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

Thirteenth Meeting
Montreal, 25-27 July 1994

PROJECT PROPOSALS: CHINA

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

UNDP

- Conversion to non-CFC technology in the manufacture of flexible and integral skin polyurethane foam at Yanfeng;

- Elimination of CFC-11 in the manufacture of rigid polyurethane foam products at Tianjin Polyurethane Plastic Plant.

World Bank

- Conversion to CFC-free technology in manufacture of rigid polyurethane pipe insulation at Shanghai #6 Plastics Product Plant;

- Fire extinguisher production conversion from Halon 1211 to ABC Dry Chemical at Zhuzhou Fire Equipment Factory;

- Halon 1211 production closure at Tongxiang Chemical Fertilizer Factory;

- Aerosol CFC-12 Substitution and Conversion Project at China Aerosol Industry Southern Filling Center (Zhongshan Fine Chemical Industrial Limited);

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

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

- Engineering assistance for conversion of refrigerator manufacture to HFC-134a refrigerant with Tecumseh designed HFC-134a compressors at Hua Yi Electrical Appliance General Company;

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

- Engineering assistance for conversion of refrigerator manufacture to use of HFC-152a refrigerant using conventional compressors at Wanbao Electrical Appliance Industrial Corporation;

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

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China	
PROJECT TITLE:	Conversion to non-CFC Technology in the Manufacture of Flexible and Integral Skin Polyurethane Foam at Yanfeng	
PROJECT COST:	Incremental capital cost	US $570,000
	Incremental operational cost	US $100,000
INCREMENTAL COST:	US $670,000	
ODS PHASE-OUT:	67.5 tons of CFC-11	
COST EFFECTIVENESS:	US $9.93 per kg ODP saved	
PROJECT DURATION:	One year	
IMPLEMENTING AGENCY:	UNDP	
NATIONAL COORDINATING AGENCY:	National Environmental Protection Agency	
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _	

SECRETARIAT'S COMMENTS

1. Under this project, Yanfeng Automobile Interior Trimming Factory plans to phase-out the use of 75 tons of CFC-11 in the production of automotive back-cushions and steering-wheels by using water-blown technology for the manufacturing of cushions (slabstock flexible polyurethane foam) and HCFC-22 for steering wheels (integral skin polyurethane foam).

2. Incremental capital costs consist of high pressure foaming machines, pre-mixing station, and trials. Incremental operational costs are claimed because the addition of TDI and softener additives to replace CFC-11 of slabstock and higher price of HCFC-22 to replace CFC-11 of integral skin.

3. In March 1993, the company entered into a joint venture with the trim division of Ford Motor Company, USA, but the existing production has been kept separated from this joint venture acting as a supplier and remains fully Chinese-owned.

SECRETARIAT'S RECOMMENDATION

4. The Secretariat recommends final approval for the amount requested, i.e., US $670,000.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China	
PROJECT TITLE:	Elimination of CFC-11 in the Manufacture of Rigid Polyurethane Foam Products at Tianjin Polyurethane Plastic Plant	
PROJECT COST:	Incremental capital cost Incremental operational cost	US $655,000 US $125,000
INCREMENTAL COST:	US $690,000[1]	
ODS PHASE-OUT:	100 tons of CFC-11 in 1993	
COST EFFECTIVENESS:	US $7.8 per kg ODP saved	
PROJECT DURATION:	One year	
IMPLEMENTING AGENCY:	UNDP	
NATIONAL COORDINATING AGENCY:	National Environmental Protection Agency	
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _	

SECRETARIAT'S COMMENTS

1. Tianjin produces both flexible and rigid polyurethane products by using CFC-11. The purpose of this project is to phase-out the CFC-11 usage in rigid PUF foam production through pentane. The company is currently implementing the phase-out projects of CFC-11 usage in flexible foam and in its polyol blending facilities utilizing Multilateral Fund Grants which were approved at the Tenth Meeting of the Executive Committee. (US $1,080,000 and US $460,000 respectively).

2. The project consists of two sub-projects: one for insulation pipe and box (this part is executed by Tianjin itself) and one for sandwich panel production (this part executed by a joint venture - Tianjin owns 75 per cent and a Swiss company owns 25 per cent). Costs of the latter were adjusted by using local ownership share of 75 per cent.

3. Pentane is a flammable material. Explosion-proof dispensers, pre-mixing station, ventilation and other safety related modifications and training will be covered by the capital costs. Incremental operational costs for the sandwich panel production section are generated due to additional MDI use, pentane and extra maintenance to replace the CFC-11.

SECRETARIAT'S RECOMMENDATION

4. The Secretariat recommends final approval for the project for the amount requested, i.e., US $690,000.

[1] The incremental costs differ from the budget by accounting for 25 per cent transnational ownership

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China	
PROJECT TITLE:	Conversion to CFC-Free Technology in the Manufacture of Rigid Polyurethane Pipe Insulation at Shanghai N° 6 Plastic Product Plant	
PROJECT COST:	Incremental Capital Cost	US $580,000
	Contingency	US $ 87,000
	Financial Agent Fee	US $ 20,000
INCREMENTAL COST:	US $687,000	
ODS PHASE-OUT:	105 tons of CFC-11 in 1992	
COST EFFECTIVENESS:	US $4.0 per kg ODP saved	
PROJECT DURATION:	One year	
IMPLEMENTING AGENCY:	The World Bank	
NATIONAL COORDINATING AGENCY:	National Environmental Protection Agency	
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _	

SECRETARIAT'S COMMENTS

1. Under this project, the company will eliminate 105 tons of CFC-11 being used for rigid molded and rigid spray pipe insulation, and rigid molded ice box. Carbon dioxide was selected as a long-term substitute to CFC-11, but HCFC-141b may be used as an interim solution until carbon dioxide technology is accepted (2-3 years).

2. Two high-pressure foaming machines and four spray machines will be purchased instead of the nine existing ones. Incremental operational costs are calculated based on 100 per cent CO_2 technology (additional MDI use).

SECRETARIAT'S RECOMMENDATION

3. It is recommended to approve US $687,000 for this project.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China
PROJECT TITLE:	Fire Extinguisher Production Conversion from Halon 1211 to ABC Dry Chemical (Zhuzhou Fire Equipment Factory)
BUDGET:	Incremental Investment Cost US $411,000 Incremental Operating Cost US $410,000 Financial Agent Fee US $ 25,000
INCREMENTAL COSTS:	US $846,000
ODS PHASE-OUT:	250 mt/yr of halon 1211
COST EFFECTIVENESS:	US $1.13/kg (ODP) halon 1211 phased out
PROJECT DURATION:	1 year
IMPLEMENTING AGENCY:	The World Bank
NATIONAL COORDINATING AGENCY:	National Environmental Protection Agency
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. The Zhuzhou project consists of three components. The first two components relate to the conversion of the halon 1211 fire extinguisher production line to ABC dry powder (70,000 units/year) and AFFF extinguishers (30,000 units/year) by retrofitting the halon extinguisher production equipment and adding testing facilities in accordance with the nature of AFFF extinguisher. Corrosion resistance equipment and testing instruments for the production of AFFF extinguishers will be imported. The third component relates to modifications of the fire extinguisher production workshop to be financed by the enterprise. The technology will be provided by Zhejiang Fire Equipment Factory.

2. Capital costs include the cost of technology at US $135,300 and cost of training at US $31,700, which the enterprise deems to be incremental.

3. The project documents states that "Zhuzhou Fire Equipment Factory plans to obtain technology from Zhejiang Fire Equipment Factory".

4. Since Zhejiang was financed by the Multilateral Fund, and since it will transfer the technology to Zhuzhou, the cost of technology to the latter should not be considered as incremental. Both factories are in China, the Fund financed a technology in one factory which in turn should provide it to other factories.

5. Incremental operating costs are calculated for 3 ½ years on the basis of lost profit, while the project will realize net savings.

SECRETARIAT'S RECOMMENDATION

6. The Secretariat recommends that approval of the project should be deferred until operating savings are calculated and taken into account when determining the grant amount for the project.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China	
PROJECT TITLE:	Halon 1211 Production Closure (Tongxiang Chemical Fertilizer Factory)	
BUDGET:	Incremental Cost	US $814,000
	Financial Agent Fee	US $ 24,000
INCREMENTAL COSTS:	US $838,000	
ODS PHASE-OUT:	400 mt/yr of halon 1211	
COST EFFECTIVENESS:	US $0.70/kg ODP saved	
PROJECT DURATION:	6 months	
IMPLEMENTING AGENCY:	The World Bank	
NATIONAL COORDINATING AGENCY:	Ministry of Public Security (MPS)	
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _	

SECRETARIAT'S COMMENTS

1. This is the first proposal for plant closure in the production sector.

2. Tongxiang Chemical Fertilizer Factory produces about 400 metric tonnes of halon 1211 annually.

3. The incremental costs of the project arise from compensation for foregone profit for the remaining life of the factory, dismantling of production facilities, demolishing of buildings, and compensation to staff and workers.

4. Financial losses to the factory from stopping halon production are calculated on the basis of the average annual profit in the past three years multiplied by the remaining life of the plant and discounted by 12 per cent (for 6 ½ years).

5. Compensation to staff and workers is calculated on the basis of the average monthly income of 50 staff and workers for a period of two years. Chinese regulations require that the level of compensation of workers should equal the average monthly income level.

