Costs: = US$ 0.1/kgODS/annum

Annex A

List of Investment Costs

Exchange Rate: US$ 1 = RMB 5.85 RMB 10000.00 unit US$ 1000.00

Item	RMB		Foreign Currency		Total	
	RMB	Convertto US$	US$	Convert to RMB	RMB	Convert to US$
Civil Works						
Land preparation	316.0	540			316.0	540
Civil construction	396.0	677			396.0	677
Public utilities						
Utilities	188.1	322			100.1	322
Boiler	62.4	107			62.4	107
Cooling Station	55.0	94			55.0	94
DME equipments						
Equipment	1154.2	1973			1125.1	1973
Instruments	10.00	17	332	194.2	204.2	349
Conversion of aerosol filling system						
3 sets of autofilling lines			622	363.9	363.9	622
2 sets of filling machines			105	61.4	61.4	105
Liquid product formulating						
Tanks for storage	22.0	38			22.0	38
Tanks for formulating	12.5	21			12.5	21
Measuring, filtering appliances, etc.	8.5	15			8.5	15
DME storage and distribution						

Main equipment, pipes, electric apparatus	286.9	490			286.9	490
Conveying system, instruments, valves			207	121.1	121.1	207
Transportation appliance						
DME truck(3)	131.0	224			131.0	224
Methanol truck (6)	36.0	62			36.0	62
Crane (2)	6.0	10			6.0	10
Cargo truck (2)	6.0	17			10.0	17
Bus (1)	25.0	43			25.0	43
Lab QC Apparatus						
Corrosion test & auxiliary instruments			90	52.7	52.7	90
Other quality test instruments	12.0	21			12.0	21
Safety facilities						
Safety equipment	25.0	43	140	81.9	106.9	183
Water spray system (2)	42.0	72			42.0	72
Transportation expenses for equipment import						
Overseas transportation			96	56.2	56.2	96
Domestic transportation	45.0	77			45.0	77
Installation & Commissioning						
Installation	226.0	386			226.0	386

Commissioning by foreign experts			60	35.1	35.1	60
Running test & training	32.0	55	30	17.6	49.6	85
Engineering Costs						
Design & Technical Assistance	100.8	172			100.8	172
Project management	65.0	111			65.0	111
Sub-total	3267.9	5586	1682	984.2	4252.2	7269
Other costs						
Floating rate 5%	163.4	279	84	49.2	212.6	363
Unpredicted expense 10%	326.8	559	168	98.4	425.2	727
Total	3758.1	6424	1934	1131.8	4890.0	8359

annex B

Calculation of Grant Amount to Yield 12% FRR

(1) Without grant

Unit: US$000.00

Year	Investment Cost	Grants	Sales Revenue	Sales Tax	Operation Cost	Operation Benefit	Net Cash Flow
1	3760.7	0	0	0	0	0	(3760.7)
2	4598.3	0	0	0	0	0	(4598.3)
3	0	0	26860.7	4728.9	22717.9	(578.1)	(578.1)
4	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
5	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
6	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
7	0		38383.8	6755.7	30089.9	1538.1	1538.1
8	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
9	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
10	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
11	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
12	(1003.1)	0	38383.8	6755.7	30089.9	1538.1	2541.2

Notes:

1. Sales revenue = revenue of products filled for the enterprise + revenue of products filled for other enterprises + revenue of DME product for sale.
2. Sales revenue = quantity for market x selling price of each part.
3. Selling price of each part is in table 2-4 of Appendix C-2.
4. Operation cost = sales total cost - depreciation cost

(2)with grant Unit: US$ 000.00

Year	Investment Cost	Grants	Sales Revenue	Sales Tax	Operation Cost	Operation Benefit	Net Cash Flow
1	3760.7	721.4	0	0	0	0	(3039.3)
2	4598.3	878.6	0	0	0	0	(3719.7)
3	0	0	26868.7	4728.9	22717.9	(578.1)	(578.1)
4	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
5	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
6	0	00	38383.8	6755.7	30089.9	1538.1	1538.1
7	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
8	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
9	0	0	38383.8	6755.7	30089.9	15538.1	1538.1
10	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
11	0	0	38383.8	6755.7	30089.9	1538.1	1538.1
12	0	0	38383.8	6755.7	30089.9	1538.1	2541.2

Unit Abatement Costs: Unit abatement costs is calculated as follows:

$$A = \frac{C(F) = (OC-OS/R)}{ODP}$$

Within the formula

(1) C(F)—annual investment cost

When investment cost = US$ 8.359 million, economic lifetime= 1- years, discount rate=1296:

C(F)=8359.0 x 0.1770= US$ 1,479.5 million

(2) OC—OS/R—the revenue in the first year of full operation

In this project, OC—OS/R= US$o.8026 million

(3) ODP—annual ODS reduction under full operation expressed on ODP

In this project, ODP=6590 tons

$$A = \frac{1479.5-802.6}{6590}$$

= US$ 0.1/kgODS/annum

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November 22, 1993

TO : Jessica Poppele FAX: 202-477-5752
Ozone Ops Coordinator-Asia
Global Environment Coordination
Room S2-113 / Dept. 655-37

COPY TO : Tom Waltz FAX: 202-522-3258
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Montreal Protocol

FROM : Harry B. McCain

SUBJECT : **China Aerosol Project**
China Aerosol Industry Southern Filling Center Project
(Zhongshan Fire Chemical Industrial Limited Aerosol CFC-12 Substitution and Conversion Engineering)

- **SCOPE**

The project under review covers the development of technology for CFC-12 phaseout of 6,590 tons annually (equivalent to 6,590 tons annually ODS use in sector reduced) in the aerosol sector.

- **RECOMMENDATION**

The project is supported. Dimethyl ether (DME) is a valid alternative propellant to CFC in the aerosol industry.

- **RELEVANCE AND ADEQUACY OF INFORMATION PROVIDED**

Information provided is comprehensive, complete and well set out to the standards in keeping with producing aerosol grade DME which will serve the Chinese aerosol industry well.

Exception: Under "List of Investment Costs", item 7, "Transportation appliance, DME truck $274,000 U.S.":

A new truck (tractor) and tank (trailer) for DME use in the U.S. costs $130,000 delivered in the U.S. Therefore, the presented cost of $274,000 U.S. seems very high indeed and should be reconsidered.

- **TECHNICAL SOUNDNESS**

The report is very extensive and well presented. However, the technical information concerning the catalytic dehydration of methanol and the specific use consideration for DME are implied rather than presented in detail. One must perceive this report as a report primarily on costing, and one must assume that the technical know-how for producing DME and using DME is well understood by Zhongshan Fire Chemical Industrial Limited.

It is stated in the report that the source of methanol is locally available. More detail is needed here. Is the local source basic, i.e., is it manufactured locally or is it imported and distributed locally?

Methanol is a world commodity whose price can fluctuate greatly depending on worldwide demand. If methanol is not manufactured locally, it is then subject to these price changes and can greatly affect the end cost of DME. Therefore, one must insure that the local source of methanol, in what one assumes to be the Guangdong Province, is basic.

- **LESSONS FROM EXPERIENCE**

The Project Accomplishment Schedule, 24 months total, is very optimistic. Forty eight months would be a more accurate figure. Example: Building construction and equipment purchase and manufacture was given six months for completion. However, there is a major chemical company in the U.S. with an excellent reputation, basic in methanol with a catalytic dehydrator for methanol in place, that has been trying for three years to produce high quality DME and are to date unsuccessful. Producing DME is not their problem; producing no-odor, high-purity DME is. Therefore, one must surely be prepared for significant delays in the production of DME in China.

- **ENVIRONMENTAL ISSUE**

This project when completed will phase out 6,590 tons of CFC-12 annually (equivalent to 6,590 tons annually ODS use in sector reduced).

SAFETY ISSUES

The safety issues regarding DME have been addressed in the report. Special considerations for handling which include electrical equipment and the aggressive solvent characteristics of DME on elastomers were considered.

- **COST EFFECTIVENESS**

The project is very cost effective at a UAC of $0.1 USD/Kg/annum. This figure may rise if project accomplishment schedule is extended beyond the present two year estimate.

- **OTHER**

None

PROJECT COVER SHEET

COUNTRY OR REGION:	China
SECTOR COVERED:	Primary Sector: Solvents
ODS CONSUMPTION IN AFFECTED SECTORS	3306 tonnes of ODP in 1991
PROJECT TITLE:	ODS - FREE CLEANING EQUIPMENT MANUFACTURING CENTER FOR PHASING OUT ODS CONSUMING SOLVENTS ACROSS CHINA
PROJECT DURATION:	Two years from funding availability
PROJECT IMPACT:	Rapid and accurate replication and placement of non-ODS technologies as they are transferred from developed countries to China.
PROPOSED BUDGET:	Total Proj Expense : US $1,446,542 **Requested funding: US $ 524,734**
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY:	NEPA THROUGH MEI

PROJECT SUMMARY

The China Country Programme addresses the rapidly growing solvent sector by employing a strategy of subsectoral demonstration projects, followed by replication. With an estimated 3000 lines consuming ODS in cleaning processes throughout China, the China Country Programme has included an Equipment Manufacturing plan to minimize the phase out cost.
It is the intent of this project to install manufacturing capability for ODS -free cleaning equipment in No. 2 Institute. ODS-Free Equipment manufacturing at this site will replace equivalent ODS equipment manufacturing capacity currently scattered across China.

PROJECT OF THE GOVERNMENT OF CHINA

ODS - FREE CLEANING EQUIPMENT MANUFACTURING CENTER FOR PHASING OUT ODS CONSUMING SOLVENTS ACROSS CHINA

1.Project Objective

The objective of this project is to provide for cost effective installation of replacement cleaning lines across China by manufacturing and then offering low cost, no-ODS cleaning equipment to Chinese firms
The project will use demonstrated technology and equipment and will demonstrate that the replication of ODS free cleaning processes can be accomplished at considerable savings to the Multilateral fund.

2.Sector Data

The Cina Country rrogramme states that total 1991 ODS consumption in China was 48,239 tonnes with an ODP (ozone-depleting potential) value of 60,352 tonnes. China has forecast that unconstrained ODS consumption would by year 2010 result in ODS consumption of 229,318 tonnes with a ODP value of 292,714 tonnes with resulting severe damage to the global ozone layer.

ODS consumption in the solvents sector in 1991 amounted to 4,947 tonnes with a combined ODP value of 3,306 tonnes. This combination reflects the weighted average of a 0.8 ODP value for CFC-113 (91%) and a 0.1 ODP value for methyl chloroform (9%). There are 3,200 middle and small-sized enterprises using ODS-based cleaning processes in China at present. With unconstrained consumption, ODS consumption in this sector by year 2010 would reach 53,571 tonnes growing at over 14% per annum over the period 1991-2010. It is thus critical that ODS consumption in this sector be reduced as soon as possible. This is technologically feasible since alternative processes exist. The main issue is to determine, and then deploy, the cleaning processes, or alternative technologies, most feasible for the many different factory applications throughout China.

3. Background

3.1 Sectoral Needs and Strategy

A major, high growth area in China is the solvents sector, as described above. China has defined its strategy in its Country Programme, and is in the process of implementation of each of the elements of that strategy. Key demonstration projects in each of several major applications, or subsectors, followed by rapid deployment and replication of the demonstrated technology, is deemed necessary for successful completion of the solvents sector overall strategy. For rapid deployment and replication to be successful, i.e.,a cost effective phase out, two additional elements are deemed essential, both of which have also been described as part of the CP solvent sector strategy:

a) An equipment manufacturing line to produce cleaning equipment for the replication in an economical, expeditious manner.

b) An Applications Deployment Center (ADC) for evaluating the cleaning process options for the replication plants, where samples from the factories will be cleaned in various processes, and the appropriate process and equipment specified for those applications.

In China, with such a significant number of enterprises spread over such a vast geography, with a significant language barrier in the ordering and installation of equipment - especially in the remote areas, the process of phase out on a plant by plant basis could be very inefficient and therefore, costly. China has existing CFC solvent equipment manufacturing capacity that is dispersed across China. China Electrical Engineering Design Institute (CEEDI) estimates that the number made is between 200 and 300 per year, depending on the ratio of batch and continuous units made. Just under two hundred additional are imported per year. The CFC based equipment manufactured across China today, essentialy as an "ad hoc" product, is made to meet local needs and generally does not adhere to international guidelines as to to emission control, solvent containment, freeboard, etc. It is normally custom made by many various machine manufacturing factories which are engaged in production of other, non-solvent, various general equipment products. The new replacement technology machines will be dealing with flammable and harsh/corrosive chemicals, and adherence to international guidelines is felt to be an essential need.

It is the intent of this project to set up an equipment manufacturing line in China that will eliminate virtually all of the aforementioned

barriers to an efficient and cost effective phase out of ODS in the solvent sector. China is committed to the plan that, when the equipment manufacturing line is brought on line, then the equivalent CFC equipment manufacturing in the various factories will cease, and there is expected to be no Incremental costs associated with the replacement of this capacity. Thus the CP strategy for a cost effective and efficient phase out can be achieved.

3.2 Enterprise Background

No. 2 institute has the expertise and the capacity, and also necessary means of studying and making cleaning systems, to satisfy various needs of the enterprises. It is believed to be the correct choice to set up the equipment manufacturing line in No. 2 institute.

No.2 institute is located in Heping South Road, Hexi District, Taiyuan City, about 5 kms away from downtown. Taiyuan City has all convenient means of communication and transportation. The institute occupies a total area of 95,000m2 and has sufficient water and power supply. Being the premier electronic process technology institute in electronics industry, the institute is mainly engaged in process technology development and electronics industrial process management. It was founded in 1962 and, during the past 30 years, has brought to market hundreds of research outcomes in the fields of automation technology, PC application, precision machining techniques, thermal processing, electronic assembly process, powder metallurgical technology and metal surface denaturation, etc..

In the 60's, it developed the first wave soldering machine and the first manufacturing line for producing C-type ferrite-core and Ta capacitor, followed by production lines of magnetic-rod loudspeaker as well as a semiautomatic line for B/W TV sets. In the 80's, it was assigned the research work of chip component mounting and soldering technology and equipment, and turned out a number of high-tech results represented by laser soft brazing machine and process, impurity alarm in cleaning process and an IR reflow machine, opening new prospects in the area of SMT technology for China.

The institute covers a wide area - 9.6 hectares with dozens of one-floor buildings and several multi-storey buildings. The manufacturing line will be located on the first floor of No. 8801 Building, a new five story structure with a building area of 6,463m2,

located northwest of the main entrance and now under construction.

The institute now has:

staff	703
in which technical personnel	321
(including senior engineers 63)	
key equipment	95pcs
key instrument	370pcs
mini-computer	20
mobile vehicles	25
books and reference materials	25,000volumes
site ground area	95,000m2
building area	27,000
original value of fixed assets	RMB 13,980,000

4. Project Description

As mentioned above, the first floor of a newly finished building will be converted to include a cleaning equipment manufacturing line that is capable of fabricating 6 types of cleaning system - ultrasonic, centrifugal, brush, spray and immersible and associated accessories and both in-line and batch systems of each type. The line should have a capacity of 300 batch units manufactured per year. With this capacity, it will take 8 years to fuifill the overall objective of conversion of China to non-ODS processes.

It has been decided that the batch system will be the typical product as there are more medium-size and small-size firms than large ones, while the in-line system will be also necessary to satisfy large firms' needs. In this aspect, the overseas mature water spray type in-line system will be in the first place for consideration.

batch system	270pcs
in-line system	10pcs (equivalent to 30 batch units)

The line will include sheet cutting, flattening, pressing, sheet bending, coldworking, benchworking, welding, surface treatment and assembly in conjunction with in-process inspection.

The process flow will be as follows: preparation - sheet cutting - machining -
inspection - surface treatment (electroplating, painting , etc) - inspection -

assembly (mounting and wiring) - on-line unit debugging -perforcemance test - packing & storage

5. Technology

The plant will use standard metal working and equipment fabrication techniques. Work areas within the manufacturing shop, to be set up, are as follows: benchworking,metalworking, machining, welding, surface preparation and coating, and the assembly area - which will consist of electric wiring, test and debugging, final assembly, and packing.

There is a significant amount of equipment already available at the institute which can be utilized for the purpose of the additional manufacturing line. It is estimated that the project would utilize 22 pieces of equipment from the Institute, but would require the addition of new pieces, many of them to be imported.

The institute, at present, has a 2t steam boiler and 2 hot water heating boilers with a capacity of 250Kcal/h each, which will be the source of hot water (95-70!f) supply to the new building. No.8801 Building will have 216m2 of air-conditioned area where t=20degrees, +/-1, RH=60%, +/-5% and mechanical exhaust system and scrubber will be installed.

The existing water source is sufficient to supply the max. 4.3m3/h additional consumption. There will be waste treatment plant or recycling unit for the effluent discharged from cleaning system debugging procedure.

Existing compressors supply compressed air at the point-of-use. The compressor in the painting area has enough spare capacity to satisfy 0.3m3/min in the new painting area. And a new compressor will be installed in the new building to meet 7.8m3/min consumption of the line.

The installed power capacity will be 310KW for the power consumed. There will be both radial and trunk systems for power distribution. There will be a separate feed line for power supply and lighting.

The equipment to be produced will utilize proven and credible international equipment technology and design, and will be based upon agreements with foreign equipment makers for the use of their technology.

6. Project Costs

The detail of the investment cost is described below. The investment cost requested of the Multilateral Fund has been determined to be US $524,734. The investment cost of the remainder of the project, to be bourne by the Government of China has been determined to be $US 921,808. There are no costs included in this project for patents or agreements, other than the technology transfer costs.

6.1 Some Explanations

1) The foreign exchange rate will be 1US$ to RMB 8.7, as issued by the State Foreign Currency Administration.
2) The imported equipment will be at CIF price and be exempted from duties and taxes on added value pursuant to certain rules. But the local support cost in RMB such as company commission, banking charges and local transport expenses and miscellaneous expenses shall be included.
3) The local source equipment will be priced with reference to ex-factory price with 6% of transport and miscellaneous expenses.
4) The installation cost for foreign and local source equipment will be separately calculated and cover both installation and debugging as well.
5) Building engineering cost is estimated for converting an area of 1,436 m2 while and external construction cost covering piping and cabling ,etc. is estimated at RMB 150,000.
6) The charges for feasibility study and design will be as stipulated in " The Charging Criteria for Engineering Design" issued by the State Planning Commission in 1984.
7) The additional power capacity required will be 240KVA and Taiyuan City regulates RMB 290/KVA for the additional power demand.
8) Insurance expense for construction period shall be 0.35% of the total cost of construction, equipment procurement and installation.
9) The cost for trial run, hospitality, office and domestic appliance shall be borne by the owner.
10) Cost for preparation work shall be 10% of the total investment both in US$ and RMB.
11) Calculation's indicated a sum of RMB 176,000 of the interest of loan in construction period,the yearly interest rate being 10.98%.