6. Five per cent contingency as well as three per cent Financial Agent's Fees are included in the grant amount.

7. China has about 50 halon producing factories.

8. The Executive Committee approved at its Seventh Meeting the Beijing ABC Powder Production project. The Committee did not made its approval contingent on closure of equivalent halon production facility. Beijing ABC Powder did not produce halons.

9. The Indicative List of Categories of Incremental Costs indicates the following in paragraph 2 (a) (ii) and (iii):

"(ii) Cost arising from premature retirement or enforced idleness, taking into account any guidance of the Executive Committee on appropriate cut-off dates:

- of productive capacity previously used to produce substances controlled by existing and/or amended or adjusted Protocol provisions; and

- where such capacity is not replaced by converted or new capacity to produce alternatives;

(iii) Cost of establishing new production facilities for substitutes of capacity equivalent to capacity lost when plants are converted or scrapped, including:

- cost of patents and designs and incremental cost of royalties;

- capital cost;

- cost of training, as well as the cost of research to adapt technology to local circumstances".

10. Consideration of the project should be made subject to the interpretation of (ii) and (iii) above.

SECRETARIAT'S RECOMMENDATION

11. The Secretariat, based on the importance of the project and the precedent it will undoubtedly set, recommends to establish a sub-committee to elaborate policy guidelines on how to deal with this and similar projects. A decision on the present project should be deferred pending the elaboration of the guidelines.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China	
PROJECT TITLE:	Aerosol CFC-12 Substitution and Conversion Project at China Aerosol Industry Southern Filling Center (Zhongshan Fine Chemical Industrial Limited)	
BUDGET:	Capital Cost	US $3,332,000
	Contingency	US $ 500,000
	Incremental operating benefit	US $2,139,000
	Financial Agent Fee	US $ 51,000
INCREMENTAL COSTS:	US $1.744 million	
ODS PHASE-OUT:	4067 mt/y of CFC-12	
COST EFFECTIVENESS:	US $0.43/kg ODP saved	
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. A composite project proposal covering both production of Dimethyl ether (DME) and conversion of aerosol filling plant, at an estimated cost of US $1.6 million, was submitted to the Twelfth Meeting of the Executive Committee.

2. The Committee considered the proposal in light of the Secretariat's comments and the remarks provided by the Government of China, and requested the World Bank to re-submit a revised proposal for future consideration.

3. GOC's remarks circulated at the Twelfth Meeting affirmed that the enterprise will self-finance DME production and subsequently requested funding of only the conversion project at an estimated cost of US $1.443 million.

4. The World Bank and Government of China submitted a revised proposal for the consideration of the Thirteenth Meeting of the Executive Committee. The cost estimated in the new proposal amount to US $1.744 million.

5. The incremental capital costs are estimated at US $3,332,000, the contingency applied amounts to US $500,000 and the incremental operating savings are estimated at US $2,139,000.

6. The incremental operating savings are calculated separately for Zhongshan's own product and for the filling services for small enterprises. Two thirds of the incremental savins of the latter would be passed onto their customers. Thus, the incremental benefit accruing to Zhongshan and only one third of the incremental benefits resulting from filling services for small enterprises are deducted from the capital costs.

7. The Secretariat provided substantial comments on the revised project to the World Bank regarding the incrementality of some of the project's cost items and the calculation of incremental benefits.

8. A consultant of the World Bank affirmed that all cost items are incremental, including the high cost of installation and commissioning which amount to 13 per cent of the investment costs; even without deducting those cost items that do not need installation or are not judged to be incremental. Also project management cost at US $55,000 cannot, and should not, be incremental.

9. The Government of China provided detailed justification for all cost items.,

10. Both GOC and the Bank's consultant refer to the two aerosol projects approved at the Seventh Meeting for China at a combined cost of US $5,079 million for the phase-out of 12,600 tonnes of CFC-12. However, the World Bank has not to date provided the Executive Committee any details on these two projects, with regard to their actual incremental costs and the amount of CFC-12 to be phased out.

11. The revised proposal claims that it will phase out 4,067 tonnes of CFC-12 bringing the total quantity of CFC-12 to be phased out as a result of the three projects to 16,667 tonnes. China's Country Programme estimates the consumption in 1991 in the aerosol sector at 8,600 tonnes, and the project proposal estimates 9,720 tonnes in 1992. Accurate estimates of China's total consumption of CFC-12 in the aerosol sector should therefore be provided.

SECRETARIAT'S RECOMMENDATIONS

12. The Secretariat recommends approval of the project and approval of funding at US $836,350 after adjusting the capital costs and contingencies for total operating savings, in addition to US $25,000 for Financial Agent's Fees.

13. The Secretariat further recommends that the World Bank should provide a progress report on the implementation of the two aerosols projects already approved by the Executive Committee.

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 $1,280,000
	b)	US $1,445,000
	c)	US $1,442,000
	d)	US $1,010,000
	e)	US $1,360,000
	f)	US $860,000

COST EFFECTIVENESS[1]: N/A

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. The six project proposals were considered by the Executive Committee at its Twelfth Meeting. The Committee granted the World Bank permission to proceed on the understanding that:

   (a) the projects would 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;

   (b) testing of appliances must be rationalized. Either the testing equipment requested in those projects should be used for other enterprises or centralized centres should be established within four to five existing R&D institutes; and

   (c) incremental operating costs of the six projects should be accurately estimated.

2. Government of China communicated its response to the Committee's decision and agreed (confirmed by the World Bank) that the response should be transmitted with the project document to the Executive Committee.

3. Government of China's response adequately addresses the points raised in the Executive Committee's decision.

4. The Secretariat is reproducing in the succeeding paragraphs some of its previous comments on the projects.

5. 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.

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

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

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

8. 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.

9. Phase I of Hua Yi project (project c) has been completed. Therefore, requested 15 per cent contingency cost for Phase I should be deleted.

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

11. 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.

12. 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 as well as CFC-12 refrigerators. This item is not incremental.

13. None of the five refrigerator production projects (b-f) mentions whether the existing CFC-12 lines will be scrapped, modified or converted.

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

SECRETARIAT'S RECOMMENDATIONS

After considering the response of the Government of China to the Executive Committee's decision regarding these projects, the Fund Secretariat recommends as follows:

1. To approve the six projects within the framework of China's strategy for the phase-out of CFC-12 in the domestic refrigeration sector. The following conditions should however be met:

   (a) Results of developmental research on refrigerants: HFC-152a, MP-39 and HFC-152a/HCFC-22 should be made available at no cost to other Article 5 countries upon request;

   (b) As per the GOC note referred to above, compressors for blends and HFC-152a could be used without redesigning. Therefore, requests for funding of redesign of compressors for these refrigerants should not be approved in the future;

(c) Existing lines for production of compressors and refrigerators should be scrapped once projects are implemented;

(d) Testing equipment provided for in these projects should be relocated in regional centres once their transitional purpose is achieved; and

(e) Costs of contingency for Phase I in Hua Yi should be deleted as well as the cost of servicing truck for Shanghai Shangling.

2. To approve the following allocations for the six projects. The approvals include 15 per cent for contingency costs and Financial Agent's Fees.

	Project	Recommended Funding (US $)
(a)	Shanghai Compressor Ltd.	1,280,000
(b)	Shanghai Shangling	1,327,000
(c)	Hua Yi	1,368,000
(d)	Shanghai Shanglu	1,010,000
(e)	Wanbao	1,360,000
(f)	Chang Ling	853,000

BUDGET

PROJECT	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 $
Capital costs* Phase I	1,012,000	920,000	500,000 (retroactive)	540,000	517,500	645,000
Capital costs* Phase II	230,000	483,000	828,000	440,000	805,000	335,000
Total Project Cost	1,242,000	1,403,000	1,328,000	980,000	1,322,500	980,000**
Financial Agent Fee	37,260	42,100	39,800	30,000	40,000	30,000

* Includes 15 per cent contingency cost

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

PROJECT COVER SHEET

COUNTRY:	**China**
PROJECT TITLE:	**YANFENG conversion to non-CFC technology in the manufacture of flexible and integral skin polyurethane foam**
SECTOR COVERED:	**Foamed Plastics**
ODS USE IN SECTOR:	**17,773 tons CFCs (=ODP) in 1991**
PROJECT IMPACT:	**Phaseout of 67.5t/y CFC-11**
PROJECT DURATION:	**one year**
PROJECT ECONOMIC LIFE:	**10 years**
TOTAL PROJECT COST:	**USD 530,000 Incremental Capital Cost** **USD 140,000 Incremental Recurrent Cost**
PROPOSED MLF GRANT:	**USD 670,000**
COST EFFECTIVENESS:	**USD 1.66/kg/y (unit abatement costs)**
EXECUTING AGENCY:	Ministry of Machinery Industry (MMI) Dept. of Automotive Industry
NATIONAL COORDINATING BODY:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	**May 11, 1994, 1993**

PROJECT SUMMARY

MMI, NCLI, NEPA and UNDP have devised a strategy for the phaseout of the use of CFCs in the automotive trim industry (about 600 t/y).

Under this project Shanghai Yanfeng Automobile Interior Trimming Factory ("YANFENG") will phaseout the use of CFCs in the production of back cushions and steering wheels. The plant will function as a demonstration project.