6.2 Project Economics

Annex 1 contains the list of equipment needed for the project. Annex 2 contains the project calculations, showing total project costs as well as the breakdown of the components and also the split between the MLF and the Government of China. Annex 3 shows the calculation basis for determining the cost of manufacture, the price comparisons between international and

local production, the profit to be deducted from the project, and the net calculations showing the basis for the request to the Multilateral Fund.

8. **Financing Plan**

From the MLF	$ 524,734
From Chinese Government	$ 921,808
TOTAL	$1,446,542

9. **Environmental, Health and Safety**

In debugging operations, city water will be used. The few printed circuit boards cleaned in debugging will have minimal impact on waste water effluent concentrations as they join the other site efluent streams. In any event, where organics or alkaline cleaning agents are used, the former will be recycled inside the area, while the latter will be treated in an enclosed system to minimize the discharge. Organic fumes released in the painting area are anticipated to be minimal. Water based acrylics will be investigated. To minimize noise in the fabrication areas, low noise equipment will be given priority in the selection process, and vibration isolation mountings will be specified as preferred. Illumination of 150 - 300Lx will be provided in compliance with national rules. Housings, covers, and wire guards will be installed on all drives, and reliable grounding will be installed throughout the manufacturing area.

Fire protection and explosion proof design will be initiated in the coating area. Indoors there will be a security pipeline, hydrant, and portable dry powder extinguishers placed appropriately throughout the area. Outdoors, there will be a water supply pipeline, an encircling access road for fire engine response, and a fire engine available with water delivery capability of 25 L/sec.

10 **Project Impact**

As a result of this project, Number 2 Institute will address the needs of the Country of China for

1. rapidly producing and distributing standard cleaning equipment, based on non-ODS cleaning technology, thereby overcoming the substantial infrastructural difficulries associated with distribution throughout the

various provinces

2. training indigenous users in the startup and operation of the equipment, thereby overcoming the difficult language problem
3. providing high quality, low cost equipment at a substantial savings to both the country and to the Multilateral Fund. The phase out plan is that, in 3 years, approximately 800 enterprises will be converted to non-ODS processes. Thus in the 3 year period, the project is expected to avoid an approximate cost of US$ 52 million to be requested from the Multilateral Fund.

	EQUIPMENT REQUIREMENTS						
				MLF	MLF	CHINA	TOTAL
Item no.	Item	qty		$ US	As RMB	RMB	RMB
1	NC Sheet shear	1		38000	330600		330600
2	Levelling Machine	1		22000	191400		191400
3	CNC Turret punch	1		275000	2392500		2392500
4	NC Programming system	1		38000	330600		330600
5	4 Bar Universal hydraulic press	1		12000	104400		104400
6	High speed hydraulic press	1		23000	200100		200100
7	Angle cutter/Iron worker	1		18000	156600		156600
8	NC Sheet bender/ tube bender	1		100000	870000		870000
9	Spot welder	1			0	40000	40000
10	40 Ton Hydraulic bending brake	1		50000	435000		435000
11	Single phase rectifier DC welder	1			0	32000	32000
12	Parts / tools grinding machine	1		43000	374100		374100
13	Spray coating equipment	1		140000	1218000		1218000
14	Welding defect detector	1		9000	78300		78300
15	Universal tool microscope	1		5000	43500		43500
16	Aqueous cleaning prototype	1		80000	696000		696000
17	Metal parts	1		80000	696000		696000
	TOTAL			933000	8117100	72000	8189100

	PROJECT CALCULATIONS							
				MLF	MLF		CHINA	TOTAL
				$ US	As RMB		RMB	RMB
1	BUILDING CONSTRUCTION							
	Conversion of Bldg						718000	718000
	outside engineering						150000	150000
	subtotal						868000	868000
2	EQUIPMENT							
	imported			933000	8117100			8117100
	Company commission			14000	121800			121800
	banking charges			4700	40890			40890
	local transport			23300	202710			202710
	local						72000	72000
	transport						4300	4300
3	INSTALLATION							
	imported			24400	212280			212280
	local						3000	3000
4	TOOLS AND FURNITURE						50000	50000
5	OTHER							
	Contractor mgt						150000	150000
	technology transfer and training			20000	174000			174000
	startup test fabrications			28000	243600			243600
	local training						100000	100000
	FSD preparation			8000	69600			69600
	Design			16500	143550			143550
	Contingency			107190	932553		211530	1144083
	Grand TOTAL			1179090	10258083		2326830	12584913
							$TOTAL =	1446541.7

CAPACITY - UNITS/YEAR			INT'L PRICE	LOCAL PRICE	SAVINGS/YR
BATCH UNITS	270		70,000	5977	64,023
IN - LINE UNITS	10		110,000	15586	94,414
		AVG	71429	6320	65,108

ESTIMATE OF MFG COSTS	(1000) RMB		
		RMB VALUE	8.7
MAJOR MATERIALS	5348		
SUPPORT MATLS	4350		
PACKING MATLS	240		
LABOR	648		
FUEL & UTILITIES	731		
OVERHEAD	2282		
TOTAL	**13599**		

AVG COST/UNIT (RMB	48568	=13,599,000/280
AVG COST/UNIT ($)	5583	
AVG PRICE ($)	6320	
AVG PROFIT, $	738	
AVG PROFIT, RMB	6418	
PROFIT/YR, $	$206,552	---------- THIS IS THE PROFIT USED TO CALCULATE
GROSS PROFIT/YR, I	1797000	THE NET BENEFITS PER YEAR
TAXES	413310	
NET PROFIT	1383690	

USE PROFIT FROM CALCULATIONS ABOVE

REQUEST TO MLF	$1,179,090	
4 YEARS PROFIT =	$654,356	---------- net present value of 4 years' profit = 4 X (0.792) X 206552
NET GRANT =	$524,734	

TOTAL PROJECT CAPITAL REQUIRED, $US	1446542
TOTAL MLF GRANT REQUESTED, $US	524734

GLOBAL CENTRE FOR PROCESS CHANGE
P.O. Box 553
Montchanin, DE
19710-0553 USA

W. G. Kenyon
Tel: 302-652-5597
Fax: 302-652-5701

TO: C. J. NORRIS (UNDP) DATE: 10 FEB., 1994

FROM: W. G. KENYON (CONSULTANT)

SUBJECT: PROJECT TECHNICAL REVIEW

I have reviewed the Solvent Project, "ODS-Free Cleaning Equipment Manufacturing Center for Phasing Out ODS Consuming Solvents Across China" prepared by CEEDI, MEI and UNDP personnel.

Technical Soundness

This project is designed for rapid, successful, cost effective deployment of non-ODS cleaning equipment throughout China after evaluation of the various alternatives. The vast geographic area of China, combined with multiple languages, makes the ordering and servicing of equipment from external vendors difficult. Local manufacture of proven equipment designs, both batch and in-line, will provide rapid deployment of non-ODS equipment in the solvent sector throughout China, while providing trained personnel for troubleshooting and maintenance. Close cooperation with the Applications Development Center will enable rapid publication and deployment of training materials and manuals to ensure meeting the phase out goals in the Country Programme. Since it is essential that proven designs be employed, maximum success will be achieved if the proposed Project Site (#2 Institute) engages in close cooperation with a developed nation equipment manufacturer with industry-proven designs.

Safety

The manufacture of cleaning equipment requires many standard procedures for cutting, bending and welding sheet metal and piping. In addition, electrical wiring, plumbing operations and painting must be carried out. Safe practice procedures for all of these operations are readily available, especially from the more heavily regulated developed countries. It is expected that such safe practices will be followed, especially if they are part of the workmanship standards supplied by one or more of the developed countries equipment manufacturers. Equipment for the use of semi-aqueous technology employs hydrocarbon substances which have flammability or combustibility potential. The use of established equipment designs ensures that the appropriate safeguards are designed into the PRC-manufactured equipment. Thus, chemical misting will be controlled or blanketed, depending on the equipment design.

Environmental

"Wet testing" of each piece of equipment is required prior to shipment to the point of use. This is accomplished by actually running the chemistry in the cleaning equipment and cleaning the parts to be manufactured. Thus waste streams will be generated which must be treated on site. It is the evaluator's understanding that aqueous treatment is already available at the #2 Institute site. In addition, the site meets all applicable workplace regulations for light and ventilation.

Aqueous technology has the potential for the detergents to complex with the heavy metal components in the removed flux residues or with the the non-electronics parts being cleaned. Semi-aqueous solvents are hydrocarbons; they are normally incinerated for disposal. They also have VOC potential. While VOCs are not regulated in developing countries, they may be a future concern.

Cost Effectiveness

The project addresses cost effectiveness, pointing out the unique opportunity for local equipment manufacture at the #2 Institute Project Site to simultaneously accelerate the phase-out in China while potentially saving the MLF a projected USD 100,000,000. From an investment standpoint, less than USD 2,000,000 in capital investment will produce more than USD 50,000,000 return in 3 years. This savings can be used to accelerate ODS phase-outs in other developing countries who perhaps do not have the manufacturing base and central planning advantages possessed by China.

Recommendations

It is recommended that this project be approved with the stipulation that (at least initially) proven equipment designs from developed country sources be manufactured, thus maintaining the momentum of the ODS phase-out.

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER PROJECT COVER SHEET

COUNTRY	The People's Republic of China	
SECTORS COVERED	Domestic Refrigeration	
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)	
PROJECT TITLE	Engineering Assistance for Conversion of Refrigerator Manufacture to use of HFC-152a Refrigerant using conventional compressors.	
PROJECT DURATION	2 years	
PROJECT IMPACT	80 MT CFC-12	
PROJECT BUDGET	Incremental Capital Cost - Phase 1	$ 520,000
	Incremental Capital Cost - Phase 2	$ 800,000
	Incremental Operating Cost	$ 0
	Total Project Cost	$1,320,000
PROPOSED OTF GRANT[1]	$1,360,000	
IMPLEMENTING ENTERPRISE	Wanbao Electrical Appliance Industrial Corporation	
IMPLEMENTING AGENCY	The World Bank	
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)	

PROJECT SUMMARY

This project will phase out chlorofluorocarbons (CFC's) used in household refrigerators manufactured at the Wanbao Electrical Appliance Industrial Corporation. The project comprises two phases and will convert the production line to refrigerators using HFC-152a as the new refrigerant. The first phase will provide for product development using CFC alternatives and will identify all equipment and process changes needed to implement the alternative technology. Part of this phase associated with the use of an alternative refrigerant is already under way. The project is based on a collaboration between the Power Engineering Department of Xi'an Jiaotong University, the Shanghai Jiaotong University, and the Wanbao company.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

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[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 15% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVES

The objectives of this project are to phase out CFC-12 through use of HFC152a in household refrigerators produced at Wanbao and to develop reliable data for comparison with other phaseout alternatives. The project provides for the purchase of equipment and the training necessary to facilitate an effective transition to HFC-152a refrigerant.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992
(metric tons)

	CFC-11	CFC-12
Insulating Foam - New Refrigerators	4600	
Refrigerant - New Refrigerators		950
Refrigerant - Service Old Refrigerators		500
Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term.

Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

The Wanbao company is located in Guangzhou, Guangdong province. There are 1,800 employees in this company of whom about 200 are technicians. It first produced refrigerators in 1980 with the models from Acma in Singapore and Hitachi in Japan, but has subsequently developed its own designs. It has up to now used domestically produced compressors.

Wanbao Group has a number of subsidiaries. Most of them are located in Guangzhou, Guangdong province. As a group corporation, it produces regrigerators, freezers, air conditioners, compressors, washing machines, rice cookers and other electrical appliances. It has six refrigerator production lines. These are capable of producing 1,200,000 refrigerators in two shifts. Approximately 40% of production is exported (80% of all refrigerators exported from China). Most are sold in the USA with a significant number sold in France. Wanbao's share of the domestic market is about 5%. This project is to convert one of Wanbao's 6 production lines (400,000 units per year capacity on 2 shift opertion) to HFC152a refrigerant. All such refrigerators are for domestic use only.

Table 3
Actual and Forecast Refrigerator Production at Wanbao

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Refrigerators Produced (000 Units)	360	300	250	180	250	300	350	400

For the past three years Wanbao and Xi'an Jiaotong University have been engaged on a collaborative venture to develop a refrigerator using HFC-152a. Energy savings in the region of 5% compared to an identical model CFC-12 refrigerator can be achieved with minimal changes made to the refrigeration circuit. The following items of work have been completed and a report is being prepared for evaluation by an independant expert:

*Appliance testing of 20 refrigerators
*Compatibility testing of lubricants, drier and compressor materials.
*A batch of 120 refrigerators using HFC-152a has been made and sold into the market. After 1 year there has been no negative feedback.

The project will consist of finalising the transition to CFC-free technology for mass production. Wanbao will purchase extra charging stations and safety equipment. HFC-152a is moderately flammable. The safety equipment is required for monitoring concentration levels and safe handling and storing of HFC-152a. Safety considerations also demand that the production line be modified to avoid inadvertant HFC152a combustion. Underwriters' Laboratories (UL) have tested Wanbao refrigerators. Their informal report is that these will satisfy UL 250. A draft proposal for "A2" category (covering HFC-152a) refrigerant use in domestic refrigerants has been prepared by them.

PROJECT DESCRIPTION.

The project will accomplish phaseout of CFC12 used as refrigerant in domestic refrigerators produced by Wanbao in two phases.

Phase I Engineering, product development and testing under local conditions to establish basic data for full conversion to HFC-152a and for comparison with results of similar programs using alternative refrigerants.

Phase II Full conversion of the Wanbao factory to HFC-152a refrigerant

Phase 1

During Phase 1, compressor oil testing studies will be completed and the condensor,evaporator and capillary tubes will be redesigned to achieve optimum performance with HFC152a. A test manufacturing run of 500 prototype refrigerators will be made to prove the viablility of the refrigerant circuit designs and the manufacturing process. Existing test facilities will be used for local testing. The USEPA will provide special assistance for testing the safety of the manufactured units in the US. The remaining refrigerators will be subjected to field tests. Consultations will be arranged with local and foreign experts (Underwriters Laboratory) to train Wanbao engineers and technicians in safe handling practices and facilities for use of HFC152a in the factory. At the conclusion of Phase 1, a feasibility study will be prepared for full conversion of refrigerator manufacturing at Wanbao to the use of HFC-152a. Based on the feasibility study results, a detailed cost estimate will be prepared and project planning will be revised to accomodate Phase 1 findings before commencing with

Phase 2

Phase 2 will implement the full conversion of Wanbao refrigerator facilities to HFC152a refrigerant over a period of 4 years.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY:

The use of HFC-152a refrigerant in domestic refrigerators is a domestic Chinese development. Theoretical predictions that energy savings could be achieved by comparison with CFC-12 systems have been borne out by test results. Independent laboratory tests corroborate Wanbao's tests which showed a 5% improvement in energy efficiency associated with the use of HFC-152a vs CFC-12. Other principal reasons for using this blend are as follows:

*HFC-152a is readily available in China

*Only minor modifications need be made to the circuit of a CFC-12 refrigerator for it to be used, and it is compatible with mineral oil lubricants and standard compressor materials.

*It possesses zero ODP and a low GWP (.055 to .068).

*Being a domestic Chinese development, replication to other enterprises once the technology is proved will be considerably cheaper than piecemeal importing of foreign HFC-134a technology.

PROJECT COST

The total project cost is estimated to be $1,320,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation,currency fluctuations, and other unforseen costs.
A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An OTF grant request will be made based on Phase 2 results. An order of magnitude estimate of these costs is US$1,400,000 for the first four years of operation, discounted at 10%.

UNIT ABATEMENT COST (UAB)

$10.29 per kg CFC-12

PROPOSED OTF GRANT

The proposed OTF grant request is US$1,360,000 is based on 100% Chinese ownershhip of Wanbao and covers the incremental capital costs for Phases-1 and 2 of the project , including a 15% contingency cost and a 3% fee for the financial agent administering the project.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

WANBAO
PROJECT COST SUMMARY

	(000US$)
Phase I	
Compressor Testing	12
Purchase Safety and Process Equipment for Test Manufacture Run	
1 Refrigerant Charging Machine	100
2 Halogen Leak Detector	82
2 HFC152a Monitor/Alarm system	16
1 Vacuum Pump	9
Ventilation equipment	47
Explosion Proofing	22
Fire Fighting Facilities	21
Test Manufacture 500 HFC152a Refrigerators (@$180 per unit)	90
Prepare Test Reports and Feasibility Study	30
Safety Training for Technical Staff	21
SUB-TOTAL	450
Phase I I	
Additional Manufacturing Equipment	
1 Refrigerant Charging Machine	100
2 Halogen Leak Detector	82
13 HFC152a Monitor/Alarm system	104
1 Vacuum Pump	9
Ventilation equipment	95
Explosion Proofing	44
Fire Fighting Facilities	45
Conveyor	141
Safety Training for Operators and Mechanics	56
Overseas - Consultations and Inspection	24
SUB-TOTAL	700
Contingency (15%)	170
TOTAL CAPITAL COSTS	1,320

Annex B

WANBAO
IMPLEMENTATION SCHEDULE[2]

	From	To
Phase 1		
Compressor Tests with HFC152a	1Q94	2Q94
Prepare Report of Test Work to date for Expert Review	1Q94	2Q94
Purchase Safety and Process Equipment for Test Manufacturing	2Q94	3Q94
Safety Training for Technical Staff	2Q94	3Q94
Test Manufacture 500 HFC152a Refrigerators	2Q94	3Q94
Prepare Feasibility Report for Phase 2	3Q94	3Q94
Phase 2		
Purchase and install equipment for mass production of HFC152a refrigerators	4Q94	2Q95
Safety Training for Operators and Mechanics	2Q95	4Q95
Startup	2Q95	2Q95
Achieve full phaseout of CFC12 refrigerant	---	4Q95

[2] Project schedule assumes ECMP approval of project during 1Q94.

Conversion of Refrigerator Manufacturing from CFC-12 to HFC-152a at Wanbao Electrical Appliance Corporation

Project Proposal by The World Bank, January 1994

⑥

Scope

The scope of this project is to convert one of the Wanbao production lines to the application of HFC-152a thereby eliminating CFC-12. The products are planned to be used in the domestic market only. The technology for this alternative has been developed by the Wanbao company itself in cooperation with the Xi'an Jiaotong University.

Recommendation

Approval

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a second stage, after a preliminary review, supplementary information was given by the Wanbao company. Altogether sufficient information for a judgment is present. *The project proposal itself does not contain all relevant information.*

Technical soundness

The Wanbao company has chosen an alternative which is not being applied elsewhere and therefore had to do its own development in cooperation with the Xi'an Jiatong University. No real cooperation with a compressor manufacturer is reported. Extensive tests with the blend are being reported (among them a successful field test of 120 appliances) and possible problems have been addressed like the application of mineral oil [1]. The information supplied gives confidence that the status of the technology is advanced enough to start a pilot production.

Lessons from experience

not applicable

Environmental issues

HFC-152a is an acceptable way to reduce CFC-12 emission.

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[1] It is stated that evaporators/condensers are going to be redesigned to get optimal performance with HFC-152a. However, the tests performed up to now were carried out with the current design. Due to the low solubility of HFC-152a in mineral oil the oil return from the circuit is more critical than for CFC-12. Due to this aspect redesigns of the evaporator/condenser could be dangerous and must be done with care.

Safety issues

HFC-152a is flammable and therefore special provisions need to be made to the production line. Standard and guidelines are in development. Safety in servicing is addressed and included in training programs.

Cost-effectiveness

No incremental operational costs are claimed in this phase yet (they must be lower than for HFC-134a projects). Therefore no cost-effectiveness can be discussed. The costs claimed for safety measures in the production lines are reasonable (approximately 400,000 USD plus additional training). Due to the characteristics of the local production line extra indirect safety costs originate (in this case the addition of a conveyer of 141,000 USD). Further costs claimed are reasonable and in line with similar projects.
The total cost of the HFC-152a project is very similar to the costs of HFC-134a projects mainly due to the safety investments which are counterbalanced by the technology transfer fee in HFC-134a projects.

Other

In the project summary it is stated that after phase 1 (pilot production and field test of 500 appliances) the results will be compared with similar projects before proceeding to phase 2. However, it is doubted whether this procedure is very realistic. Already in phase 1 large investments are made, maybe not specifically in hardware but in technology development, transfer, training etc. Another aspect is the funding itself. The question is: would this company be funded again for conversion to HFC-134a if after phase 1 it appears that the HFC-152a alternative is not so successful ? In other words, once the decision is made for funding this alternative, it is a final decision.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 10

Supplemental Comments of 6 China Refrigerant Projects

Overall Assessment

Wanbao
HFC152a Refrigerators

1. Wanbao has conduced a limited number of tests with HFC152a and expects to complete testing by June 1994. (The test runs started in June 1990).They also have made 120 refrigerators which are now about 1 year into their field test. Wanbao does not have external technology support but feels confident that their expertise in the field should be adequate as there are no changes needed in compressor design to accomodate HFC152a. They will simply use a slightly larger compressor than they would have used ordinarily to compensate for a 10% loss in cooling capacity. (This of course adds to the incremental operating cost)

2. Test data included in the feasibility study have shown no degradation of mineral oil when compared to a CFC12 unit under the same conditions. HFC152a, however, is significantly less soluble than CFC12 in the oil (1-1.5% vs 4.4%)

3. Wanbao have considered using PAG lubricants but see no advantage over mineral oil at this time. Test work has all been done with mineral oil in compressors from both Wanbao and Tianjin Haihe.

4. Wanbao plan to modify their condensors and evaporators to optimize the refrigerant circuit. Testing to date has been on older designs. It was suggested that the trail run of 500 refrigerators be made with the newly designed condensors and evaporators.

3. The Feasibility Study is well prepared but is missing a reasonable quotation for a refrigerant charging machine. The quote they did have was 3X that for charging non-flammable refrigerants. This appeared excessive and they will get a new quote. As a temporary measure, the price of a charging machine for "flammable" HFC152a was estimated at $100,000. Suggested alternative vendors were given to Wanbao, but it will take 1-2 weeks to get revised quotations.

5. The work plan does focus on the "Criteria" for appliance development. There was considerable debate on the 48 degree temperature which was specified for the controlled ambient test. (This same question arose from Hua Yi, Chang Ling, Shangling, and Shanglu). The claim is that 48 degrees is to hot for the refrigerators made in China -- their National Standard for testing is 32 to 38 degrees depending on model type. Kuijpers has been requested to review this issue and advise if lower temperatures can be accepted for meeting the "Criteria".

6. The cost to make refrigerator manufacture safe for handling flammable refrigerants is a significant factor in the cost of capital equipment, training of technical staff, training of operators and mechanics and timing project implementation. I do not think that these questions are fully appreciated by anyone at the present time. We should anticipate a rather slow project implementation.

7. As more different refrigerants are added to the "suite" of refrigerants in use in China, the question of refrigerator service will become acute. China will need to develop appropriate standards for identification of what type ("class") of refrigerant is in use and what servicing procedures should be used.

8. Wanbao has indicated project support will be obtained from the USEPA and UL. My information suggests that this support will be limited to testing some of the early Wanbao refrigerator production to receive safety approval for sales in the US. Currently, about 80% of their exports are to the US.

9. Oveall Assessment - The project is well prepared and documented (with the exception of the refrigerant charging machine quote) Prior testing work is barely adequate in the absence of an international technology supplier. The work plan meets the "Criteria" for testing appliances.

10. Recommendation - Ammend documentation of prior testing, quotations etc. prior to project submission to ECMF. OORG to support the project on the basis that it is included in the China CP Action Plan and the data is needed to assist selection of the best refrigerator technology for broad application in China.

TO: WORLD BANK (001-202-477-1273)
ATTN: MS HELEN CHAN

CC: NEPA (01-8328013)
ATTN: 雍永智 (大气处ODS办)

FROM: WANBAO
FAX: 86-20-4413034
DATE: FEB 8,1994

RE: CLARIFICATION OF WANBAO PROJECT

Comments from OORG noted. Below is our clarification.

1. Wanbao Group has about 20 subsidiaries. Its product lines include many kinds of household appliances with the refrigerator capacity of 1,200,000 units. The production line to be converted for using HFC-152a has a capacity of 400,000 units in 2 shifts. (Therefore the production capacity in the project summary should be corrected as 400,000 units. All description and figures in the FS and PS are for the excuting subcompany only except otherwise specified.) Other 2 production lines are in another subsidiary which produces fridges mainly for export. This latter company has discussed with Electrolux for the conversion of 134a technology because its large numbers of fridges are exported to the USA. But this latter project has not decided yet. Besides, there are other 3 factories producing fridges of them 2 has temporarylly stopped operating.

Wanbao group invested a lot of money in other products in recent years that caused reduction of fridge output. Another reason for fridge output reduction is the decrease of domestic market demand. Wanbao group strategically scheduled more fridges for export to compensate domestic maeket demand. But these export fridges are made in another sobcompany. Wanbao's (this project) actual production in 1993 is in 1 shift only for above reasons.

2. Wanbao has conducted a lot of tests with 152a. Some test reports given by independent laboratories are attached to FS. Up to now we are not quite clear on the point of "expert review", on what level that the experts are considered to be qualified, international, national, provincial or other? We need indication about this. We think most fundamental tests has been conducted and we are aware that some more additional tests need be condudcted in the future, which are described in FS and PS.

3. It is ture that redesigning of condensors and evaporators is not certainly necessary. Our tests are based on unmodified condensors/evaporators and nearly satisfied results have been obtained. Yet the performance of HFC-152a is not exactly the same as that of CFC-12. If we modify the condensors/evaporators, more favorable results may possibly be obtained, especially in the aspect of energy saving. We think energy saving is very important

to customers.

4. There will be a marking on the cabinet indicating the refrigerant used in the unit and guideline will be given to the service men. These will be included in training program. Standards for application of 152a will be developed when implementing the project.

5. The export fridges are made by another subcompany of the group which is considering to convert to 134a technology for the reason of USA market. The 152a project is to make fridges mainly for domastic market. The deadline for comments on UL draft proposal is May 5, 1993, thus we think the UL draft proposal has now become effective (not quite sure, will check). However, even more flammable hydrocarbons are considered to be used as refrigerant, we think the less flammable HFC-152a will eventually be sure to be accepted. And we undertake the fridges using 152a will first get approval by UL if we want them to be exported to USA.

6. The safety measures are key points of the project. We think higher costs on safety measures than other projects are reasonable. On the other hand, the technical transfer costs of the project are less than other projects. And the incremental operating cost of the project is less, too.

7. The quotation we have got for charging machines is USD 439,000 for 2 (USD 219,500 for each). We noticed that the price is higher than that of ordinary ones. It was said that this is because of 152a's flammability that the machines suitable for 152a have not been existing and many modifications have to be done. We will, however, inquire other companies to seek less-expensive ones, and are very much interested in if the World Bank Consultants or OORG could help us to find the machines with lower price. At the moment, we assume that they could be found with the price of USD 100,000 for each and USD 200,000 for two.

8. To use 152a as non-ODS refrigerant is mainly developed by our own. We have invested a lot of resources and conducted many tests on this project. We are also aware that there are still a lot of work need to be done. But as an enterprice, we could not afford to do everything on our own. We need support from outside. We need to be clear if MPEC will sopport the projexct developed by our own.

9. Feasibility Study (revised on Jan 28, 1994) on both paper and disk has been submitted to World Bank, which we think has been well received. We think you will know more detailed situation about this project when you read it.

Thanks and Best Regars

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER PROJECT COVER SHEET

COUNTRY	The People's Republic of China	
SECTORS COVERED	Domestic Refrigeration	
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)	
PROJECT TITLE	Enginnering Assistance for Conversion of Refrigerator Manufacture to a Ternary Blend Refrigerant (MP-39) using conventional compressors.	
PROJECT DURATION	2 years	
PROJECT IMPACT	70 MT CFC-12	
PROJECT BUDGET	Incremental Capital Cost-Phase 1	$ 540,000
	Incremental Capital Cost-Phase 2	$ 440,000
	Incremental Operating Costs	$ 0
	Total Project Cost	$ 980,000
PROPOSED OTF GRANT[1]	$1,010,000	
IMPLEMENTING ENTERPRISE	Shanghai Shanglu Electrical Appliances Co. Ltd.	
IMPLEMENTING AGENCY	The World Bank	
NATIONAL COORDINATING AGCY	National Environmental Protection Agency (NEPA)	

PROJECT SUMMARY

This project will lead to replacement of CFC-12 refrigerant in household refrigerators manufactured by Shanglu to a blended refrigerant consisting of HCFC22 and HFC152a. Technology has been developed in cooperation with DuPont China Limited and the Shanghai General Mechanical Institute. In Phase 1 of the project, detailed engineering, product development and lab and field testing of 500 units produced under factory conditions, will be conducted to define firm project scope and costs for full conversion of the factory output to HCFC22/HFC152a/HCFC124 ternary blend refrigerant (MP-39) during Phase 2. The results of Phase 1 will be compared with similar projects using alternative refrigerants before proceeding with Phase 2. Net incremental operating costs for the conversion will be defined during Phase 2 and presented in a separate Phase 3 project at a future date. A separate project will be defined for replacement of CFCs used in refrigerator insulating foam, pending definition of the best available technology.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 15% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVES

The objectives of this project are to establish a phased introduction of technology for use of HCFC22/HFC152aHCFC124 ternary blend refrigerant (MP-39) in domestic refrigerators produced by Shanglu as to develop reliable data for comparison with other alternative refrigerants . The results of this project will be evaluated and considered for adoption by similar refrigerator operations in China.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992

(metric tons)

	CFC-11	CFC-12
Insulating Foam - New Refrigerators	4600	
Refrigerant - New Refrigerators		950
Refrigerant - Service Old Refrigerators		500
Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term. Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

Shanghai Shanglu Electrical Appliances Co. Ltd. is located in Shanghai on the site of the former Shanghai Refrigerator factory and was set up in 1979. A total of 2,238 employees are engaged in production of refrigerators, freezers, and other household appliances. There are 4 refrigerator lines capable of producing 400,000 refrigerators on a two shift basis. Three primary models are produced with export of about 5% of the refrigerators produced..

In 1992, Shanglu produced 7% of the refrigerators sold in China. Actual and forecast production are illustrated in Table 3 for the period 1990-1997

Table 3
Actual and Forecast Refrigerator Production at Shanglu

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Refrigerators Produced (000 Units)	160	185	220	270	320	400	500	500

PROJECT DESCRIPTION.

The project will accomplish phaseout of CFC12 used as refrigerant in domestic refrigerators produced by Shanglu in two phases.

Phase I Engineering, product development and testing under local conditions to establish basic data for full conversion to HCFC22/HFC152/HCFC124a (MP-39) ternary blended refrigerant and for comparison with results of similar programs using alternative refrigerants.

Phase II Full conversion of the Shanglu factory to MP-39 refrigerant

During Phase 1, 500 refrigerators will be produced under factory conditions to prove the viability of manufacturing refrigerators safely and reliable under local conditions. At the conclusion of Phase 1, a feasibility study will be prepared for full conversion of refrigerator manufacturing at Shanglu using MP-39 refrigerant. Based on the feasibility study results, a detailed cost estimate will be prepared and project planning will be revised to accomodate Phase 1 findings before commencing with Phase 2.

Phase 2 will implement the full conversion of Shanglu refrigerator facilities to MP-39 refrigerant

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

While HFC134a has been accepted worldwide as the principal replacement for CFC12 refrigerant in domestic refrigerators, alternative refrigerants have found application in China where indigenous sources of HFC134a refrigerant and polyolester lubricant are not available.

One such alternative under consideration is the use of blended refrigerants which can function effectively in conventional CFC12 style refrigerator compressors. The HCFC22/HFC152a (binary blend) and MP-39 (ternary blend) are a leading condidates because standard CFC-12 compressors can be used without design modifications and because of a slight improvement in energy efficiency when compared to CFC12 at the same conditions in an identical compressor. Shanglu has pioneered the development of MP-39 application in China and is well positioned to implement the project successfully.

PROJECT COST

The total project cost is estimated to be $980,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation,currency fluctuations, and other unforseen costs.
A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An OTF grant request will be made based on Phase 2 results. An order of magnitude estimate of these costs is US$2,000,000 for the first four years of operation, discounted at 10%.

UNIT ABATEMENT COST (UAB)

$13.19 per kg CFC-12

PROPOSED OTF GRANT

The proposed OTF grant request is US$1,010,000 is based on 100% chinese ownershhip of Shanglu and covers the incremental capital costs for Phases 1 and 2 of the project , including a 15% contingency cost and a 3% fee for the financial agent administering the project.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

SHANGHAI SHANGLU ELECTRICAL APPLIANCES
PROJECT COST SUMMARY

	(000US$)
Phase I -	
Technology Transfer Fee	100
Refrigerant Charging Machine	60
Oil Charging Machine	70
Process Control Instruments	79
Data Logging Facility	50
Components for 510 refrigerators (@ US$161/unit)	82
Refrigerator Testing Cost	8
Training & Technology Study in US	21
SUB-TOTAL	470
Phase I I	
4 Refrigerant Charging Machines	240
2 Oil Charging Machines	140
SUB-TOTAL	380
Contingency (15%)	130
TOTAL CAPITAL COSTS	980

Annex B

SHANGHAI SHANGLU ELECTRICAL APPLIANCES
IMPLEMENTATION SCHEDULE[2]

	From	To
Phase 1		
Compressor Tests with MP-39	2Q93	4Q93
Test Manufacture 10 MP-39 Refrigerators (5 Hua Guang;5 Yuan Dong Compressors)	2Q94	2Q94
Controlled Ambient Tests	2Q94	2Q94
Prepare Report for Expert Review	3Q94	3Q94
Test Manufacture 500 MP-39 Refrigerators	4Q94	4Q94
Prepare Feasibility Report for Phase 2	4Q94	4Q94
Phase 2		
Purchase and install equipment for mass production of MP-39 refrigerators	1Q95	2Q95
Startup	2Q95	2Q95
Achieve full phaseout of CFC12 refrigerant	3Q95	4Q95

2 Project schedule assumes ECMP approval of project during 1Q94.

Annex C

TECHNOLOGY TRANSFER AGREEMENT

On 18 January 1994, Shanglu signed an agreement with Du Pont China Limited, for transfer of technology with which to convert Shanglu CFC12 household refrigerator manufacturing facility to use of DuPont MP39 refrigerant (a HFC152a/HCFC22/HCFC124 ternary blend) The memorandum of understanding for this agreement covered three elements:

Application Technology	US$ 63,000
Technical Evaluation of Components	US$ 20,000
Training, Consultation and Expense	US$ 17,000

The materials required for the Phase 1 testing program will be provided free of charge by DuPont.

Conversion of Refrigerator Manufacturing from CFC-12 to MP-39 at Shanghai Shuanglu Electrical Appliances (SSEA)

Project Proposal by The World Bank, January 1994

Scope

This project aims at the conversion from CFC-12 to MP-39 at the Shuanglu refrigerator factory. MP-39 is a ternary blend (ODP 0.03) developed by Du Pont. The application of MP-39 has been investigated by the Shuanglu company itself in cooperation with the Shanghai General Mechanic Institute.

Recommendation

Approval, provided the limited test series on 10 appliances planned at the start of the project will be completed successfully.

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a second stage, after a preliminary review, additional information was given including the full feasibility report and details of the agreement with Du Pont. Al this information together forms sufficient basis for a judgment.
The project proposal itself has serious shortcomings considering relevant information.

Technical soundness

Up to now, the Shuanglu company performed only a limited amount of test work applying the MP39 alternative (on one appliance only) and relies therefore strongly on the Du Pont company. Du Pont has a vast experience in applying this blend which experience is transferred following the technology transfer agreement signed by both parties.
A test series on a limited number of appliances (10) is planned at the start of the project where durability and performance must be demonstrated before starting the pilot production of 500 appliances.
There is no cooperation with the compressor manufacturers. In fact tests are planned with compressors from two different suppliers. Therefore no guarantee of that side can be expected.
As in fact indicated by the Shuanglu company itself, the status of the technology is not so advanced that the pilot production of 500 appliances can be started at once, but a limited test series is planned before.

Lessons from experience

not applicable

Environmental Issues

The MP39 blend still has a low ODP but is an acceptable transitional substance to reduce the CFC-12 consumption.

Safety issues

MP39 is not flammable nor toxic and is classified as a safe refrigerant.