Prepared by: Maoqi Zhang, UNDP Regional Expert "China"
Reviewed by: Bert Veenendaal, UNDP Sector Expert (Foams)

PROJECT OF THE GOVERNMENT OF CHINA

YANFENG CONVERSION TO NON-CFC TECHNOLOGY IN THE MANUFACTURE OF FLEXIBLE AND INTEGRAL SKIN POLYURETHANE FOAM

1. PROJECT OBJECTIVE

The objective of this project is (i) to phaseout the use of CFCs in the manufacture of flexible and integral skin polyurethane (PUF) foam at Shanghai Yangfeng Automobile Interior Trimming Factory ("Yangfeng") and (ii) to function as a demonstration center for the Chinese automotive trim industry in the application of ODS-free manufacturing technologies.

2. SECTOR BACKGROUND

The Chinese foam industry consumed in 1991 17,773 tons CFCs (China Country Programme). CFC-11 was the dominant substance (15,600 t, PUF), followed by CFC-12 (2,173 t, EPS/PE). Production is divided between larger state owned enterprises and smaller township or private enterprises. Production and process information from state enterprises is well documented. However information on the rest of the industry is less reliable. More detailed information about the sector is provided in the following table:

Categories Subcategories	ODS (t)	Production (t)	Plants (range)
Extruded PS/PE	2,173	13,000	30- 50
Flexible Polyurethane	2,000	50,000	50-100
Pipe Insulation	600	4,000	10- 20
Sprayed PUF	600	4,000	50-200
Appliance Foams	5,000	40,000	40- 70
PUF Panels	7,400	52,000	20- 50
Total Rigid PUF	13,600	100,000	120-340
TOTAL	**17,773**	**163,000**	**200-490**

The Chinese Foam Industry
Selected Industry Data (1991)

The National Council of Light Industry (NCLI) is responsible for phaseout coordination in all foam categories. There are other line ministries involved, i.c.:

- Ministry of Chemical Industry (MCI),
- Ministry of Internal Trade (MIT),
- China Aerospace Industry Corporation (CAIC),
- Ministry of Machinery Industry (MMI),

Complete phaseout for non-refrigeration foams is targeted for the year 2000. Refrigerating foams are expected to be CFC free from the year 2005.

MMI and UNDP in cooperation with NCLI and NEPA have devised a strategy for the phaseout of CFCs in automotive trim (car seats, steering wheels, liners, etc). This is a predominantly nationally owned industry, supplying to car manufacturing joint-ventures. The car manufacturing industry is a highly internationally oriented industry that prioritizes the phaseout of the use of CFCs in its products, thus forcing the suppliers of original equipment parts (OEM-suppliers) into an early phaseout program. The devised strategy will support and coordinate this phaseout. The first phase will consist of investment projects with demonstration character, followed by phaseout programs at affiliated trim plants. The third and last phase will address the secondary suppliers. The trim industry consumed 600 tons of CFCs in 1991.

3. ENTERPRISE BACKGROUND

Shanghai Yanfeng Automobile Interior Trimming Factory, a subsidiary of the state owned Shanghai Automotive General Corporation, was founded in 1978 as a trim supplier for the Chinese car industry. The company experienced rapid growth, mainly related to the parent company's production of Volkswagen Santana, but also related to the general rapid growth of the Chinese car industry. It employs currently 1700 in 5 plants in and around Shanghai. The production includes:

- Arm rests
- Dashboards
- Car seats
- Door panels
- Head rests
- Steering Wheels
- Motorcycle seats
- Sun visors

The parts are used in Chinese joint venture cars from Volkswagen, Jeep, Peugeot, Citroen and Audi, but also in the light trucks from the Beijing and Tianjin Automobile Works. Annex-1 shows some of the production program.

In March 1993, the company has entered a joint venture with the trim division of Ford Motor Company/USA for the production of complete car seats. The existing production will be kept separated from this JV and remain fully Chinese owned and act as a supplier.

4. PROJECT DESCRIPTION

Yanfeng operates 10 polyurethane production lines for its trim products. On most of these lines the use of CFCs has already been eliminated. There is a remaining use (base 1994) in

o	Back cushions	CFC-11	40.0 t/y
o	Steering wheels	CFC-11	27.5 t/y
o	Release agent	CFC-113	7.5 t/y

Under this project the company will implement with the help of an external expert preselected replacement technologies for the production of cushions and steering wheels. The phaseout of the use of CFCs in mold release agents will be achieved without help by the Fund through a program that started already some time ago.

During the implementation process Yanfeng will also evaluate other technologies. The results of these evaluations will be made available to other trim plants and thus avoid a duplication of efforts in the Chinese automotive trim sector.

5. TECHNOLOGY

5.1 OVERVIEW

AUTOMOTIVE BACK CUSHIONS (HOT CURED FOAM or "HCF")

CFC-11 is used in this application to soften the foam. Available replacements are:

- Alternative blowing agents (Methylene Chloride, HCFC-141b, HCFC-123)
- Softening agents
- Reduced index/additive technology
- High resilience foams ("cold cured" foams)

AUTOMOTIVE STEERING WHEELS (INTEGRAL SKIN FOAM or "ISF")

CFC-11 serves predominantly the skin formation and the viscosity reduction of the system. Available replacements are

- Reduced CFC technology
- HCFCs (-22; -123; -141b)
- All water based
- Hydrocarbons (n-pentane; isopentane, butane)
- Methylene chloride
- "Renosol" technology (HFC-134a/water blend)

5.2 SELECTION

The evaluation in cushion applications will focus on index/additive technologies. HCFC-123 and -141b are eliminated based on price and/or environmental/safety factors; HR-foams based on performance. methylene Chloride and softeners will be evaluated but are thought most likely not to meet automotive specifications.

For steering wheels the focus will be on HCFC-22 . Water based systems are eliminated based on performance and HCFC-123 based on safety. HCFC-141b, pentane and methylene chloride are feasible and may be evaluated, but generate concerns on, respectively, availability/price, safety (one plant is in a residential area) and quality.

5.3 IMPACT ON PRODUCTION PROCESS

The HCF lines for cushions and the related premix stations can handle the selected alternative without any required modifications. Only process trials will be required.

For ISF evaluation purposes, two production units need to be replaced. In addition process trials and process/safety training will be required.

6. PROJECT COSTS

Preliminary investigation indicated that softening technology (HCF) and HCFC-22 technology (ISF) will provide satisfactory product quality and these technologies are therefore taken as budgetary bench marks.

6.1 CAPITAL COSTS

HCF APPLICATION

TRIALS: 3 SERIES @ 5,000	USD	15,000

ISF APPLICATIONS

2 HIGH PRESSURE FOAM DISPENSERS	USD	240,000
ONE PRE-MIXING STATION	USD	75,000
VENTILATION, MISC. ADJUSTMENTS	USD	40,000
TRIALS: 6 SERIES @ 5,000	USD	30,000
TECHNOLOGY TRANSFER	USD	50,000
PROCESS/SAFETY TRAINING 2 PLANTS @ 15,000	USD	30,000
CONTINGENCY	USD	50,000
TOTAL INCREMENTAL CAPITAL COST	**USD**	**530,000**

6.2 OPERATING COSTS

HCF:	**BEFORE:**	40t CFC-11 @ 1,750	USD	70,000
	AFTER:	40t TDI @ 1,900	USD	76,000
		4t SOFTENER ADDITIVE @ 7,000	USD	28,000
ISF:	**BEFORE:**	27.5t CFC-11 @ 1,750	USD	48,125
	AFTER:	23.0t HCFC-22 @ 2,100	USD	48,300
		5.0 t MDI @ 2,000	USD	10,000
		INCREMENTAL RECURRENT COST/Y	**USD**	**44,175**

This amount at 10% discount over 4 years to a Net Present Value of

USD 140,000

6.3 UNIT ABATEMENT COST

a)	ODS Reduction Capital Costs	USD 530,000
b)	Annual Incremental Costs	USD 31,675
c)	Project Useful Life	10 years
d)	Capital Recovery factor (disc. rate: 10%)	0.16275
e)	ODS Reduction/y	kg 67,500

Unit Abatement Costs [{a(d) + b)/e] ..... USD/kg/y 1.93

7. FINANCING PLAN

The company requests a grant covering the full incremental capital and recurrent costs amounting to

USD 670,000

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP, MMI and NEPA will oversee the successful implementation of the project. The project will be carried out by Yanfeng at its facility and branch.

8.2 SCHEDULE

TASK	Q1	Q2	Q3	Q4
Project Preparation				
Specifications	x			
Tenders, Selection	x			
Purchase Orders	x			
Site preparation				
Civil Works		x		
Equipment arrival				
Customs clearance		x		
Installation		x		
Startup, trials, training			xxx	xxx
Commissioning				x

9. REQUIRED REGULATORY ACTION

The project will not require regulatory action. Yanfeng will contact the local fire department and assure that the installations to allow the use of (minor amounts of) pentane meets local safety requirements and approval of the department.

10. PROJECT IMPACT

This project will eliminate the use of at least 67.5 tons of CFC-11 in the first year of implementation. Market and company growth indicates that this may increase by 10-15% annually in subsequent years. The project will employ commercially and environmentally acceptable technology.