Cost-effectiveness

No incremental operational costs are claimed in this phase yet (the claim is that the blend is cheaper and will remain cheaper than HFC-134a). Therefore no cost-effectiveness can be discussed.
Though MP39 is supposed to be a cheap and easy transition substance still considerable costs originate from the conversion process. For the Shuanglu project this is mainly due to the necessity of new refrigerant charging stations (as for HFC-134a) and to the installation of oil-charging machines for the new alkyl-benzene oil (which the compressor manufacturers cannot charge). *The fact that a new oil is used was not even mentioned in the project proposal.* Other costs claimed are reasonable. Summarizing, the total costs claimed for this project are lower than for comparable HFC-134a projects but not to the order which might be expected.

Other

In the project summary it is stated that after phase 1 (pilot production and field test of 500 appliances) the results will be compared with similar projects before proceeding to phase 2. However, it is doubted whether this procedure is very realistic. Already in phase 1 large investments are made, maybe not specifically in hardware but in technology development, transfer, training etc. Another aspect is the funding itself. The question is: would this company be funded again for conversion to HFC-134a if after phase 1 it appears that the blend alternative is not so successful ? In other words, once the decision is made for funding this alternative, it is a final decision.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 10

Supplemental Comments of 6 China Refrigerant Projects

Overall Assessment

Shanghai Shanglu
DuPont MP39 Blend

1. Test work at Shanglu includes one model BCD-185 refrigerator at Shanglu which has been running since August 1992 on MP39 (so far there have been no problems, however, critical measurements on compressor wear have not been made by Shanglu); first stage efficiency test (MP39 power consumption 5% higher than CFC-12); capacity test (MP39 7% higher than CFC-12); pull down test (MP39 pull down speed slightly faster than CFC12). While test work shows no real problems, additional supporting test work needs to be revealed through the technology supplier to demonstrate the viability of this technology over a suitable range of operating conditions.

2. Shanglu did not provide quotations for major equipment. There is a possibility that they may have these before the January 22 when I leave China. I plan to visit their factory on the 22nd and will expect them to have more quotes at that time.

3. Shanglu have not provided details of their technology agreement but agreed to do so before Jan 22nd. Shanglu was also requested to provide an updated version of their Feasibility Study on the 22nd.

4. The work plan which Shanglu developed is somewhat optimistic but does focus on the "Criteria" for appliance development. There was considerable debate on the 48 degree temperature which was specified for the controlled ambient test. (This same question arose from Wanbao, Chang Ling, Shangling, and Hua Yi). The claim is that 48 degrees is to hot for the refrigerators made in China -- their National Standard for testing is 32 to 38 degrees depending on model type. Kuijpers has been requested to review this issue and advise if lower temperatures can be accepted for meeting the "Criteria".

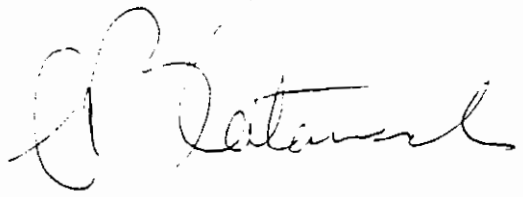
5. The assumption was made that since Shanglu will purchase standard compressors containing standard mineral oil, and that the purpose of Phase 1 is to test manufacturing under local conditions, the Shanglu project must only meet the "Criteria" for Testing of Appliances (but not those Criteria for Compressor Manufacture). This is a key point for the Wanbao, Shangling, Chang Ling projects as well). Compressor testing is to be done by compressor manufacturers (e.g. Shanghai Compressor,Hua Yi) as necessary to meet the compressor "Criteria"

6. A major issue to be resolved for the Shanglu project is the proof of compressor testing with MP39 under refrigerator conditions. Shanglu does not have this experience yet. DuPont, as the primary supplier of technology for this project should be requested to provide documentation of testing work with MP39 which meet the "Criteria" requirements. Since the "Criteria" are primarily designed to prove manufacturing procedures, it would appear that a revision or addendum to the "Criteria" should be developed for consideration not only on the Shanglu project but also for the Wanbao and Chang Ling projects.

7. The issue of refrigerant cost does not appear to be significant. Apparently, the prices for HFC152a, HCFC22, and HCFC124(imported) will all be the same in the future and will be about 2x those for CFC12 today but $1-2 per kg below HFC134a. This means that blends will be competitively priced. As demand increases, local blending facilities will be created to reduce shipping costs.

8. Overall assessment - MP39 technology has the potential to be a low cost and quick way to phaseout CFC12 in refrigerator manufacture because: MP39 can be used in the same compressor as CFC12, energy efficiency is slightly (2-3%) better; MP39 is non-flammable; ICI makes a competitive product; transformation of manufacturing only requires improved blend handling and testing facilities for quality control. MP39 is also a possible retrofit for repair of old refrigerators once CFC12 supplies dry up.The major fault at this time is the limited testing work which has been performed to assure commercial viability.

9. Recommendation - Strengthen technology agreement. Request strong support from DuPont, possibly including financial and technical support of Phase 1. Upgrade documentation of prior testing, quotations etc. prior to project submission to ECMF. OORG to support the project on the basis that it is included in the China CP Action Plan and the data is needed to assist selection of the best refrigerator technology for broad application in China.



TO: GENERAL ASSOCIATION OF LIGHT INDUSTRY

CC: NATIONAL ENVIRONMENT PROTECTION AGENCY

RE: MP39 CONVERSION PROJECT

IN RESPONSE TO THE OORG COMMENTS OF FEB. 2 ON THE PROPOSED PROJECT FOR CONVERSION OF REFRIGERATOR MANUFACTURE FROM CFC12 TO MP39 AT SHANGHAI SHUANGLU ELECTRICAL APPLIANCE (SSEA), FOLLWING WRITEUP ARE TO ADDRESS THE CONCERNS AND ISSUES:

MP39 AS A NEAR DROP-IN REFRIGERANT ALTERNATIVE TO CFC12 IS IDENTIFIED BY ASHRAE STANDARD 34 WITH ASHRAE REFRIGERANT NO. 401A AND SAFETY CLASSIFACTION A1/A1. IT IS ALSO LISTED IN U.S EPA "SNAP" PROGRAM AND HAS BEEN INCREASINGLY APPLIED IN RETROFITTING EXISTING SYSTEMS REFRIGERATED BY CFC12 IN U.S., AUSTRILIA, AND AND OTHER ASIA PACIFIC COUNTRIES.

WE AWARED AS EARLY AS JUNE 1992, DUPONT HAD WORKED WITH BEIJING HOUSEHOLD ELECTRICAL APPLIANCE RESEARCH INSTITUTE (BHEARI), FORMER MINISTRY OF LIGHT INDUSTRY(MLI) DESIGNATED NATIONAL CENTRE FOR HOUSEHOLD REFRIGERATOR TESTING AND QUALIFICATION, INITIATED TEST OF USING MP39 ON THREE CHINA STANDARD REFRIGERATORS (BRAND "ZHONGYI" BCD182) WITH NO OPTIMIZATIONS. THE CONCLUSION INDICATES "MP39 REFRIGERATOR DULY MEETS THE STATE STANDARD GB 8059.2 UNDER THE CRITERIAS FOR COOLING (PULL DOWN) SPEED, ENERGY CONSUMPTION, FREEZER/FRESHER TEMP. NOISE, VIBARATION ETC." (TEST REPORT ARE AVAILABLE).

ON AUG. 1992, WE WORKED WITH SHANGHAI MACHNICAL RESEARCH INSTITUTE UNDER DUPONT SPECIALISTS ON SITE GUIDANCE, RETROFITTED A STANDARD SHUANGLU REFRIGERATOR. THE OPERATION PERFORMANCE IS ALMOST IDENTICAL TO THE TRIAL RUN AT BHEARI. THE TEST WAS AGAIN RUN WITHOUT ANY OPTIMIZATION BUT WITH COMPARABLE PERFORMANCE TO THE ORIGINAL CFC12 SYSTEM.

VIEWING THE APPLICATION TECHNOLOGY PROCEDURES/PROCESS OF MP39 AS ALTERNATIVE ON EXISTING CFC12 CONSUMING REFRIGERATORS DEVELOPED BY DUPONT AND DOMESTRATED ON OUR PREDOMINENT NATIONAL STANDARD REFRIGERATORS, WE PURSUED FURTHER TO COOPERATE WITH DUPONT AND HAVE BEEN ASSURED BY DUPONT WITH TECHNICAL ASSISTANCE AND SUPPORT COMMITTED TO FACILITATE OUR CONVERSION THROUGHOUT THE PROJECT IMPLEMENTATION PERIOD. THEREFORE, MP39 APPLICATION TECHNOLOGY INCLUDING RETROFITTING EXSITING SYS., MODIFICATION AND OPTIMIZATION, RECOVERY AND SERVICE TECHNOLOGY ARE NECESSARY.

USING MP39 AMONG OTHER THINGS LIKE SAFETY, COMPATIBILITY, STABLITY, IS ITS EXCEPTIONAL ADVANTEGY THAT COMPRESSOR CAPACITY RELIABILITY AND DURIBILITY ARE MAINTAINED. THIS IS BECAUSE ESSENTIAL THERMAL PHASICAL PROPERTY AND PRESSURE OF MP39 IS ALMOST PRECISE TO CFC12 AND THE TYPICAL TEST CONDUCTED PASSED 500 HOURS DURABILITY TEST IN SMALL HERMETIC COMPRESSORS AS WELL AS HIGH PRESSURE COMPRESSORS IN U.S. DEMOSTRATED ALSO BY OUR RETROFITTED REFRIGERATOR THAT HAS BEEN RUNNING NORMALLY UP TO DATE SINCE AUG. 1992. WORLDWIDE, IT IS PRACTICALLY PROVED BY MANY SYSTEMS NOW REFRIGERATED USING MP39, INCLUDING DUPONT, COPLAND, TRANE, COCA COLA, MCDONALD

THE MONTREAL PROTOCOL ON
SUBSTANCES THAT DEPLETE THE OZONE LAYER
PROJECT COVER SHEET

COUNTRY	The People's Republic of China	
SECTORS COVERED	Domestic Refrigeration	
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)	
PROJECT TITLE	Engineering Assistance for Conversion of Refrigerator Manufacture to HFC134a Refrigerant with Tecumseh designed HFC134a compressors.	
PROJECT DURATION	2 years	
PROJECT IMPACT	60 MT CFC-12	
PROJECT BUDGET	Incremental Capital Cost - Phase 1	$ 575,000
	Incremental Capital Cost - Phase 2	$ 825,000
	Incremental Operating Cost	$ 0
	Total Project Cost	$1,400,000
PROPOSED OTF GRANT[1]	$1,442,000	
IMPLEMENTING ENTERPRISE	Hua Yi Electrical Appliance General Company	
IMPLEMENTING AGENCY	The World Bank	
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)	

PROJECT SUMMARY

This project will convert the existing CFC12 refrigerator line to HFC134a refrigerant using new reciprocating compressors manufactured by Hua Yi in a new facility. Retroactive financing of Phase 1 of the project (detailed engineering, product development and lab and field testing of 500 units produced under factory conditions) is being requested. A firm project scope and detailed costs for full conversion of the factory output to HFC134a refrigerant was made at the conclusion of Phase 1. Net incremental operating costs for the conversion will be defined during Phase 2 and presented in a separate Phase 3 project at a future date. A separate project will be defined for replacement of CFCs used in refrigerator insulating foam, pending definition of the best available technology.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

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[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 15% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVES

The objectives of this project are to establish a phased introduction of technology for use of HFC134a in domestic refrigerators equipped with new reciprocating compressors and produced by Hua Yi. The project will develop reliable data for comparison with other refrigerant projects . The results of this project will be evaluated and considered for adoption by similar refrigerator operations throughout China.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992

(metric tons)

	CFC-11	CFC-12
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Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term. Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

Hua Yi Electrical Appliance General Co. is located in Jingdezhen and produces household electric appliances, air conditioners and freezers. A total of 510 employees are engaged in refrigerator production on one production line imported from Merloni (Italy) in 1985. The line is capable of producing 300,000 refrigerators annually based on 2 shift operation. Sixteen models are produced with export of about 10% of the refrigerators produced..

In 1992, Hua Yi produced 6% of the refrigerators sold in China. Actual and forecast production are illustrated in Table 3 for the period 1990-1997

Table 3
Actual and Forecast Refrigerator Production at Hua Yi

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Refrigerators Produced (000 Units)	120	150	200	200	200	200	250	300

PROJECT DESCRIPTION.

The project will accomplish phaseout of CFC12 used as refrigerant in domestic refrigerators produced by Hua Yi in two phases.

Phase I Engineering, product development and testing under local conditions to establish basic data for full conversion to HFC134a refrigerant has been completed. A feasibility study for full conversion of Hua Yi refrigerator manufacturing to HFC134a has also been completed.

Phase II Full conversion of the Hua Yi factory to HFC134a refrigerant

During Phase 1, 4000 refrigerators have been produced under factory conditions to prove the viability of manufacturing refrigerators safely and reliable under local conditions. Five models were fully tested by Kirby(Austrailia) and permission to proceed with full scale production was granted. At the conclusion of Phase 1, a feasibility study was prepared for the full conversion of Hua Yi refrigerator manufacturing and is being used to guide project completion.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY:

HFC134a has been accepted worldwide as the principal replacement for CFC12 refrigerant in domestic refrigerators. Its thermodynamic properties are similar to CFC12, it is non-flammable, non-toxic, and has a zero ODP. Hua Yi has completed startup of a compressor manufacturing line to produce HFC-134a compressors based on Tecumseh designs. These compressors are to used to make new HFC134a model refrigerators, with the assistance of Kirby (Australia). Hua Yi experience with startup and operations during 1994 will provide valuable data for continued development of this technology and for comparison with other technolgies as defined in the China Country Program.

PROJECT COST

The total project cost is estimated to be $1,400,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation,currency fluctuations, and other unforseen costs. A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An OTF grant request will be made based on Phase 2 results. An order of magnitude estimate of these costs is US$6,300,000 for the first four years of operation, discounted at 10%.

UNIT ABATEMENT COST (UAB)

$41.33 per kg CFC-12

PROPOSED OTF GRANT

The proposed OTF grant request is US$1,442,000 is based on 100% Chinese (state) ownershhip of Hua Yi and covers the incremental capital costs for Phases 1 and 2 of the project , including a 15% contingency cost and a 3% fee for the financial agent administering the project.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

HUA YI
PROJECT COST SUMMARY

	(000US$)
Phase I -	
Technology Transfer Fee	300
Testing of Refrigerators by Kirby	10
Training of Engineers	66
Preparation of Feasibility Study	30
Test Manufacture of 510 Refrigerators (@ US$185 per unit)	94
SUB-TOTAL	500
Phase I I	
3 Refrigerant Charging Machines	195
4 Halogen Leak Detectors	28
30 Vacuum pumps	72
2 Vacuum Dehydrators	200
1 Helium Leak Detector	90
Controlled Ambient Test Room	100
Operator and Mechanic Training	35
SUB-TOTAL	720
Contingency (15%)	180
TOTAL CAPITAL COSTS	1,400

Annex B

HUA YI
IMPLEMENTATION SCHEDULE[2]

	From	To
Phase 1 (complete)		
Test Manufacture 4000 refrigerators	3Q93	1Q94
Prepare Feasibility Report for Phase 2	3Q93	4Q93
Phase 2		
Purchase and install equipment for mass production of HFC134a refrigerators	1Q94	3Q94
Startup	3Q94	4Q94
Achieve full phaseout of CFC12 refrigerant	4Q94	4Q94

[2] Project schedule assumes ECMP approval of project during 1Q94.

Annex C

TECHNOLOGY TRANSFER AGREEMENT

On 15 June 1992, Hua Yi Electric Appliance General Co signed an agreement with James N. Kirby Pvt. Ltd. for transfer of technology with which to develop a HFC134a refrigerator.

the memorandum of understanding for this agreement covered three elements:

Technical assistance for developing HFC134a refrigerators	US$300,000
Testing of HFC134a compressors withHua Yi cabinets	US$ 10,000
Training of Hua Yi Technical Personnel	US$ 66,000

Conversion of Refrigerator Manufacturing from CFC-12 to HFC-134a at Hua Yi Refrigerator Company

Project Proposal by The World Bank, January 1994

⑤

Scope

The scope of this project is to convert the Hua Yi refrigerator factory from CFC-12 to HFC-134a. The selected technology is a proven technology and a partner in the developed world (Kirby, Australia) assists in the conversion process. This project is in an advanced state as Hua Yi already produced 4000 appliances with HFC-134a. Part of the funding requested can be considered retroactive financing.

Recommendation

Approval, see remarks below.

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a second stage, after a preliminary review, supplementary information was given by Hua Yi. Altogether sufficient information for a judgment is present.
The project proposal itself does not contain all relevant information.

Technical soundness

This project has a sound technical basis. The Hua Yi company has already performed a pilot production using HFC-134a with successful results. The compressors applied are produced by the Hua Yi company itself which started HFC-134a compressor production in May '93. Compressor manufacturing technology was obtained from Kirby, Australia. The status of the compressor production is such that a reliable supply for the refrigerator project can be assumed.

Lessons from experience

not applicable

Environmental and safety issues

HFC-134a is an acceptable way to reduce CFC-12 consumption.

Cost-effectiveness

No incremental operational costs are claimed in this phase yet. Therefore no cost-effectiveness can be discussed.
The costs claimed are high but reasonable and in line with similar projects.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 09

Supplemental Comments of 6 China Refrigerant Projects

Overall Assessment

Hua Yi
HFC134a Refrigerators - Kirby Technology

1. The work plan does focus on the "Criteria" for appliance development. There was considerable debate on the 48 degree temperature which was specified for the controlled ambient test. (This same question arose from Wanbao, Chang Ling, Shangling, and Shanglu). The claim is that 48 degrees is to hot for the refrigerators made in China -- their National Standard for testing is 32 to 38 degrees depending on model type. Kuijpers has been requested to review this issue and advise if lower temperatures can be accepted for meeting the "Criteria".

2. Hua Yi has produced over 4000 refrigerators to date in proving the manufacturing technology obtained through Kirby. Testing work on these units has led Kirby to grant approval to proceed with full scale production. Consequently, Phase I is complete and the funding request is for RETROACTIVE financing of the cost of the work that otherwise would have been funded through the OTF.

3. The project feasibility study is complete and thorough and will be in hand by Jan 22.

4. Hua Yi was requested to prepare a separate project proposal to cover their HFC134a compressor plant incremental costs. Hence, costs and discussions relative to the compressor plant are not included in this project summary.