11. ANNEXES

Annex-1: Product Information
Annex-2: Technical Assessment

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TECHNICAL REVIEW

PREPARED BY: Bert Veenendaal
UNDP Foam Sector Expert

DATE: June 13, 1994

1.	COUNTRY OF ORIGIN:	CHINA
2.	PROJECT TITLE:	YANFENG Conversion to non-CFC technology in the manufacture of flexible and integral skin polyurethane foam
3.	(SUB)SECTOR	Foamed Plastics
4.	CP RELATIONSHIP:	Not known
5.	TECHNOLOGY:	This project is a demonstration project. It will address the most promising technologies from a cost and quality standpoint for the enterprise as well make this information available through KMI to other trim manufacturers in China. The selection of the technologies to be evaluated is supported and the choice of "bench mark" technologies for cost calculations is reasonable
6.	ENVIRONMENTAL IMPACT:	All technologies to be evaluated are acceptable from an environmental view. However the technologies based on HCFCs are of interim character, and this should be taken into account during the evaluation
7.	PROJECT COSTS:	The unit abatement cost are reasonable for flexible as well as for integral skin foam (acceptable range 1.50- 5.00). It is lower that comparable projects in Malaysia, mainly based on economy of scale.
8.	IMPLEMENTATION:	Adequate
9.	RECOMMENDATION:	The project is recommended for approval

END

PROJECT COVER SHEET

COUNTRY:	China
PROJECT TITLE:	Elimination of CFC-11 in the manufacture of rigid polyurethane foam products at Tianjin Polyurethane Plastic Plant.
SECTOR COVERED:	Foamed Plastics
ODS USE IN SECTOR:	17,773t CFCs (= ODP) in 1991
PROJECT IMPACT:	100t CFC-11, based on 1993 consumption
PROJECT DURATION:	One year
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	USD 655,000 Incremental Capital Cost USD 125,000 Incremental Recurrent cost USD 780,000
PROPOSED MLF GRANT:	USD 690,000
COST EFFECTIVENESS:	USD 1.51/kg/y (unite abatement cost)
EXECUTIVE AGENCY:	National Council of Light Industry
COORDINATING NATIONAL BODY:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	June 3, 1994

PROJECT SUMMARY

Tianjin Polyurethane Plastic Plant is a state owned enterprise under Tianjin Second Light Industry Bureau. The company produces both flexible and rigid polyurethane products by using CFC-11 as a blowing agent. The purpose of this project is to phaseout the CFC-11 usage in rigid PU foam production through pentane.

The company is currently completing the phaseout of CFC-11 usage in flexible foam and in its polyol blending facilities utilizing MLF grants.

TECHNICAL ASSESSMENT

Prepared by: Maoqi Zhang, Regional Expert, and Tianjin Polyurethane Plastic Plant

Reviewed: Bert Veenendaal, UNDP senior foams sector expert. Comments attached.

PROJECT OF THE GOVERNMENT OF CHINA

TIANJIN POLYURETHANE PLASTIC PLANT ELIMINATION OF CFCs IN THE MANUFACTURE OF POLYURETHANE RIGID FOAM PRODUCTS

1. PROJECT OBJECTIVE

The objective of this project is to phase out the use of CFCs in the manufacture of polyurethane rigid foam products in Tianjin Polyurethane Plastic Plant.

2. SECTOR BACKGROUND

The Chinese foam industry consumed in 1991 17,773 tons CFCs (China Country Programme). CFC-11 was the dominant substance (15,600 t, PUF), followed by CFC-12 (2,173 t, EPS/PE). No other ODS was used in statistical significant amounts, although some MCF may be used in adhesive applications. Furthermore some MCF and CFC-113 may be used in mold release agents. Production is divided between larger state owned enterprises and smaller township or private enterprises. Production and process information from state enterprises is well documented. However information on the rest of the industry is less reliable. More detailed information about the sector is provided in the following table:

Categories Subcategories	ODS (t)	Production (t)	Plants (range)
Extruded PS/PE	2,173	13,000	30- 50
Flexible Polyurethane	2,000	50,000	50-100
Pipe Insulation	600	4,000	10- 20
Sprayed PUF	600	4,000	50-200
Appliance Foams	5,000	40,000	40- 70
PUF Panels	7,400	52,000	20- 50
Total Rigid PUF	13,600	100,000	120-340
TOTAL	**17,773**	**163,000**	**200-490**

The Chinese Foam Industry Selected Industry Data (1991)

Government and industry are committed to sharply reduce, and ultimately eliminate CFC utilization. NCLI is responsible for the phaseout coordination in all foam categories. Ministerial responsibility is divided into two areas:

- Refrigerating foams.
- Non-refrigerating foams

There are other ministries involved in the refrigeration foams, i.c.:

- Ministry of Chemical Industry (MCI),
- Ministry of Internal Trade (MIT),
- China Aerospace Industry Corporation (CAIC),
- Ministry of Machinery Industry (MMI).

Complete phaseout for non-refrigeration foams is targeted for the year 2000. Refrigerating foams are expected to be CFC free from the year 2005. Uninhibited use of CFCs in foams for domestic refrigeration is expected to lead to an increase during 1991-1995 by 8 %/y, and after 1995 by 3 %/y. For other foams, a growth rate of 6 %/y is forecasted.

3. ENTERPRISE BACKGROUND

Tianjin Polyurethane Plastic Product Factory ("Tianjin") is one of the leading enterprises in the foam sector in China. The company counts more than 672 employees, from which about 52 constitutes the technical staff. The production program includes the manufacture of polyols, elastomers, polyether polyol blends, different types of polyurethane foams and products from flexible foams (rolls, sheets, etc). Major equipment is imported from abroad, and relatively new. Beside the installations for polyol and elastomer production, the company operates:

- 3 continuous flexible foam lines,
  (2 Cannon Viking, 1 Martin Sweets)
- 1 continuous panel line (OMS),
- 1 continuous pipe insulation line (Siku),
- 1 unit for in situ foaming.

The annual production (base year 1991) is as follows:

PRODUCTION (T)	PRODUCT	CFC USE (T)
2,000	Polyether Polyol,	-
500	Polyester Polyol,	-
3,000	Polyether Blends[1]	120
4,000	Flexible PUF,	180
600	R-PUF Panels,	75
80	R-PUF Pipe Insulation,	15
20	R-PUF In Situ Foaming,	5
1,000	PU Elastomers	-

The sandwich panel production has changed into a joint venture (Tianrong Sandwich Panel Plant) since 1990. Tianjin owns 75% of the joint venture, a Switzerland company owns 25%.

4. PROJECT DESCRIPTION

Tianjin Polyurethane Plastic Plant, as one of the biggest polyurethane manufacturer in China, leads in CFC phaseout. It will soon finish the phaseout in flexible foam production and polyol blending. At the same time, it would like to begin the phaseout in rigid foam production.

Tianjin's rigid foam production consumes 100 tons of CFC-11 each year. After technically and economically evaluating different options, the plant selected pentane.

Under this project, the plant will make safety modifications as well as infrastructure measure to mitigate fire and exposure hazards from the use of pentane and will provide extensive production and safety training.

5. TECHNOLOGY

5.1 OVERVIEW AND SELECTION

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

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

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

---

[1] Used in the production of rigid polyurethane foams. About 25% or 700 t/y is used in own production.

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

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

Cyclopentane technology has recently been introduced commercially in Germany. Its flammable character requires safety conditions and limits its use. Several companies currently offer cyclopentane packages, including equipment. Based on economic environmental considerations, cyclopentane would be the best choice for these applications.

5.2 IMPACT ON PRODUCTION PROCESS

The use of pentane will require substantial changes in the production process and storage facilities. Required equipment modifications and additions may include:

Storage
- Separate, explosion proof storage of the butane tank.

Feeding systems
- More injection systems for additives,
- Replacement of the foamant metering pump and injection system,
- New gaskets and seals,
- New pressure gauges.

Extrusion system
- Replacement or modification of the screw,
- Replacement or modification of the extrusion die.

Electrical systems
- Installation of spark arresters,
- Sealing of electrical control cabinets,
- Explosion proof motors and switches.

Auxiliary safety devices
- Ventilation to prevent the accumulation of hydrocarbon vapors,
- Monitoring and alarm systems for hydrocarbon vapors,
- Extra fire extinguishers.

Production and aging areas
- To be separated from other working areas,
- To be sprinklered or otherwise protected against fire hazards.

Production and maintenance personnel
- To be trained in the safe handling of hydrocarbons, in addition to production training.

Start-up trials
- To adjust for foamant volume and permeability.

6. PROJECT COSTS

6.1 CAPITAL COSTS

INSULATION PIPE AND BOX

1 EXPLOSION PROOF FOAM DISPENSER	USD	180,000
1 PRE-BLENDING STATION	USD	80,000
VENTILATION, DETECTORS, MISC. SAFETY	USD	50,000
TRIALS	USD	10,000
TECHNOLOGY TRANSFER	USD	20,000
PROCESS/SAFETY TRAINING AND AUDIT	USD	10,000
CONTINGENCY	USD	35,000
SUBTOTAL	USD	385,000

SANDWICH PANEL

DISPENSER RETROFIT	USD	50,000
ONE PRE-BLENDING STATION	USD	80,000
METERING PUMP	USD	10,000
VENTILATION, DETECTORS, MISC. SAFETY	USD	50,000
TRIALS	USD	20,000
OUTSIDE VERIFICATION TESTING	USD	5,000
TECHNOLOGY TRANSFER	USD	20,000
PROCESS/SAFETY TRAINING AND AUDIT	USD	10,000
CONTINGENCY	USD	25,000
SUBTOTAL	USD	270,000

TOTAL INCREMENTAL CAPITAL COST.....USD 655,000

6.2 OPERATING COSTS

The Net Present Value calculated following MLF instruction is expected to amount to cost of

USD 125,000

The calculation of incremental recurrent cost is in Annex-2.