5. Overall Assessment - The project is well prepared and has no significant flaws.

6 Recommendation - GEORG to support the project on the basis that the work included in the project is more than 50% complete and is well supported by international technology suppliers (Kirby-Tecunseh) and the project it is included in the China CP Action Plan. Data from the Hua Yi is needed to assist selection of the best refrigerator technology for broad application in China.

DATE, FEB.7,1

SUPPLEMENT STATEMENT TO THE FEASIBILITY STUDY ON CONVERSION OF REFRIGERATOR MANUFACTURE FROM CFC-12 TO HFC-134A AT HUA YI REFRIGERATOR FACTORY

According to the comments made by Mr.Janssen,M.J.P.(OORG) Feb.2,1994, we prepared the supplement statement as follows:

1. In October,1991, Hua Yi Electrical Appliance General Compa signed with James N. Kirby Pty. Ltd. a contract that introdu manufacture technology and production line of new reciprocati compressor applying HFC-134a from Tecumseh Product Company (t U. S.A.). The installation and testing of imported equipment beg in May of 1993, and in the September first batch of new compress were assembled with imported pump kits. By the end of last year, a the erection and testing of production lines have been completed ar 5000 finished products came out of the lines. Now the new plant ha been put into production. The plnning capacity in 1994 shall b 400, 000, half of which are used to match the refrigerator produce at Hua Yi and the remaining half will be exported to internationa market such as Netherland and Turkey and so on. Reliability test fc HFC-134a compressor had been done by Kirby, please see details i Annex 1.

2. The capacity of Hua Yi's project is 300,000 instead of 200,000. A ambient controlled test room and vacuum dehydrator are necessary t be set up and purchased in order to guarantee the product quality, because moisture absorption of HFC-134a is very high and it shoul be much more strictly to HFC-134a than to CFC-12 in respect o residue moisture and and contamination.

3. Unit price of USD185 claimed for 510 refrigerators is the E Factory Price. Actually, the production cost of one refirgerator (the cost of raw material and components) is USD172. Though i looks higher than traditional product, some of the main parts shoul be replaced and cost much more than before, for example HFC-134a, new compressor and special dryer and etc...By the end of last year, 4000 HFC-134a refrigerators have been produced by Hua Yi and bee put into demostic market for trial sales. Hua Yi put forward request of OTF grant for only 510 refrigerators which amounts to b USD94, 000, after Mr.Charles Catanach kindly advised that it is no suitable to exceed the figure of 510 in Hua Yi's proposal fo refrigerator test manufacture. If possible, Hua Yi sincerely hop MPEC could consider the test manufacture fee as per actual figure o 4000.

4000.

4. The quotation of USD90,000 for helium leak detector includes th cost of recovery system. Helium leak detector model no.ECOTE500 i made by Leybold Ltd.(Germany), it costs about USD35, 000/set. Please see details in Annex 2.

Should you have any question need our explaination durin the project review and appraisal, please do not hesitate to advis us as soon as possible.

Hua Yi Electrical Appliance General Company

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER PROJECT COVER SHEET

COUNTRY	The People's Republic of China	
SECTORS COVERED	Domestic Refrigeration	
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)	
PROJECT TITLE	Engineering Assistance for Conversion of Refrigerator Manufacture to HFC-134a refrigerant with Rotary Compressors.	
PROJECT DURATION	2 years	
PROJECT IMPACT	108MT CFC-12	
PROJECT BUDGET	Incremental Capital Cost - Phase 1	$ 920,000
	Incremental Capital Cost - Phase 2	$ 600,000
	Incremental Operating Costs	0
	Total Project Cost	$ 1,520,000
PROPOSED OTF GRANT[1]	$1,570,000	
IMPLEMENTING ENTERPRISE	Shanghai Shangling General Refrigerator Factory (SSGRF)	
IMPLEMENTING AGENCY	The World Bank	
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)	

PROJECT SUMMARY

This project will lead to replacement of CFC-12 refrigerant in household refrigerators manufactured by Shanghai Shangling General Refrigerator Factory with HFC-134a . In Phase 1 of the project, detailed engineering, product development and lab and field testing of 500 units produced under factory conditions, will be conducted to define firm project scope and costs for full conversion of the factory output to HFC134a refrigerant during Phase 2. The results of Phase 1 will be compared with similar projects using alternative refrigerants before proceeding with Phase 2. Net incremental operating costs for the conversion will be defined during Phase 2 and presented in a separate Phase 3 project at a future date. A separate project will be defined for replacement of CFCs used in refrigerator insulating foam, pending definition of the best available technology.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 15% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVE

The objective of this project are to establish a phased introduction of proven and useful technology for HFC-134a refrigerant in rotary compressors in China. The results of this project will be evaluated and considered for adoption by similar refrigerator operations in China.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992

(metric tons)

	CFC-11	CFC-12
Insulating Foam - New Refrigerators	4600	
Refrigerant - New Refrigerators		950
Refrigerant - Service Old Refrigerators		500
Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term.

Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

SSGRF produces refrigerators, air conditioners, microwave ovens and other domestic appliances. The factory is located in the Pudong special development area of Shanghai and covers 17,000 sq. meters. The location entitles the company to import foreign made components duty free.

A total of 2600 employees are engaged in refrigerator production on one production line imported from Mitsubishi (Japan). The line is capable of producing 500,000 refrigerators annually based on 2 shift operation. Eight models are produced with about 1% exported.

In 1992, Shangling produced 11% of the refrigerators sold in China. Actual and forecast production are illustrated in Table 3 for the period 1990-1997

Table 3
Actual and Forecast Refrigerator Production at SSGRF

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Refrigerators Produced (000 Units)	280	320	360	480	520	600	600	600

SSGRF first produced refrigerators designed by Mitsubishi in 1986 and subsequently developed its own designs based on use of Mitsubishi designed rotary compressors produced by the Shanghai Refrigerator Compressor Company(SRCC). Since 1991, SSGRF has been engaged on a collaborative venture with SRCC to produce a prototype HFC134a refrigerator equipped with a rotary compressor. This work has been supported by the Power Machinery Engineering Department of Xi'an Jiaotong University, Shanghai Research Institute of General Machinery and Shanghai Organic Chemical Research Institute.

Work completed to date includes the following:

- O Performance and material compatibility testing with HFC134a in SRCC rotary compressors.
- O Identification and testing of suitable lubricants
- O Lab testing of SSGRF refrigerators equipped with the SRCC rotary compressors.

In March 1993, Mitsubishi signed an agreement with SSGRF to support the full development of refrigerator circuit designs for 4 refrigerator models (2 CFC and 2 non-CFC models). This agreement includes provision of drawings and manufacturing procedures, a parts schedule, assistance with achieving quality control, and testing of SSGRF's test manufactured refrigerator units The agreement includes technology transfer for both CFC and non-CFC refrigerators (Annex C).

PROJECT DESCRIPTION.

The project will accomplish phaseout of CFC12 used as refrigerant in domestic refrigerators produced by SSGRF in two phases.

Phase I Engineering, product development and testing under local conditions to establish basic data for full conversion to HFC-134a and for comparison with results of similar programs using alternative refrigerants.

Phase II Full conversion of the SSGRF facilities to HFC-134a refrigerant

During Phase 1, over 500 refrigerators will be produced under factory conditions to prove the viability of refrigerant circuit designs provided by Mitsubishi. Testing facilities to be installed at SSGRF will include a controlled ambient test room and a data acquisition system for monitoring refrigerator performance under test conditions. Consultations will be arranged with local and foreign experts to instruct SSGRF engineers and technicians in the design, testing and manufacturing procedures for non-CFC refrigerants. At the conclusion of Phase 1, a feasibility study will be prepared for full conversion of refrigerator manufacturing at SSGRF to the use of HFC-134a refrigerant with a rotary style compressor. Based on the feasibility study results, a detailed cost estimate will be prepared and project planning will be revised to accomodate Phase 1 findings before commencing with Phase 2.

Phase 2 will implement the full conversion of SSGRF refrigerator facilities to HFC134a refrigerant over a period of 4 years.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

HFC134a has been accepted worldwide as the principal replacement for CFC12 refrigerant in domestic refrigerators. Its thermodynamic properties are similar to CFC12, it is non-flammable, non-toxic, and has a zero ODP. SSGRF's program to develop the use of HFC134a in refrigerators of its design, with the assistance of Mitsubishi, has made it the leading candidate for continued development of this technology for comparison with other technolgies as defined in the China Country Program.

PROJECT COST

The total project cost is estimated to be $1,520,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation, and other unforseen costs.
A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An OTF grant request will be made based on Phase 2 results. An order of magnitude estimate of these costs is US$3.300,000 for the first four years of operation, discounted at 10%.

UNIT ABATEMENT COST (UAB)

$13.48 per kg CFC-12

PROPOSED OTF GRANT

The proposed OTF grant request is US$1,570,000 is based on 100% chinese ownershhip of SSGRF and covers the incremental capital costs for Phases 1 and 2 of the project , including a 15% contingency cost and a 3% fee for the financial agent administering the project.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

SHANGHAI GENERAL REFRIGERATOR FACTORY
PROJECT COST SUMMARY

	(000US$)
Phase I -	
Controlled Ambient Test Room	70
Data Acquisition System	57
Technology Transfer Agreement	430
Test manufacture 500 Refrigerators (@US$ 160 per unit)	80
Testing of Trial Manufactured Units	33
Consulations and Training	100
Feasibility Study Preparation	30
SUB-TOTAL	800
Phase I I	
Refrigerant Charging Machine	50
Leak Detectors & Instruments	60
80 Vacuum Pumps for In-Line Testing	110
Calorimeter for Quality Control	200
Sprecial Service Unit for HFC134a Refrigerators	100
SUB-TOTAL	520
Contingency (15%)	200
OTAL INCREMENTAL CAPITAL COST	1,520

Annex B

IMPLEMENTATION SCHEDULE[2]

	From	To
Phase 1		
Install Test Room and Data System	3Q94	4Q95
Train Technicians and Engineers	1Q94	2Q94
Test Manufacture 500 Refrigerators	3Q94	3Q94
Conduct Lab Tests	4Q94	3Q95
Conduct Field Tests	1Q95	3Q95
Prepare Feasibility Study	2Q95	2Q95
Phase 2		
Convert Manufacturing to HFC-134a	4Q95	4Q97

[2] Project schedule assumes ECMP approval of project during 1Q94.

Annex C

TECHNOLOGY TRANSFER AGREEMENT

On March 18, 1993, Mitsubishi Electric Corporation and Shanghai Shangling General Refrigerator Factory (SSGRF) concluded a technical collaboration agreement for manufacture of refrigerators by SSGRF in China. Under the terms of this agreement, Mitsubishi will provide SSGRF with technical support for manufacturing 2 CFC models as well as designs, drawings and specifications for manufacture of 2 non-CFC refrigerator models in SSGRF facilities. Testing of non-CFC refrigerators by Mitsubishi is also included.

The agreement will be valid for 7 years and requires a payment of 640,000,000 japanese yen on the following payment schedule.

1993 - 40,000,000
1994 - 70,000,000
1995 - 90,000,000
1996 - 110,000,000
1997 - 110,000,000
1998 - 110,000,000
1999 - 110,000,000

As the agreement covers technical support for CFC and non-CFC foams and refrigerants, the portion applicable to various activities was estimated as follows:

85% to support existing CFC refrigerator manufacture.
7.5% to support technology transfer for non-CFC refrigerants.
7.5% to support technology transfer for non-CFC refrigerator foam.

The portion of the technology transfer agreement attributable to refrigerant circuit design for HFC-134a refrigerant in this project is therefore 48,000,000 yen (US$430,000)

Conversion of Refrigerator Manufacturing from CFC-12 to HFC-134a at Shanghai Shangling General Refrigerator Factory (SSGRF)

Project Proposal by The World Bank, January 1994

③

Scope

The scope of this project is to replace CFC-12 by HFC-134a in the Shanghai Shangling refrigerator factory. This is a proven technology and back up is provided from a developed country manufacturer (Mitsubishi Japan).

Recommendation

Approval

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a second stage, after a preliminary review, a satisfactory response was given to outstanding issues by the Shangling company. Altogether sufficient information for a judgment is present.
The project proposal itself does not contain all relevant information.

Technical soundness

This project has a sound technical basis. The technology transfer from Mitsubishi, Japan is essential. Rotary compressors will be obtained from the Shanghai Refrigerator Compressor Company who request for funding itself and is also supported by Mitsubushi, Japan. It can be expected that the technology transfer will be adequate and that the project can be completed successfully.

Lessons from experience

not applicable

Environmental and safety issues

HFC-134a is an acceptable way to reduce CFC-12 consumption.

Cost-effectiveness

No incremental operational costs are claimed in this phase. Therefore no cost-effectiveness can be discussed.
The costs being claimed are reasonable and in line with similar projects.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 09

Supplemental Comments of 6 China Refrigerant Projects
Overall Assessment

Shangling
HFC134a Refrigerators using Mitsubishi Rotary Compressors

1. The Shangling project will rely heavily on Mitsubishi for technology. As can be seen in the project summary discussion on Technology Transfer, the agreement cost Shangling about $6,000,000 and includes full designs for 2 non-CFC model refrigrators based on their rotary compressors. There os a separate technology agreement for compressors between Shanghai Compressor Factory and Mitsubishi. We debated how much of the technology transfer agreement cost shoud be allocated to this project and concluded 7.5% on the basis that $430,000 would be in line with similar agreements elsewhere. Transfer of technology from Mitsubishi has started.

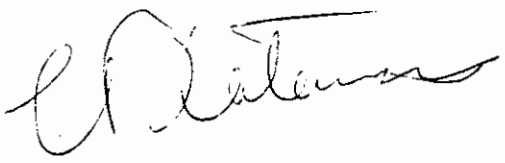
2. The basic question posed to Shangling was, "is Mitsubishi producing similar refrigerators in Japan today?" "Is the technology commercially proven?" Shangling will consult with Mitsubishi and prepare a formal response for inclusion in the feasibility study.

3. Two cost items in Phase 2 were extensively discussed - a calorimeter and a service unit. The calorimeter is claimed to be necessary to assure quality control of incoming compressors from Shanghai Refrigerator Factory. I questioned if this was really necessary. We also felt that the original quote of $375,000 was too high and $200,000 was agreed to for the project.
Shangling have a policy of servicing all of the refrigerators they produce. They state the $100,000 service facility in Phase 2 is to provide the necessary capital equipment to permit servicing of the HFC134a refrigerators that they will produce as well as the CFC12 units still in service.

4. The work plan does focus on the "Criteria" for appliance development. There was considerable debate on the 48 degree temperature which was specified for the controlled ambient test. (This same question arose from Hua Yi, Wanbao, Chang ling, and Shanglu). The claim is that 48 degrees is to hot for the refrigerators made in China -- their National Standard for testing is 32 to 38 degrees depending on model type. Kuijpers has been requested to review this issue and advise if lower temperatures can be accepted for meeting the "Criteria".

5. Overall Assessment - the project feasibility study is adequate. The support of Mitsubishi is essential for project success. Clarification of the state of HFC134a rotary compressor development in Japan is needed to resolve outstanding questions on commerciality of the technology.

6. Recommendation - OORG to support the project on the basis that it is included in the China CP Action Plan and the data is needed to assist selection of the best refrigerator technology for broad application in China. As HFC134a technology is currently the world standard CFC12 replacement, China must fully understand the impact of this technology on their industry to remain competitive in the world markets, particularly if they choose to adopt a different technology.



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To: Helen Chan 海伦·陈
World Bank 世界银行
Washington, U.S.A 美国华盛顿
Fax: 001-202-477-1273

From: Chen Lingxiang 陈令祥
Shanghai Shangling General Refrigerator Factory
Shanghai, China 中国上海上菱电冰箱总厂
Fax: 901-8621-885-7367
Tel: 901-8621-885-7888

Further Explanation For Some Quotation under the Project of Conversion of Refrigerator Manufacturing from CFC-12 to HFC-134a at Shanghai Shangling General Refrigerator Factory (SSGRF)

1. In China, it has become a custom that a quality test of some or all of the products should be carried out before they used upon new products, although those tests have been made by the manufactures before the products get to the market.

The calorimeter for compressor owned by Shanghai Refrigerator Compressor Co., Ltd.. is used to its limit, so it is impossible for the equipment to be used by SSGRF anymore.

Furthermore, the calorimeter for compressor using CFC-12 can not be used for compressor with HFC-134a. In this case, a new calorimeter for compressor must be bought to ensure the quality of the HFC-134a refrigerator.

2. It is indicated in the provisions of the technical contract signed between Shangling and Mitsubishi that

(1) The cost of sending Japanese technicians to China, including the cost of technical guide and traffic, should be paid by Shangling.

a. Payment to every Japanese technician for everyday is 50,000 yen.

b. Traffic fee for every technician every tour is 170,000 yen.

It takes a Japanese technician US$ 500 a day and US$ 60,000 altogether for three persons in 40 days.

(2) Payment for the cost of sending Chinese technicians abroad to receive technical training. It is estimated of as much as US$ 40,000 for three persons in 44 days abroad, if every one takes US$ 300 per days.

All this money is exclusive of the total technical contract cost of 640 million yen. Shangling must pay this US$ 100,000 (US$ 60,000 + US$ 40,000) extra expenses.

3. In our project feasibility study, we have explained that service becomes more and more important for the refrigerator manufactory in China. The existing service system can only service CFC-12 refrigerators but not HFC-134a ones. On the other hand, becauses the existing service system isn't adapted HFC-134a, it can't service CFC-12 refrigerators and HFC-134a ones alternately. Thus, in order to ensure the service of both Shangling CFC-12 refrigerators and HFC-134a ones, we wish this investment can be supported by OORG.

4. In SSGRF, there are two test production phases before a new model put into operation. One is model test phase, it uses to check whether the performance of the new refrigerator achieves the goal of design. The other is test production, it uses to check whether the equipment and technological process are adapted to production. When test production, the equipment and instruments invested must be adjust and tested. So the producing line can't run normally and Shangling will exert a tremendous influence on the profit. On the base of two days calculating, Shangling will suffer heavy losses of 700,000 yuan (US$80,000). That means US$ 160 per refrigerator.

In fact, this expense is cost of test production.