6.3 UNIT ABATEMENT COST

a)	ODS Reduction Capital Costs	USD	655,000
b)	Annual Incremental Costs	USD	73,510
c)	Project Useful Life		10 years
d)	Capital Recovery factor (disc. rate: 10%)		0.16275
e)	ODS Reduction/y	kg	100,000

Unit Abatement Costs [{a(d) + b)/e] ..... USD/kg/y 1.80

7. FINANCING PLAN

The company requests a grant covering the Chinese shareholder's incremental capital and recurrent costs amounting to

USD 690,000

The calculation of this grant request is provided in Annex-3.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP, NCLI and NEPA will oversee the successful implementation of the project. The project will be carried out by Tianjin at its facility and branch.

8.2 SCHEDULE

TASK	Q1	Q2	Q3	Q4
Project Preparation				
Specifications	x			
Tenders, Selection	x			
Purchase Orders	x			
Site preparation				
Civil Works		x		
Equipment arrival				
Customs clearance		x		
Installation		x		
Startup, trials, training			xxx	
Commissioning				x

9. REQUIRED REGULATORY ACTION

The project will not require regulatory action. TIANJIN will contact the local fire department and assure that the installations to allow the use of (minor amounts of) pentane meets local safety requirements and approval of the department.

10. PROJECT IMPACT

This project will eliminate the use of at least 100 tons of CFC-11 in the first year of implementation. Market and company growth indicates that this may increase by 10-15% annually in subsequent years. The project will employ commercially and environmentally acceptable technology.

11. ANNEXES

Annex-1: Technical Assessment
Annex-2: Incremental Recurrent Cost Calculation
Annex-3: Calculation of Grant

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94-06-03/003

TECHNICAL REVIEW

PREPARED BY: Bert Veenendaal
UNDP Foam Sector Expert

DATE: June 13, 1994

1.	COUNTRY OF ORIGIN:	CHINA
2.	PROJECT TITLE:	Elimination of CFC-11 in the manufacture of rigid PUF products at TIANJIN POLYURETHANE PLASTIC PLANT
3.	(SUB)SECTOR	Foamed Plastics
4.	CP RELATIONSHIP:	Mentioned
5.	TECHNOLOGY:	The choice of technology is supported. It should be emphasized that the company intends to use n-pentane and not cyclopentane. The document is not always clear on this matter. N-pentane is available in China--although not readily--and is lower in cost. it is specifically in Europe widely applied in panels
6.	ENVIRONMENTAL IMPACT:	pentane is highly flammable and should be handled accordingly. The project addresses this adequately. pentane is also photochemically active and its status under local regulations should be monitored
7.	PROJECT COSTS:	The unit abatement cost are reasonable, even low (standard about 1.50-2.50)
8.	IMPLEMENTATION:	Adequate
9.	RECOMMENDATION:	The project is recommended for approval

ANNEX - 2

INCREMENTAL RECURRENT COST CALCULATION

ASSUMPTIONS:

- Price of CFC-11 in China was RMB 15,000/t in May; Pentane price: RMB 10,000 t.
- Price of MDI in China was RMB 18,000/t in May
- Ratio: 8 Pentane = 10 CFC-11
- Preventative maintenance: 5% of equipment related project costs: $37,400.
- 1 USD = 8.5 RMB

1) MATERIAL

• Before:	100t CFC-11 @ 1,765		USD 176,500
• After:	75t MDI @ 2,118		USD 158,850
	30t pentane @ 1,176		USD 41,160
		NET	+ 23,510

2) OTHER RECURRING INCREMENTAL COSTS

• Recurrent training/monitoring costs	USD	5,000
• Extra maintenance & utility	USD	25,000
• Extra insurance	USD	20,000
TOTAL	USD	50,000

3) TOTAL ANNUAL RECURRING INCREMENTAL COSTS

• Annual cost of project	USD	73,510

4) NET PRESENT VALUE OF THE RECURRENT INCREMENTAL COST

2 YEAR/10% DISCOUNT	USD	125,000

ANNEX - 3

CALCULATION OF THE GRANT REQUEST

The company operates the panel production as a joint venture with 75% share of local ownership. The production of pipe and box insulation is 100% locally owned.

The calculation of the foreign participation in the cost of the project and the requested grant is as follows:

($ IN USD)	**PIPE AND BOX**	**PANELS**
INVESTMENT	$ 385,000	$ 270,000
CFC-USE	25,000 kg	75,000 kg
INCREMENTAL RECURRENT COST (Apportioned by CFC Usage)	$ 31,250	$ 93,750
TOTAL INCREMENTAL COST	$ 416,250	$ 362,750
GRANT (with rounding)	$ 418,000	$ 272,000 (75%)

TOTAL GRANT = USD 690,000

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

COUNTRY:	The People's Republic of China
PROJECT TITLE:	Conversion to CFC-free technology in manufacture of rigid polyurethane pipe insulation
SECTOR COVERED:	Foamed Plastics
ODS USE IN SECTOR:	17,770 tons CFCs in 1991
PROJECT IMPACT:	Phase-out 105 tons CFC-11 per year (base year: 1992)
PROJECT DURATION:	One year
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	Incremental Investment Cost: US$580,000 Contingency: US$ 87,000 Financial Agent Fee: US$ 20,000
PROPOSED OTF FINANCING:1/	US$ 687,000
IMPLEMENTING ENTERPRISE:	Shanghai No.6 Plastics Product Plant
COORDINATING NATIONAL BODY:	National Environmental Protection Agency
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY

Under this project Shanghai No.6 Plastics Product Plant will phase-out use of CFC-11 in production of rigid poly urethane pipe insulation. Carbon dioxide was selected as a long term substitute to CFC-11. HCFC-141b can be used as an interim solution during the period when recipes using 100% CO_2 as a blowing agent can not achieve technical specifications.

The project employs commercially available technology and previous country study investigations have identified it as a high priority project. It has been designated by NCLI as a priority project.

TECHNICAL ASSESSMENT: The project has been reviewed and supported by the OORG technical reviewer, Dr. Mike Jeffs. His comments are addressed in the final version of this project.

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 project objectives are (a) to phase-out use of CFCs in production of rigid polyurethane (R-PUF)pipe/spray insulation at Shanghai No.6 Plastics Products Plant (Shanghai No.6) and (b) to make Shanghai No.6 a commercial demonstration for phase out of CFC-11 in pipe insulation.

SECTOR BACKGROUND

The Chinese foam industry consumed about 17,800 tons of CFCs in 1991, including 15,600 tons of CFC-11 (PUF) and 2,200 tons of CFC-12 (EPE/EPS). The consumption of CFC-11 in rigid polyurethane foam sector was 13,600 tons, including 600 tons used for pipe insulation. Complete phaseout of non-refrigeration foams is targeted for the year 2000. From 1994 to 2000, the consumption of CFC-11 in polyurethane pipe insulation sector is expected to increase by 6% annually, if local use of CFCs is not inhibited. National Council of Light Industry (NCLI) is responsible for coordinating the phase-out in all foam sectors.

ENTERPRISE BACKGROUND

Shanghai No.6 is a part of Shanghai Plastics Products Co. which in turn belongs to Shanghai Second Light Industry Bureau. Shanghai No.6 was the first plant in China to produce rigid pipe/spray insulation. Consumption of CFCs is 660 tons. All products are sold on the domestic market. Sales in 1992 was 90 million RMB(10 million USD). The market share in polyurethane foam sector was about 5%. The following is an overview of production related data:

PROCESS	CAPACITY (t/y)	PRODUCTION (1992)	CFC-USE (t/y)	EQUIPMENT
Polyol mfg	5,000	1,500	--	2 reactors
Blending	5,000	2,500	385	1 blender
Rigid PUF panels	4,000	700	95	2 laminators
Pipe insulation				
Rigid molded	1,000	400	60	4 LP units
Rigid spray	200	100	15	5 LP units
Flexible	100	10	--	1 units
Flexible Slabstock	5,000	3,000	75	2 units
Miscellaneous			30	(hand pour)
TOTAL CFC-USE			660	

The company has already prepared a project for its blending and polyol manufacturing facilities and is in the process of evaluating phaseout technologies for other applications.

PROJECT DESCRIPTION

To prepare for this project, representatives of Shanghai No.6, NCLI and NEPA went to Europe in September 1993 to look for technologies which could phase out the use of CFC-11 in PUF pipe

insulation. They visited chemical producers, PUF-manufacturers and attended a seminar which introduced pipe insulation technology. After evaluating the different technologies, they chose the "water blown" as a main option. However, this option will need time for formulators to optimize recipes and engineers to adjust production process to ensure the quality of foams produced will be the same as the original ones. HCFC-141b was selected as an interim solution for those formulations that are not yet successfully optimized. Approximately 20 MT of HCFC-141b will be used for 2-3 years at which time it is expected that CO_2 will be adopted for all applications.