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER PROJECT COVER SHEET

COUNTRY	The People's Republic of China	
SECTORS COVERED	Domestic Refrigeration	
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)	
PROJECT TITLE	Application development for conversion of compressor manufacturing to HFC-134a rotary compressor designs.	
PROJECT DURATION	2 years	
PROJECT IMPACT	Indirect - 100 MT CFC-12	
PROJECT BUDGET	Incremental Capital Cost - Phase 1	$ 1,130,000
	Incremental Capital Cost - Phase 2	$ 230,000
	Incremental Operating Cost	$ 0
	Total Project Cost	$ 1,360,000
PROPOSED OTF GRANT[1]	$1,400,000	
IMPLEMENTING ENTERPRISE	Shanghai Refrigerator Compressor Co. Ltd.	
IMPLEMENTING AGENCY	The World Bank	
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)	

PROJECT SUMMARY

This project will result in the annual production of up to 500,000 high efficiency rotary HFC134a compressors to supply the needs of the Shanghai Shangling General Refrigeration Factory and others as they introduce HFC134a refrigerant into their line of refrigerators. Technology will be obtained from Mitsubishi (Japan) under the terms of an existing technology transfer agreement. In Phase 1 of the project, detailed engineering, product development and lab and field testing of 1000 units produced under factory conditions, will be conducted to define firm project scope and costs for full conversion of the factory output to HFC134a refrigerant during Phase 2. The results of Phase 1 will be compared with similar projects using alternative refrigerants before proceeding with Phase 2. Net incremental operating costs for the conversion will be defined during Phase 2 and presented in a separate Phase 3 project at a future date. A separate project will be defined for replacement of CFCs used in refrigerator insulating foam, pending definition of the best available technology.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

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[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 15% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVES

The objective of this project is to provide an indigenous source of Mitsubishi HFC134a rotary compressors for use with new model refrigerators based on HFC134a refrigerant at Shanghai Shangling General Refrigerator Factory.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992

(metric tons)

	CFC-11	CFC-12
Insulating Foam - New Refrigerators	4600	
Refrigerant - New Refrigerators		950
Refrigerant - Service Old Refrigerators		500
Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term. Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

The Shanghai Refrigerator Compressor Co. Ltd (SRC) factory is located in Shanghai and supplies a variety of refrigerator compressors to Shanghai Shangling Refrigerator Co. Ltd., China Industry Co. Ltd., Shanghai Shanglu Electrical Appliances Co. Ltd., and Beijing Xue Hua Electrical Appliances Group. In 1993, 550,000 compressors were produced (Table 3), about 10% of China's total requirement.

SRC has 2600 employees including 260 professional engineers. In addition to refrigerator compressors, SRC also makes air conditioning compressors and other refrigerating equipment.

Table 3
Actual and Forecast Refrigerator Compressor Production at Shanghai Refrigerator Compressor Co.

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Compressors Produced (000 Units)	350	420	470	550	800	850	950	1100

PROJECT DESCRIPTION.

The project will convert manufacturing of domestic refrigerator compressor manufacture from CFC12 designs to an newly developed rotary compressor suited to HFC134a refrigerant at Shanghai Refrigerator Compressor Co.
The project will be conducted in 2 Phases.

Phase I Engineering, product development and testing under local conditions to integrate new Mitsubishi technology and to establish basic data for full conversion of the factory to make the new rotary compressors.

Phase II Full conversion of the SRC factory to Mitsubishi HFC134a rotary compressor designs.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY:

HFC134a has been accepted worldwide as the principal replacement for CFC12 refrigerant in domestic refrigerators. Its thermodynamic properties are similar to CFC12, it is non-flammable, non-toxic, and has a zero ODP. SRC's program to convert their manufacturing facility to HFC134a designs, with the assistance of Mitsubishi, has made it the leading candidate for continued development of this technology.

PROJECT COST

The total project cost is estimated to be $1,360,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation,currency fluctuations, and other unforseen costs.
A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An order of magnitude estimate of these costs is US$2,000,000 for the first four years of operation, discounted at 10%. If these costs are passed on to the users of SRC compressors, the net incremental operating costs for OTF fund will be negligible.

UNIT ABATEMENT COST (UAB)

Not applicable to compressors manufacture as CFC phaseout is determined to be as a result of appliance manufacture.

PROPOSED OTF GRANT

The proposed OTF grant request is US$1,400,000 is based on 100% Chinese ownershhip of Shanghai Refrigerator Compressor Co. Ltd. and covers the incremental capital costs for Phases I and 2 of the project ,

including a 15% contingency cost and a 3% fee for the financial agent administering the project.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

SHANGHAI REFRIGERATOR COMPRESSOR PROJECT COST SUMMARY

CAPITAL COSTS	US$
Phase I -	
Technology Transfer Fee	475
Calorimeter	200
Noise and Vibration Sensors & Instruments	50
Data Logger	180
Components for 1000 Compressors (@ US$35 per compressor)	35
Training of Technicians in Japan	20
Foreign Consultations	20
SUB-TOTAL	980
Phase I I	
Oil Charging System	150
Operator Training at SRC	30
Installation and Commissioning	20
SUB-TOTAL	200
Contingency (15%)	180
TOTAL CAPITAL COSTS	1,360

Annex B

SHANGHAI REFRIGERATOR COMPRESSOR IMPLEMENTATION SCHEDULE[2]

	From	To
Phase 1		
Purchase Equipment for Test Manufacture	1Q94	3Q94
Modify Production Line for Test Manufacture	1Q94	2Q94
Train Technical Personnel	1Q94	2Q94
Make 1000 New Rotary Compressors	2Q94	2Q94
Test Compressors	3Q94	3Q94
Prepare Phase 2 Feasibility Study	3Q94	3Q94
Phase 2		
Purchase and Install New Equipment	3Q94	4Q94
Train Operators and Mechanics	3Q94	3Q94
Startup	4Q94	4Q94
Acheive Full Production Rate	1Q95	1Q98

[2] Project schedule assumes ECMP approval of project during 1Q94.

Annex C

TECHNOLOGY TRANSFER AGREEMENT

On November 23, 1993, Shanghai Refrgerator Compressor Company and Mitsubishi Electric signed an agreement for transfer of technology for manufacture of rotary compressors suitable for use of HFC134a.

The terms and conditions of this agreement include the following:

10 year term
4 compressor models
Annual update of latest Mitsubishi improvements on the 4 models
Designs modified to meet Chinese Standards
Technical assistance provided by Mitsubishi on request

The technology fee is 53,000,000, denominated in Japanese Yen (equiv. US$475,000)

Designs	20,000,000
Process Technology	25,000,000
Testing Technology	8,000,000

Conversion of Compressor Manufacturing from CFC-12 to HFC-134a at Shanghai Refrigerator Compressor Factory

Project Proposal by The World Bank, January 1994

①

Scope

The scope of this project is to convert the production of rotary compressors from CFC-12 to HFC-134a. Assistance is provided from a developed country manufacturer (Mitsubishi, Japan).

Recommendation

Approval

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a first instance some questions were asked which were satisfactorily answered, so altogether sufficient information for a judgment is present.
The project proposal itself does not contain all relevant information.

Technical soundness

This project has a sound technical basis. The technology transfer from Mitsubishi, Japan is essential. An adequate technology transfer can be expected also due to successful cooperation between the two companies in previous projects.

Lessons from experience

not applicable

Environmental and safety issues

HFC-134a is an acceptable way to reduce CFC-12 consumption.

Cost-effectiveness

No incremental operational costs are claimed in this phase. In a future phase it must be decided who can claim for operational costs, the compressor producer or the users. The costs being claimed are reasonable and in line with similar projects.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 09

Supplemental Comments of 6 China Refrigerant Projects
Overall Assessment

Shanghai Refrigerator Compressor Factory
HFC134a Mitsubishi Rotary Compressors

1. The Shangling and Shanghai Compressor projects will rely heavily on Mitsubishi for technology. As can be seen in the project summary discussion on Technology Transfer, the agreement cost Shangling about $6,000,000 and includes full designs for 2 non-CFC model refrigrators based on their rotary compressors. The technology agreement for compressors is an additional $430,000.

2. The basic questions posed to Shangling and Shanghai Compressor wer, "is Mitsubishi producing similar refrigerators and compressors in Japan today?" "Is the technology commercially proven?" Shangling will consult with Mitsubishi and prepare a formal response for inclusion in the feasibility studies for Shangling and Shanghai Compressors.

3. We felt that the original quote of $375,000 for a calorminete was too high and $200,000 was agreed to for the project.

4. Overall Assessment - the project feasibility study is adequate. The project scope definition and costs is comparable to other similiar projects which have been reviewed and approved. The support of Mitsubishi is essential for project success. Clarification of the state of HFC134a rotary compressor development in Japan is needed to resolve outstanding questions on commerciality of the technology.

5. Recommendation - OORG to support the 2 projects (Shangling and Shanghai Compressor) on the basis that the Shangling project is included in the China CP Action Plan and the data is needed to assist selection of the best refrigerator/compressor technology for broad application in China. The Shangling project would be moot without approval of the Shanghai Compressor project. As HFC134a technology is currently the world standard CFC12 replacement, China must fully understand the impact of this technology on their industry to remain competitive in the world markets, particularly if they choose to adopt a different technology.

To: Miss Helen Chan Fax: 1-202-477-1273
From: Shanghai Refrigerator Compressor Co.Ltd.

Additional Remarks For SRC Project

1. Noise and Vib ration equipment

As the pressure ratio of suction to discharging and oil circuit are different between HFC134a and CFC12 during compressor running, so noise and vib ration of compressor is also different.

1). Noise is tested after the equipment filled with HFC134a reach a steady running. But the existing equipment in the company is only suit for CFC12, so it can not be used for HFC134a.

2). Noise equipment is placed in the noise elimination room. Another noise elimination room will be set up necessarily for HFC134a compressor, so the equipment will be set up at the same time.

3). The CFC12 compressor will be produced for several years, it is impossible to remove the existing CFC12 system. So the noi se and vib ration equipments for both CFC12 and HFC134a will be existed simultaneously for several years.

2. The basis of 35 USD per compressor (for 1000 compressors)

In fact the cost of existing CFC12 compressor in the company is 39 USD (the domestic sale price is 49 USD, which can not be compared with the nationaol price). For trial production, the cost will be higher than 40 USD (including some special reasons, such as material, higher reject rate and design fee, etc.). So the company will bear some portion of cost by itself except 35 USD per comperssor applied from The World Bank.

SHANGHAI REFRIGERATOR COMPRESSOR CO., LTD.

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER PROJECT COVER SHEET

COUNTRY	The People's Republic of China		
SECTORS COVERED	Domestic Refrigeration		
ODS CONSUMPTION IN AFFECTED SECTOR	3300 MT CFC-11 (1991) 1500 MT CFC-12 (1991)		
PROJECT TITLE	Engineering Assistance for Conversion of Refrigerator Manufacture to HFC152a/HCFC22 Blended Refrigerant in Conventional Compressors		
PROJECT DURATION	2 years		
PROJECT IMPACT	70 MT CFC-12		
PROJECT BUDGET	Incremental Capital Cost - Phase 1	$	645,000
	Incremental Capital Cost - Phase 2	$	335,000
	Incremental Operating Cost	$	0
	Total Project Cost	$	980,000
PROPOSED OTF GRANT[1]	$ 860,000		
IMPLEMENTING ENTERPRISE	Chang Ling (Group) Co. Ltd.		
IMPLEMENTING AGENCY	The World Bank		
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)		

PROJECT SUMMARY

This project will lead to replacement of CFC-12 refrigerant in household refrigerators manufactured by Chang Ling with a blended refrigerant consisting of HFC152a and HCFC22. Technology has been developed locally in cooperation with Xi'an Jiaotong University. In Phase 1 of the project, detailed engineering, product development and lab and field testing of 500 units produced under factory conditions, will be conducted to define firm project scope and costs for full conversion of the factory output to HFC152a/HCFC22 blended refrigerant during Phase 2. The results of Phase 1 will be compared with similar projects using alternative refrigerants before proceeding with Phase 2. Net incremental operating costs for the conversion will be defined during Phase 2 and presented in a separate Phase 3 project at a future date. A separate project will be defined for replacement of CFCs used in refrigerator insulating foam, pending definition of the best available technology.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Martien Janssen. His comments are attached together with supplementary information pertaining to the review.

---

[1] The OTF grant is based on 100% Chinese ownership. A 3% financial agent fee and a 15% contingency is included in the estimates of incremental capital costs. Chang Ling will self finance $150,000 of Phase 2 the capital cost for plant renovations.

PROJECT OBJECTIVES

The objective of this project is to establish a phased introduction of technology for use of HFC152a/HCFC22 blended refrigerant in domestic refrigerators produced by Chang Ling. The results of this project will be evaluated and considered for adoption by similar refrigerator operations.

SECTOR BACKGROUND

Table-1

CHINA - ODS Consumption in Domestic Refrigeration, 1992

(metric tons)

	CFC-11	CFC-12
Insulating Foam - New Refrigerators	4600	
Refrigerant - New Refrigerators		950
Refrigerant - Service Old Refrigerators		500
Total - Domestic Refrigeration	4600	1450

In 1992, the Chinese domestic refrigeration sector consumed 6050 MT CFCs, 11% of the total CFC consumption in the country. The major CFC application was CFC-11 blowing agent used to generate the insulation foam in refrigerator cabinets (4600 MT). Assuming an average refrigerator in China contains 175 grams CFC-12 refrigerant, new refrigerators accounted for a total of 5550 MT CFC usage. The remaining 500MT in the sector replaced refrigerant in the fleet of existing CFC12 refrigerators during servicing operations..

At present, there are over 70 production lines for refrigerators in China with an annual capacity of 12 million units annually. In addition, there are 16 production lines for compressors with an annual capacity of 16 million units. Refrigerator production capacity utilization has been slighly below 50% . Actual production of new refrigerators in China has averaged 5.7 million units annually since 1990. Production is expected to increase 8% per year as economic conditions continue to improve and consumers acquire additional discretionary income. Currently, only 13% of housholds in China have a conventional refrigerator. A total of 39 million units are estimated to have been in service at the beginning of 1993. Refrigerator life averages about 20-25 years during which refrigerant is replaced every eight years.

Phaseout of CFC use in the domestic refrigerator sector will require integration of new technologies for non-ODS foams and refrigerants, and compressor designs to accomodate the new refrigerants while sustaining energy efficiency and overall mechanical performance. The National Strategy as defined in the China Country Program will concentrate initially on reducing CFC use by 50% as new foam technologies evolve. Transitional substitute technologies will be evaluated in the medium term (1997-2000) and fully non-ODS technologies defined in the long term. Starting in 1994, a comprehensive program for refrigerant selection will be carried out in a series of applications development projects using the leading candidate refrigerants - HFC-134a ; HFC-152a ; Blends. These projects are summarized in the following table:

Table 2

Projects included in China Refrigerant Program

	Refrigerant	Compressor	Technology Source	Prod. Capacity (units/yr)
Shangling	HFC-134a	Rotary	Mitsubishi	500,000
Hua Yi	HFC-134a	Reciprocating	Kirby	300,000
Shanglu	Ternary Blend	Reciprocating	DuPont	400,000
Chang Ling	Binary Blend	Reciprocating	Chang Ling	400,000
Wanbao	HFC-152a	Reciprocating	Wanbao	400,000

Note: Binary Blends are mixtures of HFC152a and HCFC22; Ternary Blends also include HCFC124

While HFC-134a has been the leading candidate refrigerant in developed countries, China does not have available capacity for production of HFC-134a , associated polyolester lubricant and dessicant and would need to import substantial quantities of these costly ingredients to sustain production. The net incremental operating cost to China for these imports is estimated to be US$50-100 million at current market prices. Less costly refrigerant options would be HFC-152a, which is produced in China, and binary and ternary blends, most of which could be blended domestically using imported HCFC124 if necessary. As HFC-152a based refrigerants use lubricants closely related to those currently used for CFC-12 further potential savings are possible. Hydrocarbon refrigerants may be considered for inclusion in the program as mature technology becomes available.

The development program is designed to obtain actual data upon which to identify the best technology mix with which to achieve a complete ODS phaseout by the year 2000, considering all issues and parameters including adoption of safety standards for flammable refrigerants and establishing indigenous capacity for new refrigerants, lubricants, and blowing agents.

ENTERPRISE BACKGROUND

Chang Ling (Group) Co. Ltd. is located in Baoji city in a large military complex which produces household electric appliances, textile, military and domestic electronics. It is a large company with 4 research institutes and 1525 engineers and technicians.

A total of 1,200 employees are engaged in refrigerator production on one production line imported from Merloni (Italy) in 1987. The line is capable of producing 400,000 refrigerators annually based on 1 shift operation. Thirty models are produced with export of about 3% of the refrigerators produced.

In 1992, Chang Ling produced 6% of the refrigerators sold in China. Actual and forecast production are illustrated in Table 3 for the period 1990-1997.

Chang Ling is committed to phaseout all CFCs used in refrigerator manufacture before 1997.

Table 3
Actual and Forecast Refrigerator Production at Chang Ling

	Actual				Forecast			
Year	90	91	92	93	94	95	96	97
Refrigerators Produced (000 Units)	210	260	270	397	450	600	600	600

Since 1990, Chang Ling and Xi'an Jiaotong University have been engaged in a collaborative venture to develop a refrigerator based on HFC152a/HCFC22 refrigerant. Phase 1 type activities completed to date include: calorimeter testing of 9 compressors using the blend, appliance testing of 20 refrigerators, and compatibility testing of lubricants, driers and compressor materials. Advantages of the blended refrigerant were found to be minimal engineering changes to compressors and refrigerators and higher energy efficiency. Ongoing work is focused on optimization of the refrigerator-compressor system.

PROJECT DESCRIPTION.

The project will accomplish phaseout of CFC12 used as refrigerant in domestic refrigerators produced by Chang Ling in two phases.

Phase I Engineering, product development and testing under local conditions to establish basic data for full conversion to HFC152a/HCFC22 blended refrigerant and for comparison with results of similar programs using alternative refrigerants.

Phase II Full conversion of the Chang Ling factory to HFC152a/HCFC22 blended refrigerant

During Phase 1, 500 refrigerators will be produced under factory conditions to prove the viability of manufacturing refrigerators safely and reliable under local conditions. Technical collaboration will be sustained with Xi'an Jiaotong University. At the conclusion of Phase 1, a feasibility study will be prepared for full conversion of refrigerator manufacturing at Chang Ling using HFC152a/HCFC22 refrigerant. Based on the feasibility study results, a detailed cost estimate will be prepared and project planning will be revised to accomodate Phase 1 findings before commencing with Phase 2.

Phase 2 will implement the full conversion of Chang Ling refrigerator facilities to HFC152a/HCFC22 blended refrigerant

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

While HFC134a has been accepted worldwide as the principal replacement for CFC12 refrigerant in domestic refrigerators, alternative refrigerants have found application in China where indigenous sources of HFC134a refrigerant and polyolester lubricant are not available.
One such alternative under consideration is the use of blended refrigerants which can function effectively in conventional CFC12 style refrigerator compressors. The HFC152a/HCFC22 blended refrigerant is a leading condidate because of refrigerant availability at a resonable cost compared to CFC12 and because of a slight improvement in energy efficiency. Chang Ling has pioneered this application and is well positioned to implement the project successfully.

PROJECT COST

The total project cost is estimated to be $980,000 including a 15% contingency to cover supplemental scope development as the project matures, price escalation,currency fluctuations, and other unforseen costs. A breakdown of incremental capital costs included in the OTF grant request is given in Annex A.

INCREMENTAL OPERATING COST

Incremental operating costs will be defined in Phase 2 of this project. An OTF grant request will be made based on Phase 2 results. An order of magnitude estimate of these costs is US$1,300,000 for the first four years of operation, discounted at 10%.

UNIT ABATEMENT COST (UAB)

$ 9.87 per kg CFC-12

PROPOSED OTF GRANT

The proposed OTF grant request is US$860,000 is based on 100% Chinese (state) ownershhip of Chang Ling (Group) Co. Ltd. and covers the incremental capital costs for Phases 1 and 2 of the project , including a 15% contingency cost and a 3% fee for the financial agent administering the project. Chang Ling will self finance $150,000 of the Phase 2 costs covering plant renovations.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR)

The ERR for the project will be determined during project appraisal.

Financial Rate of Return (FRR)

The FFR for the project will be determined during project appraisal.

Financial status of the enterprise

To be completed at appraisal

Financing plan

To be completed at the appraisal

PROJECT IMPLEMENTATION

Project Schedule

The project implementation schedule is presented in Annex B.

Annex A

CHANG LING
PROJECT COST SUMMARY

Phase I	(000US$)
Technology Transfer Fee	50
1 Refrigerant Charging Machines	75
Analytical and Special Test Equipment	75
Safety Control and Alarm Equipment	191
Blend Supply and Recovery Facility	36
Ventilation and Fire Safety Improvements	33
Test Manufacture of 500 Refrigerators (@US$ 160 per unit)	80
Preparation of Phase 2 Feasibility Study Report	20
SUB-TOTAL	560
Phase I I	
1 Refrigerant Charging Machine	75
Reorganization of Production Line including Ventilation and Fire Protection	175[2]
7 Halogen Leak Detectors	40
13 Blend Recovery Units	20
SUB-TOTAL	310
Contingency (15%)	110
TOTAL CAPITAL COSTS	980

[2] US$150,000 to be self financed by Chang Ling (Group) Ltd.

Annex B

CHANG LING
IMPLEMENTATION SCHEDULE[3]

	From	To
Phase 1		
Run compressor tests with Blends and performance tests on 20 refrigerators containing HFC152a/HCFC22 blend	1989	1Q91
Test Manufacture 500 Blend Refrigerators	2Q94	2Q94
Prepare Feasibility Study for Phase 2	3Q94	3Q94
Phase 2		
Purchase and Install equipment for mass production of Blend Refrigerators	4Q94	1Q95
Test Manufacture 2000 refrigerators on full scale production line	2Q95	2Q95
Increase Production Rate to achieve complete phaseout of CFC12 refrigerant use	4Q95	4Q96

[3] Project schedule assumes ECMP approval of project during 1Q94.

Annex C

TECHNOLOGY TRANSFER AGREEMENT

Chang Ling (Group) Co. Ltd. (formerly Shaanxi Refrigerator Factory)(Chang Ling)) and Xi'an Jiaotong University (XJU) have reached the following technical and safety system coordination agreement for producing refrigerators using HFC152a/HCFC22 blended refrigerant.

In a previous agreement (Dec. 26,1990) XJU transferred to Chang Ling technology applicable to use of the HFC152a/HCFC22 blend in refrigerator service. In this agreement XJU will provide additions technology and testing services to assist Chang Ling with the following activities:

Production of 500 refrigerators
Design of facilities for mass production
Safety analysis of project plans and facilities
Training of operators and mechanics

XJU will be responsible for ensuring the reliability and reasonability of all project plans.

A one time fee of $50,000 will be charged for the above services.

The term of the agreement will conclude in December 1995.

Conversion of Refrigerator Manufacturing from CFC-12 to HFC-152a/HCFC-22 blend at Chang Ling Refrigerator Company at Baoji

Project Proposal by The World Bank, January 1994

④

Scope

The scope of this project is to convert the Chang Ling household refrigerator factory from CFC-12 to the binary blend HFC-152a/HFCF-22 using conventional compressors. The technology for this alternative has been developed by the company in cooperation with the Xi'an Jiatong University.

Recommendation

Approval

Relevance and adequacy of information provided

The original information supplied was only a project summary (which lacks some relevant information) together with explanatory remarks by the World Bank consultant. In a second stage, after a preliminary review, supplementary information was given by the Chang Ling company. Altogether sufficient information for a judgment is present. *The project proposal itself does not contain all relevant information.*

Technical soundness

The Chang Ling company has chosen an alternative which is not being applied elsewhere and therefore had to do its own development in cooperation with the Xi'an Jiatong University. Also the compressor manufacturer (Yuan Dong Co., Xian) participated in this development and guarantees their CFC-12 compressors with the HFC-152a/HCFC-22 blend.
Extensive tests with the blend are being reported and possible problems have been addressed like the application of mineral oil and the higher discharge temperature. For the latter problem accelerated life time tests for the compressor are still being scheduled. The tests performed and information supplied gives confidence that the status of the technology is advanced enough to start a pilot production.

Lessons from experience

not applicable

Environmental issues

The blend HFC-152a/HCFC-22 still has a low ODP and is therefore a transitional substance only.

Safety issues

The blend applied is flammable and therefore special provisions need to be made to the production line.
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.

Cost-effectiveness

No incremental operational costs are claimed in this phase yet (they must be lower than for HFC-134a projects) Therefore no cost-effectiveness can be discussed.
The costs claimed for safety measures in the production lines are reasonable (approximately 400,000 USD). Also the other costs claimed are reasonable and in line with similar projects.

Other

In the project summary it is stated that after phase 1 (pilot production and field test of 500 appliances) the results will be compared with similar projects before proceeding to phase 2. However, it is doubted whether this procedure is very realistic. Already in phase 1 large investments are made, maybe not specifically in hardware but in technology development, transfer, training etc. Another aspect is the funding itself. The question is: would this company be funded again for conversion to HFC-134a if after phase 1 it appears that the blend alternative is not so successful ? In other words, once the decision is made for funding this alternative, it is a final decision.

Janssen, M.J.P. (OORG), Eindhoven, the Netherlands, 1994 02 09

Supplemental Comments of 6 China Refrigerant Projects
Overall Assessment

Chang Ling
HFC152a/HCFC22 Binary Blend Refrigerant

1. Chang Ling has conduced extensivie tests with HFC152a/HCFC22 in cooperation with Xi'an Jiaotong Univ (XJU) starting in 1989. They claim the test work is now complete (3 years of data) but is all in Chinese. They are summarizing these tests for inclusion as an annex to their feasibility study. This will be in hand by Jan 22. The next step will be to make 500 refrigerators on their main manufacturing line for field testing. Chang Ling does not have external technology support but feels confident that their expertise in cooperation with XJU should be adequate as there are no changes needed in compressor design to accomodate the HFC152a/HCFC22 blend.

2. Chang Ling do not plan to modify their condensors and evaporators to optimize the refrigerant circuit. They are planning to evaluate a replacement for mineral oil as the discharge temperature for the blend is higher than that for CFC12 and oil degradation may result over a long period of time.

3. The work plan does focus on the "Criteria" for appliance development. There was considerable debate on the 48 degree temperature which was specified for the controlled ambient test. (This same question arose from Hua Yi, Wanbao, Shangling, and Shanglu). The claim is that 48 degrees is to hot for the refrigerators made in China -- their National Standard for testing is 32 to 38 degrees depending on model type. Kuijpers has been requested to review this issue and advise if lower temperatures can be accepted for meeting the "Criteria".

4. Even though the addition of HCFC22 to HFC152 reduced flammability, the binary blend which Chang Ling plan to use (80/20 HFC152a/HCFC22) is still flammable. The cost to make refrigerator manufacture safe for handling flammable refrigerants is a significant factor in the cost of capital equipment, training of technical staff, training of operators and mechanics and timing project implementation. I do not think that these questions are fully appreciated by anyone at the present time. We should anticipate a slower project implementation than has been suggested by Chang Ling.

5 Chang Ling is committed to a full phaseout of CFCs in their line of refrigerators by 1997. This is an admirable goal and deserves support, however, caution should be exercised on the flammability issue. Chang Ling will commit $150,000 of their funds to Phase 2 of this project to encourage its progress and support.

6 As more different refrigerants are added to the "suite" of refrigerants in use in China, the question of refrigerator service will become acute. China will need to develop appropriate standards for identification of what type ("class") of refrigerant is in use and what servicing procedures should be used.

7. Oveall Assessment - The project is well prepared and documented. The work plan meets the "Criteria" for testing appliances.

8. Recommendation - Ammend documentation of prior testing prior to project submission to ECMF. OORG to support the project on the basis that it is included in the China CP Action Plan and the data is needed to assist selection of the best refrigerator technology for broad application in China.

1. ChangLing's blend technology was approved by expert group organized by the related goverment scientific agency.
The English translation copy of "Evaluated Certificate of Science and Technology Achievement ofproject" are attached this time.
The chinese copy was involved in the feesibility study.

2. Yuan Dong compressor Manufacture Co. Xian, Shaanxi province, China, is the leading compressor supplier of Chang Ling.
According to the Goverment arrangement of Shaanxi Province, the two company cooperate on blend technology.
Yuan Dong Co. fully guarantee the Justification that its CFC-12 compressor directly use blend.

2.1 Yuan Dong Co. Xian.

2.1.1 Yuan Dong compressor range from 1/8HP to 1/3HP reciprocating type.

2.1.2 production capacity 650000sets/year.

2.1.3 Yuan Dong compressor QD62GA, QD75GA have been fully tested with using blend as refrigerant.
English translation copy of the test report are attached this time.

3. Higher discharge temperature, mineral oil

3.1 Discharge temperature
when use blend, compressor's dischargetemperature raises a little compered with that of using CFC-12.
Surpose the increase Δt

3.1.1 DUPONT CO. U.S.A report
Acconding DUPONT'S report(U.S.A), for SUVA MP39. Δt=+10℃ about and they claim that there is no problem for the compressor made within the nearest decade to do with.

3.1.2 our test report

The different of the compressor type, the different of the Δt.

ASPERA A1112A (Italy) $\Delta t=+8℃$

QD75GA (Yuan Dong Co. Xian, China) $\Delta t=+5℃$

3.1.3 Above all, we think it can be accepted.

3.2 Minezal oil

By fully tested, we are confident enough that exist compressor oil is compatible with blend. We have dismantled one prototype compressor that had run over one year, we find no change of its minenal oil, nor the compressor parts.

3.3 Accelerated Life time test

We schedule to carry out this test according to CRITERIA and compressor standerd.

Start Date : 20/2/94

Duration : 2 months

Coooperator: Yuan Dong Co.

Xian Jiao Tong University

Yuan Dong's test reports of its CFC-12 compressor QD75GA directly use blend attached this time, the result is okay.

Refrigerator prototypes using blend have well operate for 3 years without any problem.

4. Flammability

In Appendix 2.f. of our feasibility study, there are full test reports to show blend's flammability being in safety level and weakest compared with HFC-152a's.

For single customer refrigerator using blend, flammability isn't exist.

4.2 Flammability Guidlines of blend using appliances and the way to distingulsh them from others will be accordence with the National standard scheduled to he

made out by NEPA and NCLI. recently.

5. Investment

5.1 Background of the 160 USD/unit for 500 refrigerators.

5.1.1 In item 6.3 of feasibility study

6.3 500 sets refrigerator with blend: field test fee plus increamental cost of production are 20000 USD.

That is: 40 USD/unit

5.1.2 In item 6.4 of feasibility study

6.4 Techincal pzeparation fee, cost of prototypes, tset fee, designing feeof safety systemand cost for standard making out, totally: 60000 USD

That is: 120 USD/unit

5.1.3 40+120=160 USD/unit

5.2 Blend supply and recovery facility

5.2.1 In Item 5.1, NO.4 of feasibility study. we totally need is set recovery equipment.

For 500 blend refrigeafor test production, (phase I), only 2 set were needed. one for production line, the other for repairing center.

91500 USD/unit 2×1500=3000 USD

5.2.2 In item 5.3, NO.3

Micro-mass flow meter and pump set (supply pump) we need 4 sets

1. It was used to pump the HFC-152a and HCFC-22 into blend changing Machine accuratly and individually.
2. As one each changing machine for prediction lineand repairing line, and two supply pumps for each. so total 4 set were needed.
3. 8250 USD/set 4×8250=33000 USD

5.2.3 Total: 3000+33000=36000 USD

5.3 Special introduction

1. 160 USD/Unit for 500 refrigeration
2. 36000 USD supply and recovery facility

The above data were summarized by W.B. expert Mr.

Project Cover Sheet

Country:	People's Republic of China
Project Title:	CFC-12 to HCFC-22 Plant Conversion
Sector Covered:	Chemical Production
Project Impact:	Reduce 7,000 tons per year CFC-12. Increase HCFC-22 5,000T/Y. ODP reduction 6,750T/Y
Project Duration:	2.5 years
Project Economic Life:	10 years
Total Project Costs:	US$ 8.935 million
Proposed OTF Financing:	US$ 6.369 million (see below)
Implementing Enterprise:	Shangnai Chlor-Alkali Chemical Co.
Coordinating Agency:	NEPA/Ministry of Chemical Industry
Implementing Agency:	World Bank

Project Summary. This project will simultaneously close an existing CFC-12 plant with rated capacity of 7,000 tpy at Shanghai Chlor-Alkali Chemical Co (SCAC) and replace it with a plant with rated capacity of 5,000 tpy HCFC-22. Existing infrastructure will be kept. Technology and key equipment will be imported. ODP reduction will be 6,750 tpy. This project reflects the Chinese Government strategy in CP to phase out ODS, which is: conversion from using ODS products to ODS substitutes should be carried out smoothly by adopting from high ODP substances, to low ODP substances, and then to substances without ODP. China has chosen HCFC-22 as an important transitional substance.

The project is being submitted to MPEC at this stage for preliminary , provisional review with regard to methodology and assumptions for calculating incremental costs. There is disagreement between SCAC/MCI and Bank on assumptions that determine incremental costs, mainly on foregone production level of CFC 12, production buildup of HCFC 22 and base year for discounting. SCAC assumes higher levels of CFC 12 production foregone, lower production of HCFC 22, discounts all recurring costs and benefits streams to the same year; each leading to higher incremental costs. SCAC's calculation of incremental costs are presented herein as an alternate and advice from MPEC is being solicited on how to resolve the differences.

Technical Assessment: A preliminary technical review has been undertaken by the OORG reviewer, Mike Harris, and project is provisionally supported as presented. Feasibility report will be revised once firms bids are received and recalculate capital costs and incremental costs. OORG comments will be taken into consideration when project is resubmitted to MPEC for funding.

Project Objectives. The project objectives are to reduce annual production capacity of 7,000 tons of CFC-12, and simultaneously increase HCFC-22 production capacity of 5,000 tpy to ensure that HCFC 22 product will be available as a CFC substitute, in line with China's ODS CP strategy. If demand for HCFC-22 grows rapidly as projected in the CP, similar projects can be carried out in other plants.

Sector Background. Currently, there are about 38 CFCs production facilities in China. These enterprises are comprised of 13 large-scale state-owned enterprises and about 25 small-scale collective enterprises. In 1991, total production capacity was about 47,000 tons, including 7,000 tpy CFC 12 at SCAC. Production capacity is expected to increase to about 74,000 in 1994 due to several ongoing expansion projects that are being completed. They all employ domestic, liquid phase technology, to produce CFCs with raw materials purchased from domestic sources. However, most plants are not "swing" plants and can only produce one type of CFC. The current CFC production capacity in China cannot meet the demand of CFC 11 and 113, but there is an excess of CFC 12 capacity. Imported CFCs have occupied a large portion in CFC consumption market, but that is expected to decrease rapidly over the next 2-3 years. In 1991, total output of CFC-12 was 21,900 tons. The imported amount was 1,100 tons and consumption was 23,000 tons. Unconstrained CFC market is forecast to be 45,900 tons in 1996; 65,100 tons in 2000; 95,900 tons in 2005, and 138,500 tons in 2010.

Enterprise Background. SCAC is a large chemical producer in Shanghai, with production facilities dating back to the mid 1960s; that have been continually modernized and expanded since that time. SCAC was restructured as a separate entity in 1992. Registered capital for the company amounts to 832 million RMB. In 1991, SCAC had the largest CFC-12 production plant in China, with a rated capacity of 7,000 tpy CFC 12. (In 1884 , there are two plants larger.) Its total output in 1991 was 5,350 tons (highest production for any year), which was one-fourth of total national output in 1991. However, raw material supply was a major constraint and SCAC commissioned a 10,000 tpy CTC plant in 1993 to remove the bottleneck. However, there is an emerging overall surplus of CFC 12 capacity in China and the impact on output from SCAC in terms of assessing future CFC 12 production levels is difficult to quantify.

Project Description. This project will adopt imported technology to produce HCFC-22. Currently, HCFC-22 production at home and abroad all adopt the liquid-phase halogen exchange process, which uses hydrogen fluoride (HF) and chloroform ($CHCl_3$), as a catalyst. Domestic techniques, due to reactions taking place in lower pressures, having higher consumption of raw materials, power and catalysts, larger discharges of wastes and by-products. Foreign technology, due to higher reaction pressure, has lower consumption and less discharge of wastes and by-product HCl. Design will be provided by foreign contractors and detail designs will be carried out by domestic contractors. The HCFC-22 plant is made up of raw material supply, reaction and stripping, HF removal and drying, product separation and rectification, and packaging system. Key equipment,piping and instruments, will be imported and other equipment and materials will be furnished by domestic suppliers. There are about 140 total pieces of equipment HCFC-22 production process, of which, 29 pieces will be imported and 19 pieces will be from original CFC-12 plant. The project will be implemented within existing battery limits of CFC-12

production plant that will be razed and same site will be used to erect the HCFC 22 plant. The office, analysis room, maintenance workshop and other installations of original CFC-12 plant will be used in the project. The raw materials of HCFC-22 production, with exception of chloroform and sulphuric acid, will be provided by raw material supply system of the CFC-12 plant. Utilities and waste water treatment will also be from original CFC-12 system.