All technologies mentioned above need high pressure dispensing machines which allow processing of higher viscosity of the polyol after elimination of a physical blowing agent and improve the K-Value through a more regular, consistent, finer cell structure. Foam chemical and processing experts will assist the enterprise modify foam formulations and adjust processing to meet specifications and quality standards. In addition, the elimination of flushing, higher efficiency and less product scrap will partially offset increased costs generated by using the "water blown" technology and HCFC-141b option.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION

The choice of non-ODS technology for PUF pipe insulation is--as for all rigid PUF foams--highly depending on the manufacturing process and the application. Generally the following mature technologies are available for rigid PUF:

Low ODS technologies:	* Reduced CFC
(interim)	* HCFCs (-141b, -22, -22/142b)
Non ODS technologies:	* Pentanes
(permanent)	* HFCs (-134a, -152a)
	* Chemically generated CO_2 ("water blown")

Representatives of Shanghai No.6, NCLI and NEPA have evaluated most of these technologies during their visit to Europe.

It was concluded that CO_2 would constitute an environmentally acceptable and economically viable permanent solution for the subject applications. HCFC-141b would be an acceptable blowing agent in formulations which require strict K-value standards and physical properties. Therefore, HCFC-141b was selected as an interim substitute in the formulation adjustment towards non-ODS production for 2-3 years. After that period, the enterprise will operate on a non-ODS basis.

The company will retain outside experts to supervise the implementation of CFC-free technology and to help with the development of appropriate chemical blends as well as safety training. The implementing agency will provide the company with a roster of recommended experts.

PROJECT COST

The total project cost is estimated at US$667,000 and is to be used for new equipment, technology transfer, in service training, trials, plus a 15% contingency. There are no incremental operating costs included in this project.

Investment costs of US$580,000 include capital investment in 6 high pressure PU foam machines,

technology transfer, in service training and trial production (Annex 1).

Operating costs. The use of "water blown" (i.e. CO_2) technology and HCFC-141b will increase formulation costs. It is expected that CO_2 will constitute the dominant technology and that formulation costs in itself will rise. However, improved processing leading to less scrap and other savings such as self cleaning mixing heads are expected to compensate for any increase in formulation costs. The company will therefore refrain from a request to be reimbursed for incremental operating costs. More information is provided in Annex 2.

Other costs. A 15% contingency (US$ 87,000) was included to ensure adequate funding of project costs following project appraisal. An additional US$20,000 (3%) was added to the grant request to cover the fee for services of the financial agent that will appraise the project and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Shanghai #6 is US$687,000 and was calculated as follows: investment costs, 15% contingency and 3% financial agent fee.

FINANCING PLAN

100% of project cost is to be covered by the grant.

PROJECT IMPLEMENTATION

Management: The National Environmental Protection Agency will oversee the successful implementation of this project. The project will be carried out at the Shanghai No.6.

Schedule

Task	Q1			Q2			Q3			Q4		
	1	2	3	4	5	6	7	8	9	10	11	12
Project preparation												
Specifications	X											
Tenders, Selection	X											
Purchase Orders	X											
Site preparation												
Civil works				X								
Equipment arrival												
Customs clearance							X					
Installation								X				
Start-up, trial, training										X	X	
Commissioning												X

REQUIRED REGULATORY ACTIONS: The company will comply with local regulations.

RESULTS:

Direct Project Impact: This project will eliminate use of at least 105 tons of CFC-11 in first year of operation. Market and company growth indicates that this may increase by 5-8% annually in subsequent years. Shanghai No.6 has been designated to be a pilot/demonstration plant in PUF pipe insulation CFC-11 phase out process in China. It will be instrumental in subsequent elimination of use of CFCs in similar plants. Approximately 20 MT of HCFC-141b will be used for 2-3 years at which time it is expected that CO_2 will be adopted for all applications.

Indirect Project Impact: The project will not influence the prices of products.

ANNEX 1

SHANGHAI #6
INCREMENTAL CAPITAL COSTS

	Project Capital Cost (US Dollars)
2 High pressure foaming unit, incl. freight and installation	300,000
1 Premix Station, Freight and Installation	80,000
2 High pressure medium output spray units with lance attachment, incl. freight and installation	70,000
2 High pressure low output spray units incl. freight and installation	50,000
Trials	30,000
Technology transfer (Breakdown in Annex 4)	50,000
Subtotal	580,000
Contingency (15%)	87,000
TOTAL INCREMENTAL CAPITAL COST:	667,000

ANNEX 2

INCREMENTAL OPERATING COSTS

OBJECTIVE: Phaseout CFC-11 by using "Water Blown" (i.e. CO_2) technology

1. Assumptions

- Calculations are based on water blown technology.2/
- Price for CFC-11: RMB 14,900/t
  MDI: RMB 12,200/t

  (information provided by the company and by ICI)

- 1 part CFC-11 replaced by Water/Carbon dioxide requires 1.6 parts additional MDI.

- 1 USD = 8.7 RMB

2. Material Costs

Before Project:	105t CFC-11 @ US$ 1,710/t	US$ 180,000
After Project:	168t MDI @ US$1,400/t	US$ 235,200
Additional Material Costs/yr		US$ 55,200

3. Other Operating Costs

The new, high pressure, equipment has self-cleaning mixing heads. This means elimination of cleaning agent. The company could not provide exact figures as to the amount of cleaning agent, but from experience in other projects annual cost savings of USD 5,000-10,000 are to be expected.

It is expected that the new equipment will considerably decrease the amount of rejected material. Again, no figures could be provided, but it is expected to be considerable.

In view of the expected but not quantified potential savings from quality and flushing, the company does not request reimbursement of incremental operating costs.3/

2/ HCFC-141b (Price: US$2,052/ton) may be used as an interim solution in some formulations, leading to higher operating costs. The company was not able to quantify this and consequently its use was not included in the cost considerations.

3/ Incremental operating cost/benefit depends on relative price assumptions for CFC-11 and MDI. Even if subsequent price changes may result in additional incremental operating cost/benefit, the enterprise has agreed to not request any funding.

ANNEX 3

CALCULATION OF UNIT ABATEMENT COST

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

Where: 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 = The annual incremental operating costs in the first year of full operation.

OS/R = The annual incremental operating savings or revenues in the first year of full operation.

ODP = The annual ODS reduction at the first year of full operation expressed in ODP units.

In this project:

C(F) = $108,600
OC = $0
OS/R = $0
ODP = 105,000 t

A = $1.03 per kg CFC

ANNEX 4

BREAKDOWN OF TECHNOLOGY TRANSFER COST

Two experts will be needed for this project: one chemical and one processing expert.

The chemical expert will assist the factory in the area of polyol manufacturing for about a month, while the processing expert will help in the mechanics of how the equipment/machines operate, test-runs etc. for about 2 months, involving two trips to China and travel within China.

Detailed breakdown of the cost is as follows:

	Fee	Airfare/hotel/food	Total
Chemical expert (1 mo. @ US$10,000/mo.)	US$10,000	US$ 5,000	US$15,000
Processing expert (2 mo. @ US$10,000/mo.)	US$20,000	US$10,000	US$30,000
Preparation of training manuals, etc.			US$ 5,000
		TOTAL	**US$50,000**

SCOPE

The project is concerned with the replacement of CFC 11 in production of polyurethane pipe insulation by CO_2 (water) with a transition use of HCFC 141b for applications were insulation values are critical.

RECOMMENDATIONS

The project is approved. The items on technology transfer and quotations (see below) should be addressed.

RELEVANCE AND ADEQUACY OF INFORMATION PROVIDED

The review procedure has benefitted from several exchanges during project development. There should be an explanation given of what is involved and from whom under "technology transfer". Additionally, the equipment listed has generic rather than detailed prices and detailed quotations should be reviewed during project implementation.

TECHNICAL SOUNDNESS

State of the art technologies were reviewed in detail during project development and the chosen technologies are sound. HCFC 141b is viewed as a transitionary solution for those applications requiring the highest levels of insulation; HCFC 141b gives the best insulation values of non CFC blowing agents.

A recommendation for subsequent replacement of HCFC 141b may arise from the OORG Foam Working Group on Pipe Insulation planned for May 1994.

The need for the new dispensing machines has been thoroughly investigated and is justified on the grounds of the significantly higher viscosities of the new technologies and the different mix ratios for the CO_2 technology during spray operations.

LESSON FROM EXPERIENCE

None.

ENVIRONMENTAL ISSUES

Chemically generated CO_2 technology provides a environmentally robust solution. The project recognises HCFC 141b as a transition material - see Technical Soundness above.

SAFETY ISSUES

There are no safety issues associated with CO_2 technology. For HCFC 141b there should be provision for adequate ventilation to ensure that the lower explosive limit is never reached. Technology transfer should include adequate training.

COST EFFECTIVENESS

The UAC is acceptable for a foam project, partly due to the enterprise not claiming for incremental operating costs. Net operating costs have not been defined.

The project costs are mainly for new dispensing equipment and these have been investigated in detail and are justified.

It is noted that the RMB : US Dollar exchange rate has not been updated since the Chinese currency realignment.