Rationale for CFC Substitute Choice. Demand for products made of ODS in China is far from being satisfied before 2010. Reductions of ODS production and consumption should not harm normal industrial and consumer demands for such products. Thus the conversion should be carried out smoothly by adopting from high ODP substances, low substances, to substances without ODP. To speed up phaseout process in the current circumstances of unfully-developed technique to produce non-ODS substitute, China is going to choose transitional substances specified in MP, especially HCFC-22 as the important transitional substance in ODS phaseout process. Concerning demand for ODS substitute, strategy of Chinese government is to mainly base upon development of domestic production. Meanwhile ODS reduction should be carried out simultaneously with ODS substitute production to meet domestic consumption. Developing production capacity of HCFC-22 is imperative, so that State Plan can be carried out. No ideal substitute has been found which can completely replace CFC-12. Substitutes with zero ODP value such as HFC-134a and HFC-152a require high investment for capital construction, high selling price, and also have problems such as greenhouse effect and high energy consumption of HFC- 134a and inflammability of HFC-152a. China is a developing country, lacking capital and techniques. It is impossible to complete development of ODS substitute with zero ODP value and provide enough ODS substitute with zero ODP value as required in such a short time under Chinese conditions. Currently, there are still some binary and trinary combination substitutes in transitional substitutes developed both at home and abroad. Most of these contain HCFC-22. Thus, development of HCFC-22 production capacity has advantages for application of binary and trinary combination substitutes.

ODP value of HCFC-22 is only 5% of that of CFC-12. With mature production process and low investment costs, unit ODS reduction cost would be lower and profit would be higher. The price of HCFC-22 is only 1.5 times of that of CFC-12, much lower than HFC-134a, so that HCFC 22 can be easily used by the consumer. According to the State Plan, requirement of HCFC-22 for projects of small commercial compressor can be over 2,400 tpy CFC substituted.

Project Costs and Incremental Costs.

Incremental costs are based on compensation for premature closure of the existing CFC 12 unit and incremental costs for the new HCFC 22 unit as shown below (calculated at US$ = RMB 5.37):

HCFC 22 Unit

Capital costs for new plant	US$ 8,935,000
Net incremental recurring benefits:	-US$ 5,041,000
Incremental costs due to HCFC 22 production	US$ 3,894,000

CFC 12 unit

Incremental costs from foregone production of CFC 12 would be added to the above figure to arrive at the net incremental costs for the project as a whole, as shown below. There is disagreement between the Bank and SCAC on some of the assumptions that determine incremental costs, with the main difference in level of foregone production for CFC 12, production buildup of HCFC 22 and base year for discounting. Calculations are in annexes 2 and 3 and summarized below, in US$ millions:

	SCAC Calculation	Bank Calculation
Capital Costs	8.935	8.935
Incremental Costs HCFC 22	- 5.041	-5.661
Incremental Costs Lost CFC12	+5.020	+3.095
net overall incremental costs	8.914	6.369

Proposed OTF Grant: US$ 6.406 million (to be recalculated once final project capital estimates are available and assumptions are agreed). Please note that the above figure is based on Bank assumptions as noted above. SCAC figures give US$ 8.914 as shown above and in annexes 2 and 3.

Unit Abatement Costs: to be determined

Financial and Economic Analysis: To be determined at appraisal.

Financing Plan: to be determined

Project Implementation. This project will be undertaken by the enterprise. A foreign company will provide technology and basic design. The engineering design of this project will be undertaken by the design department of SCAC with the assistance of local engineering firms. Construction will be also be handled by local firms. Construction time is 2 1/2 years and shown in the schedule on the following page. The CFC 12 unit will be closed after the first 6 months to give a 2 year period when the factory will have no sales revenue of CFC 12 nor HCFC 22. This 2 year period contributes tothe high incremental costs shown above.

Project Benefits

Direct Effects. When the project begins implementation, the domestic production capacity of CFC-12 will be reduced by 7,000 tpy. When the project has been completed, i.e HCFC-22 has been put into operation, HCFC-22 can be supplied with 5,000 tpy, and ODP reduction is 6,750 tpy. Indirect Effects. If demand for HCFC-22 grows rapidly, similar projects can be carried out in other plants.

Task	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Basic Design	xxx	xx x								
Detailed Design			xx x	xxx	xxx					
Equipment Purchasing		xx x	xx x	xxx	xxx	xx x				
Construc-tion					xxx	xx x	xxx	xxx	xxx	xxx
Training								xx	xx	
Test Run										xx

Unit Abatement Cost:

$$A=ODP = \frac{C(F)+(OC-OS)}{ODP}$$

where UAC = Unit abatement costs, $/kgODP/year

C = ODS reduction investment cost, including all initial one time costs such as technology and training

F = Capital recovery factor; the annualized capital cost charges, discounted at a standard rate of 10% per year over the economic life of the investment

OC= Annual incremental operating costs in the first year of full operation

OS= Annual incremental operating savings (OS) in the first full year of full operation

ODP= Annual ODS reduction at the first year of full operation expressed in ODP units

Calculation of C(F)

The annualized investment costs consider the total investment plus the amount of interest that would be repaid over the life of the project if the investment were a loan (the investment is a grant) and if the loan were repaid in equal installment.

Result: to be determined after final capital costs and incremental costs are determined

Annex 1 Capital Costs ($1,000)

Item	Home	Abroad	Subtotal
A. Equipment Cost of which a-f	687.8	2,925.0	3,612.8
(a) Feedstock System	(116.1)		
(b) Reaction & Stripping system	(88.4)		
(c) De-HF Drying System	(58.1)		
(d) Separating & Rectifying System	(80.2)		
(e) Tail Gas Treatment & HCL System	(54.3)		
(f) Packing System	(290.7)		
B. Civil Construction	453.1		453.1
C. Equipment Installation	1,065.1		1,065.1
D. Design/Technology	177.2	1575.0	1752.2
E. Training	60.2	68.6	128.8
F. Commissioning (of which a-c)	646.9	240.6	887.5
(a) Equipment	(10.3)	(224.0)	(234.3)
(b) Trail Tests	(174.6)		(174.6)
(c) Others[1]	(409.9)	(15.8)	(425.7)
G. Working Capital	140.6		140.6
H. Contingency	332.0	600.0	932.0
Subtotal	3562.9	5409.2	8972.1
Residual Equipment Value	37.2	-	37.2
Total	3525.7	5409.2	8934.9

Note:

1. The cost of others in startup includes:
   a. Feasibility study fee, amounting to US$ 52,630 have been deleted.
   b. Domestic costs for imported part (including fee for foreign trade formalities, banking and finance, customs supervision and administrative formalities, and domestic transportation), amounting to US$ 147,000 and inspection fee for imported equipment, amounting to US$ 29,250.
   c. Management of project implementing company, amounting to US$ 185,820.
   d. Project insurance, amounting to US$ 23,520.
   e. Translation and copy for materials and drawings form home and abroad, amounting to US$ 40,050.

Annex 2

Review of Incremental costs for China- SCAC HCFC 22 Project

The Bank review of the SCAC HCFC 22 Project based on revised proposal from SCAC (fax dated December 21,1993.) will consist of:

a) technical review including costs of HCFC 22 project; and

b) financial and economic analysis of eligible incremental costs for closure of CFC 12 unit and for construction of HCFC 22 unit. For purpose of this initial review (costs in US$ millions):

Capital costs	$8.9879
Minus feasibility study fees	.0530
Net capital cost	8.9349

(However, capital costs will change once firm estimates are available after receipt of bids.)

As the Bank has agreed with SCAC and MCI, incremental costs should be based on a six year period for foregone profits on CFC 12 closure and a 10 year economic life for the HCFC 22 unit; price and cost data should based on 1991 figures; and a 12% p.a. discount rate used. (Even though the Bank has agreed on the above assumptions, the Bank does not have precise guidelines from MPEC on assessing incremental costs for production sector and any of these above assumptions could be questioned by MPEC.)

As discussed with SCAC in Shanghai in December, the Bank does not agree with the production levels for both HCFC 22 and for CFC 12 on which the incremental costs as calculated by SCAC are based. The combination of low HCFC 22 production and high CFC 12 production overstates the incremental costs. There is also a difference in calculation methodology. The Bank calculation of incremental costs based on SCAC production level for HCFC 22 and CFC 12 as shown in SCAC's Annex 2 shows an incremental cost of:

Capital costs for HCFC 22 unit	$US 8.935 million
Net inc. benefits from HCFC 22 production	-$US 5.041 million
Net inc. costs from lost CFC 12 production	$US 4.007 million
Net incremental costs	$US 7.901 million

The above figures are discounted to 1997 for the HCFC 22 component and to 1995 for the CFC 12 component. The SCAC figure for incremental costs is US$ 8.860 million, discounted to 1995 for both HCFC 22 and CFC 12. The difference between the SCAC figure and the Bank figure is due to the different base years for discounting. Since the CFC 12 plant closes in 1995 its incremental cost should be discounted to that year. Since the HCFC 22 unit starts operating in 1997, the operating costs and benefits should be discounted to 1997 to determine the incremental costs for that unit. Thus, SCAC has not used the

correct years for discounting.

However, there are additional differences in determining the base line for calculating incremental costs that need to be considered. A more consistent and reasonable basis for calculating incremental costs, considering both performance of SCAC and domestic demand for CFC 12, would be the production levels in tons per year listed below under "Bank." The SCAC production buildup is shown below and in annex 3 for comparison:

Year	CFC 12 production		HCFC 22 Production	
	Bank	SCAC	Bank	SCAC
1995	6000	6000	0	0
1996	6000	6000	0	0
1997	6000	6500	3000	3000
1998	6000	6500	4000	3500
1999	6000	7000	5000	4000
2000	6000	7000	5000	4500
2001	0	0	5000	5000
2002	0	0	5000	5000
2003	0	0	5000	5000
2004	0	0	5000	5000
2005	0	0	5000	5000
2006	0	0	5000	5000

The main difference in incremental costs will be the different assumptions by SCAC and the Bank in buildup of production for HCFC 22 and foregone CFC 12 production level, and discounting HCFC 22 to 1997 and CFC 12 to 1995.

Incremental costs calculated on above "Bank" basis will be:

capital costs for HCFC22 unit	$US 8.935 million
net incremental benefits from production of HCFC 22	-$US 5.661 million
net incremental costs from lost CFC 12 production	$US 3.095 million
net incremental costs	$US 6.369 million

The SCAC HCFC 22 Project is being submitted to MPEC for review and preliminary decision and guidance on the several assumptions and methodology. The Bank recommendation is be to base the incremental costs on the Bank suggested production buildup or a preliminary funding level for incremental costs of US$ 6.369 million. (Please keep in mind that the incremental costs will change when the capital costs figures are revised.) SCAC calculated incremental costs of US$ 8.859 million with the main differences due to the different assumptions as discussed above. MPEC should take both figures into consideration in arriving at a recommended methodology and assumptions for determining eligible incremental costs.

Annex 3 - Breakdown of Incremental Benefits (SCAC Assumptions)
(US$= RMB 5.7)

Year	CFC-12			HCFC-22			Incremental Benefits
	Sale Price Unit (US$) *	Total Annual Produc -tion (Units)	Annual Sales (US$ 1,000)	Sale Price Unit (US$) *	Total Annual Produc-tion (Units)	Annual Sales (US$ 1.000)	US$ 1.000)
1995	1347.4	6000	8084				-8084
1996	1347.4	6000	8084				-8084
1997	1347.4	6500	8757.43	2017.5	3000	6052.5	-2704.93
1998	1347.4	6.500	8757.43	2017.5	3500	7061.3	-1696.13
1999	1347.4	7.000	9431.8	2017.5	4000	8087	-1361.8
2000	1347.4	7000	9431.8	2017.5	4500	9078.75	-353.05
2001				2017.5	5000	10087.5	10087.5
2002				2017.5	5000	10087.5	10087.5
2003				2017.5	5000	10087.5	10087.5
2004				2017.5	5000	10087.5	10087.5
2005				2017.5	5000	10087.5	10087.5
2006				2017.5	5000	10087.5	10087.5

NPV = 3394.75
i = 12%

* Factory price in 1991

b:\SCAC

OORG - Production Sector

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Cover Note

Tom: please find attached a revised version of the Technical Opinion on the SCAC 22 project. Passing via my home this weekend I have found in my mail some suggested amendments to the SCAC 22 TO from one of my experts. I append a revised version in case it is still not too late to use it instead of the original. The problem is that everyone is so overloaded that my internal deadlines are not always met!

PS. I also found in my mail a cheque in respect of the hours worked in the UK. We're now up-to-date on historical travel expenses and remuneration. Thank you for your help.

Kind regards

Shanghai Chlor-Alkali Chemical Co Ltd (SCAC) - CFC-12 to HCFC-22 Conversion

Recommendation

The project should be conditionally approved. At this stage a political decision is required and the proposal as it stands is of sufficient merit to deserve moving to the next stage. Further information required includes (priority items only):

(a) Process flow diagram and details of existing CFC-12 plant for comparison, to improve calculation of incremental cost, and to underpin the CFC-12 production estimates.
(b) Explanation of the need for some 45 process equipment items (from a total of 142) not found on some other operational developed world HCFC-22 plants.
(c) A preliminary hazard study (HAZOP-1 or similar).
(d) Explanation of the unusual yields (low for HCFC-22, high for HCl) and high reliability (95% - despite several years of low occupacity) stated for the process.
(e) Quality (eg F⁻ content) of HCl by-product, its value and markets.
(f) Description of controls on emissions of HFC-23, a very powerful global warming gas.

Relevance and adequacy of information provided

The main items of information required are provided, except for the major items listed above. It should be noted that a major and complex chemical process project of this nature cannot be adequately assessed in an opinion of this length, and that a large amount of further specific information would be required for a capital proposal in the private sector. However, much of this information will be both commercially sensitive and very specific to the particular plant and the particular technology supplier. No two HCFC-22 plants are the same, not least because each exists in a unique infrastructure of other plants and processes. So far as is possible, the chosen technology (which will differ in important detail from supplier to supplier) should be as close to the operating experience of SCAC in their existing fluorocarbon operations - to maximise re-use of equipment, and to facilitate the changeover to HCFC-22.

Much more detail will be required before final approvals are given to the specific project, but the information available (plus that requested above) suffices for an initial 'permission to proceed to the next stage'.

Technical soundness

The technology considered involves the conversion of a liquid-phase (assumed) CFC-12 plant to a liquid-phase HCFC-22 plant and is generically the only reasonable approach. Large differences exist as to options for the detailed implementation of this conversion. The merits of each option will depend on the choice of technology supplier *vis-à-vis* the details of the existing equipment and infrastructure. The technology is very well established and is commercially ready for transfer to an LDC. The technical risks involved are low (as to the technology) and normal (as to implementing the technology on site and within the domestic infrastructure).

Lessons from experience

This is a largely conventional project of a kind which is often undertaken for commercial reasons, regardless of environmental concerns about CFCs. In the developed world, there has been considerable movement from CFC-12 to HCFC-22 in important refrigeration applications (eg food chain refrigeration)

for well-established technical reasons. By the same token, the downstream technology to use the HCFC-22 product is well-established and available.

Environmental issues

The key environmental issue is the view of the ECMF as to the desirability of funding a conversion from a CFC to an HCFC given that the Copenhagen Amendments to the Protocol call for, an albeit long-term, phase-out of HCFCs in the developed world. Decision V/8 of the Parties at their 5th meeting in Bangkok (1993) requested "each Party ... to give consideration in selecting alternatives ... to economic aspects ... taking into account ... all interim steps leading to final ODS elimination". The ECMF may feel that they wish to consider the costs of eventual replacement of this new HCFC-22 plant by a non-ODS production facility. The other major issue is the emission of HFC 23 from the process. No mention is made of provision for its control, monitoring or minimisation - nor recognition that the problem exists. HFC 23 is a persistent greenhouse gas with a GWP in excess of 12 (relative to CFC 11) and an atmospheric lifetime of over 300 years. Emissions are likely to exceed 250 tonnes/year unless tightly controlled - equivalent to 750 te/yr of CFC-12 or 12,000 te/yr of HFC 134a in GWP terms.

Safety issues

In all fluorocarbon plants, HF is an important feedstock and a very hazardous material unless properly handled and controlled. There are also safety aspects to the composition of the mixture in the main reactor vessel (R201) where special provision needs to be made to keep water levels low (to avoid aqueous HF), and to avoid the formation of "magic acid" ($HSbF_6$) both of which will lead to severe corrosion. There are doubts as to the fail-safe operation of the vent scrubber (T502) in the event of chlorine break-through in that no caustic absorption system is provided. These issues need addressing at the next stage.

Cost-effectiveness

The overall capital cost of the project is of the right order of magnitude at $8.86 million. However, from the information provided, a cost estimate cannot be made to an accuracy of better than ± $2 million. Much depends on the detailed sizing of the process vessels, and the extent to which items may indeed be re-used. Detailed process diagrams would be required for this, and will depend on the detailed choice of technology and supplier. At this stage there is little purpose in attempting to refine or further validate the cost-estimate. This must be done at the pre-sanction stage on the basis of detailed design, drawings and sizings.

One general point must be made: some four dozen or so of the major items of equipment on the flowsheet are *not* used on at least one major operational developed world plant. While a case could be made that perhaps eight to ten of these are desirable, there seems no good reason for the remainder. As equipment items are not individually costed, it is not possible to state the capital saving implicit - but it could be on the order of $300-400k.

Other

A significant factor in calculating the incremental cost is the value of foregone CFC-12 sales. This is based on annual production of 7,000 te (nameplate capacity of the latest plant expansion in 1990/91). Yet the plant has never operated above 5,350 tpa, and only at about 3,500 tpa in the last two years (1992/3) - apparently because of CTC feedstock shortages. It remains to be seen whether the plant is capable of 7,000 tpa operation (equivalent to a surprising 95% reliability). It might also be asked why investments were made in expanding CFC-12 capacity in 1990/91 and CTC capacity in 1991/94 even though China indicated in mid-1990 its intention to ratify the Montreal Protocol, and actually ratified in mid-1991. These recent investments in the production of CFC-12, and its feedstock CTC, have increased the incremental costs of the project - which could otherwise have been based on 1989/90 CFC-12 production/sales levels of some 3,750 te/yr saving some $5M/year (undiscounted).