OTHER

None

GMFJ/kd/28/2/94

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER CHINA ODS PHASE OUT PROJECT

PROJECT COVER SHEET

COUNTRY:	The People's Republic of China
PROJECT TITLE:	Fire Extinguisher Production Conversion from Halon 1211 to ABC Dry Chemical
SECTOR COVERED:	Fire Fighting Industry
ODS USE IN SECTOR (1992):	12,500 MT ODP (4,000 MT Halon 1211 & 50 MT 1301)
PROJECT IMPACT:	Phase out 780 MT ODP per year (260 MT Halon 1211)
PROJECT DURATION:	One Year
PROJECT COST:	Incremental Investment Cost: US$357,000 Contingency:1/ US$ 54,000 Incremental Operating Cost:2/ US$410,000 Financial Agent Fee:3/ US$ 25,000
PROPOSED OTF GRANT:	US$ 846,000 4/
COST EFFECTIVENESS (UAC):	US$0.28 Kg/ ODP/Year
IMPLEMENTING ENTERPRISE:	Zhuzhou Fire Equipment Factory, Zhuhai, Guangdong
COORDINATING AGENCY:	National Environmental Protection Agency
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY

This project will eliminate 780 MT ODP per year (260 MT Halon 1211) in China. Halon 1211 extinguisher production line will be replaced by ABC dry chemical powder and light water foam (AFF Foam) fire extinguisher production. Redesign and additional equipment for the factory is required. After the production line is converted, 260 MT of Halon 1211 use can be eliminated annually. The project will set up an example for production conversion from halon extinguisher to non-halon ones for the medium sized halon based fire extinguisher factories in China.

Technical Assessment: The project has been reviewed and supported by the OORG technical reviewer, Phil Di Nenno. His comments are attached.

1/ 15 percent of incremental investment cost.

2/ 3-1/2 years of operating profit loss, without discount.

3/ 3 percent of incremental investment cost, contingency and incremental operating cost.

4/ The factory will, of the total amount OTF grant, receive US$792,000 as the grant to implement the project, while that contingency of US$54,000 will be granted by the World Bank on as-needed basis.

PROJECT OBJECTIVE:

The objective of this project is to convert the factory's production of fire extinguisher from halon to ABC dry chemical powder filled(ABC) and affinity light water film foam (AFF) extinguishers, as part of the overall country strategy to phase out use of halon while simultaneously providing for satisfactory alternate fire protection systems.

SECTOR BACKGROUND

Because halon extinguishers have unique qualities, such as clean, non-conducting, efficient, low toxicity, rapid knockdown of flames, halons use have been widespread in developed countries in the 1980s. Its use began in China in mid 1980s. Along with economic development of China, halon extinguishers came to extensive application to protect computer rooms, telecommunication centers, central control rooms, archives, transformer substations, oil depots, etc. Halon application in China is well accepted as the preferred fire protection system, but use of ABC powder as a main fire fighting chemical is still being evaluated under local conditions and fire safety regulations.

In 1992, about 4,500 tons of halons were consumed in producing fire fighting equipment in China. Annual consumption of halon by Zhuzhou Fire Equipment Factory alone is 250 tons.

ENTERPRISE BACKGROUND

Zhuzhou Fire Equipment Factory was founded in 1988 and began operations in 1989. Guangdong Provincial General Brigade of Fire Protection designates its manufacture of fire fighting equipment to the factory. The factory has 8 senior and mid-level engineers and 5 quality inspectors, 2,800 square meters of workshop buildings and complete production equipment. The factory possesses 44 sets of equipment, including machining, stretching, punching, welding (including CO_2 restraint welding), plastic-spraying, assembling installations, which can be used to produce various types of extinguisher and hosereel. Different functional sections are established at the factory, such as research and development, production, marketing, quality control, measurement, and accounting. The reliable quality control system guarantees long term stability of product quality. For major product quantities of the factory, refer to Annex 1. The factory used 260 tons of Halon 1211 in 1993, or 6.5% of sector consumption in China.

Technology of products is domestic. Production is approved by Fire Protection Bureau of Guangdong Province. Products are appraised based on state criteria and examined by concerned quality inspection authorities. Ministry of Public Security issued production licenses to the factory for Halon 1211 extinguisher and dry powder chemical extinguishers, which are sold only on the domestic market. Local ownership is 100 percent.

PROJECT DESCRIPTION

The project is composed of three components. The first two components relate to conversion of the plant's existing Halon 1211 fire extingusher production line to the production of ABC and AFF extingushers. The existing line which has a capacity of 100,000 units was built in 1988. The third component relates to modification of the fire extinguisher production workshop.

The first component would convert about two-third of the Halon 1211 line to production of ABC dry chemical powder extingushers resulting in production capacity of 70,000 ABC units.

The second component would be the production of AFF extinguishers, with an annual production capacity of 30,000 units. By retrofitting the halon extinguisher production equipment and adding some

new testing facilities in accordance with the nature of AFF extinguisher production requirement, the AFF extinguisher production line would be developed. Conversion of the halon extinguisher production line by these two types of extinguishers will be phased in. During project construction period, there will be no AFF extinguisher production, only 16,000 ABC extinguishers will be produced in addition to the 40,000 Halon 1211 extinguishers which will be produced so as to minimize economic losses when the two new products have not yet reached full capacity. In the first year of operations, 40,000 ABC and 5,000 AFF extinguishers will be produced and the halon extinguisher production will be stopped completely. From the second year of operations on, 70,000 of ABC and 30,000 AFF extinguishers will be produced.

The third component would be the technical transformation of the original halon extinguisher production workshop. This component, which the enterprise will finance (no grant funding requested), is necessary to meet special requirements for the production of the ABC and foam extinguishers. Conversion involves adding key equipment and relevant testing apparatus; and providing technical assistance in the production of both ABC portable and AFF foam extinguishers.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION

Substitute products will meet social demands for fire protection equipment. Like halon extinguishers, portable ABC powder extinguishers can put out Class A,B, and C fires and the extinguishing performance of an ABC powder extinguisher exceeds a halon extinguisher with the same weight standard. Light water foam extinguisher possesses excellent property of extinguishing fires of class A and B. In terms of extinguishing Class A fire, the extinguisher exceeds halon extinguishers. Therefore, substitution of halon extinguisher by ABC and AFF extinguishers will satisfy demand for fire protection equipment. However, actual market perception in China is that ABC is inferior to halon, and so ABC extingushers must be sold at a lower profit margin than halon extinguishers.

TECHNOLOGY SOURCES AND AVAILABILITY

The Zhejiang Fire Equipment Factory, as one of the first Halon 1211 conversion projects approved by the Montreal Protocol Executive Committee in March, 1993, now possesses or will soon acquire technology of ABC and AFF extinguishers. Zhuzhou Fire Equipment Factory plans to obtain technology from Zhejiang Fire Equipment Factory. However, the corrosion resistance equipment and testing instruments for production of AFF extinguishers still need to be imported. Zhuzhou Fire Equipment Factory could obtain the above technology and equipment, and produce the relevant equipment themselves to obtain the production capability for ABC and AFF extinguishers.

PROJECT COSTS

The total project cost of US$821,000 equals the ODS reduction portion of the overall project (investment cost plus net incremental operating cost). This project will not provide Zhuzhou with any incremental revenues, but will result in profit loss which was used as proxy to calculate incremental operating cost.

Investment costs of US$411,000 including the purchase of additional equipments needed for the conversion of production line to replace Halon 1211 extinguishers with ABC and AFF extinguishers and 15% contingency (Annex 1: Tables 1 & 2). To meet special requirements for production of ABC and AFF extinguishers, the enterprise will finance the technical transformation of the original halon extinguisher production workshop will be conducted (including adoption of new technology and transformation of workshop area) for a total cost of US$331,000 (Annex 1: Table 3).

Net incremental operating costs of US$410,000 are due to the conversion of production line to replace Halon 1211 with ABC and AFF extinguishers. Since ABC and AFF extinguishers do not sell as well on the market as Halon 1211 extinguishers, average profit is lower than halon extinguishers. Therefore, the factory will lose an annual profit of US$117,000 after the conversion (Annex 2). No compensation is being sought for lost profits due to reduced production during project implementation and the first year of project operation. Thus the estimated incremental operating cost will be:

US$117,000*3.5 years = US$410,000

Other costs. An additional US$25,000 (3%) was added to the grant request to cover the fee for services of the financial agent that will appraise the project and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Zhuzhou is US$846,000 and was calculated as follows: total investment cost, including 15% contingency, was added to the incremental operating costs over three and a half years of the project. The resulting total project cost was increased by 3% to account for the financial agent fee.

PROJECT IMPLEMENTATION:

Management: Guangdong Provincial General Brigade of Fire Protection will oversee the successful implementation of the project. The project will be carried out at Zhuzhou Fire Equipment Factory.

The Project Manager: Mr. Lai Guangsheng, Director of Zhuzhou Fire Equipment Factory.

Chief Engineer of the Project: Mr. Weng Zuomin, Deputy Director and Senior Engineer of Zhuzhou Fire Equipment Factory

ENVIRONMENTAL CONSIDERATIONS

Environmental Assessment (EA) is carried out by local Environmental Protection Bureau (EPB). The project will meet standards and regulations stipulated by the local EPB. No new pollutants will be generated from the production.

PROCUREMENT:

Imported and domestic equipment needed are shown in Annex 1. Contracts will be awarded after evaluation and comparison of quotations solicited from at least 3 qualified suppliers. Procurement agency will be discussed at appraisal and selected after appraisal.

REQUIRED REGULATORY ACTIONS

As the project is not for profit ,it is suggested that the Government, particularly through the NEPA and MPS ministries make special laws to limit the production and sales of halon extinguishers and halon-use extinguishers as soon as possible. A complementing suggestion to promulgate a preferential tax policy would further encourage factories wishing to convert.

PROJECT RESULTS

Direct Project Impact: This project will remove 260 MT of Halon 1211 per year (780 MT ODP).

Indirect Project Impact: Factory closure is not necessary. This project will play a significant role of demonstrating successful conversion from halon extinguisher production at small and medium-sized enterprises to ABC dry powder and AFF extinguishers in China.

ANNEX 1

Table 1: Costs Breakdown for Additional Equipment for ABC Extinguisher Production
US $

Description	Quantity	Unit Cost	Total Cost
Twin act tensil Hydropress	1	15,000	15,000
Cylinder Trim.Shears	1	6,600	6,600
Bottom Ring Trimming Shear	1	6,600	6,600
CO2 protection welder	1	4,000	4,000
Dust remove equip.	1	10,000	10,000
DCP Auto Charging gauge	1	20,600	20,600
CO2 bottle shrink equip.	1	6,200	6,200
CO2 auto charging gauge	1	17,900	17,900
Pressure test equip.	1	6,600	6,600
Leakage test equip.	1	2,800	2,800
Punch/draw dies eqp't	1		7,300
Installation			10,000
Training			2,300
Subtotal			116,000
Contingency (15%)			18,000
Total			134,000

Table 2: Costs Breakdown for Additional Equipment for AFF Extinguisher Production
US $

Description	Quantity	Unit Cost	Total Cost
Puch/drawing dies equip.	1	7,820	7,820
AFFF test guage	1	28,300	28,300
Inner cylinder coating equip.	2	13,430	26,860
Coop./ZFE Plant & Amerex			135,300
Training			31,700
Trial production	100	47	4,700
New product test/approval			6,300
Subtotal			241,000
Contingency (15%)			36,000
Total			277,000

Table 3: Costs Breakdown for Halon Extinguisher Workshop Transformation
(funded by enterprise)

Description	Cost ($)
Equipment/Apparatus	97,645
Civil works for ABC DCP line	42,000
Civil Works/AFF line: Base Floor Wall	37,380 41,580 45,640
Installation	14,000
Technical Training	3,000
Trial Production	6,600
Sub-Total	287,845
Contingency (15%)	43,180
Total (domestic resources)	**331,000**

ANNEX 2

Table 1: Actual Production Cost and Profit Indicators in 1993 Before Conversion

Halon 1211 Extinguisher	Average Annual Output	Sales Income $/pc	Production Cost $/pc	Average Sales Cost $/pc	Average Profit $/pc	Profit Total ($)
MY1	12,853	8.52	6.48	0.19	1.85	23,778
MY2	64,156	12.59	10.97	0.19	1.43	91,743
MY4	17,954	21.11	18.17	0.22	2.72	48,835
MYT25	1,270	166.67	144.44	2.96	19.27	24,473
G.Total	96,233	1,508,000	1,297,000	22,000		189,000

Table 2: Average Production and Profit Indicators After Conversion

ABC-DCP AFF Extinguisher	Average Annual Output	Sales Income $/pc	Production Cost $/pc	Average Sales Cost $/pc	Average Profit $/pc	Profit Total ($)
MFZ1L	10,000	5.67	4.71	0.18	0.78	7,800
MFZ2L	45,000	6.33	5.68	0.17	0.48	21,600
MFZ4L	10,000	11.67	9.87	0.30	1.50	15,000
MFZ6L	5,000	12.97	9.25	2.76	0.96	4,800
MPM6-AFF	30,000	10.83	9.43	0.40	1.00	30,000
Total	100,000	848,000	731,000	38,000		79,000

Table 3: Projected Fire Extinguisher Production and Incremental Operating Cost After Conversion (US$)

	Without Conversion (Halon 1211)				With Conversion (ABC DCP & AFF)				Profit Loss (Inc. Operating Cost)
	Annual Output (Unit)	Sales	Operating Cost	Profit	Annual Output (Units)	Sales	Operating Cost	Profit	
Yr	45,000	710,000	618,000	92,000	45,000	353,069	320,000	33,000	59,000
1996	100,000	1,567,000	1,371,000	196,000	100,000	848,000	769,000	79,000	117,000
1997	100,000	1,567,000	1,371,000	196,000	100,000	848,000	769,000	79,000	117,000
1978	100,000	1,567,000	1,371,000	196,000	100,000	848,000	769,000	79,000	117,000

ANNEX 3

Breakdown of Project Cost and Financing
(US$)

I.	Investment Cost	Investment Cost	Contingency	Total
	ABC powder extinguisher production	116,000	18,000	134,000
	AFF foam extinguisher production	241,000	36,000	277,000
	Halon extinguisher workshop transformation	288,000	43,000	331,000
	Subtotal	645,000	97,000	742,000
	Less: Self financing by enterprise (Halon Extinguisher Workshop)	(288,000)	(43,000)	(331,000)
	Incremental investment cost proposed for OTF financing	357,000	54,000	411,000
II.	Incremental Operating Cost for OTF financing			410,000
	Subtotal			821,000
III.	Financial Agent fee (3%)			25,000
	Total (proposed ODS Grant)			846,000
	Proposed OTF Grant			846,000

a) Incremental operating costs will be disbursed to the enterprise at the end of each year of operation, based on actual production; thus the operating costs are not discounted to arrive at incremental cost.

ANNEX 4

Calculation of Unit Abatement Costs

$$UAC = \{C(F) + (OC-OS/R)\}/ODP$$

Where:

UAC = Unit Abatement Cost, $/kg ODP/year

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

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 = The annual incremental operating costs (i.e., profit loss) in the first year of full operation

OS/R = The annual incremental operating savings of revenue in the first year of full operation.

ODP = The annual ODS reduction at the first year of full operation expressed in ODP units.

The investment cost of the project is US$742,000 (incl. 15% contingency) and the economic life is 15 years. Then:

$C(F) = \{\$742,000 \times 0.1\}/\{1 - (1 + 0.1)^{-15}\} = 97,566$

OC = $106,000

$$UAC = \frac{US\$97,566 + (US\$117,000 - 0)}{780,000 \text{ kg ODP}} = US\$0.28/\text{kg ODP/year}$$

ANNEX 5

Table 1: Project Implementation Schedule

1994 – 1995 Task	1996 Task
1. Design alternative product/equip, test & trial runs 2. Procure general equip., install and trial runs 3. Design, build install and trial runs special equip. 4. Training	Complete production conversion, eliminate halon application completely

Items of Tasks	Description	1994	1995
Portable ABC DCP Extinguisher	General equipment	Order/Procure	Installation
	Special equipment	Design/Build	Install/test
	Technical equipment.	Design/Build	Exam/testing
Light Water Foam AFF Extinguisher	Product design/test		
	Indust.Enginrg/Design & Instal	Techni.Design	Manufacture
	Special equipment	Tender/Import	Install/test
	Trial production		Trial run

ANNEX 6

Table 1: Price of Main Product Material and Suppliers

	Halon 1211	ABC Dry Chemical Powder	AFF Foam Agent
Price	3.67 US$/kg	0.67 US$/kg	1.36 US$/L
From	Dongyang Chemical Company	BJ Fire Equipment Plant	BJ Fire Equipment Plant

* Costs include importing testing technology on AFF foam agent, cylinder internal spray coating technology and study in Zhejiang Fire Equipment Factory.

** Including various performance testing during trial production.

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December 1, 1993

Zhuzhou - First Review

Ms. Jessica Poppele
Ozone Ops Coordinator – Asia
Global Environment Coordination, Room S2-133
World Bank Group
Washington, DC 20433

Dear Ms. Poppele:

I have attempted to review the four project proposals related to halons in China. Specific project comments follow, but I offer the following overall questions and comments that apply to all proposals.

(1) I cannot (nor should I) verify the economic basis of the proposals. This is most important because in general the project costs are dominated by "nontechnical" cost items such as "lost" profit, unemployment, lost revenue, etc.

(2) In regards to issues associated with "lost profit," it seems to me that the production of lower cost and hence lower profit Halon 1211 portable extinguishers is a net country economic benefit. For a particular factory, the lower cost/lower profit replacement unit (e.g., DPE vs. 1211) is "lost revenue" the nation receives the same benefit of a portable fire extinguisher for a lower cost. Therefore, it is not clear to me that the World Bank or others should fund this "cost."

(3) In general, replacement of 1211 extinguishers with DPE is technically acceptable. There is some residual demand for a "clean" extinguisher such as CO_2 (for use in control rooms, computer rooms, etc.). It is of some concern that none of the projects are directed in this manner.

(4) I have technical questions on each of the proposals which require resolution. Hence, I am unable to make a specific recommendation on any of them.

(5) The efficacy or effectiveness of any of these proposals is tied to overall plan for the country. Since I am not familiar at all with the overall program for China, it will be difficult to adequately assess any particular project. If the country program documentation would be made available, perhaps some of my concerns would be alleviated.

(6) The unit abatement costs vary widely across all proposals as do the assumptions on economic life of the proposed plant or modifications. These need to be rationalized.

A. Construction of Halon Recovery Equipment

(1) The value of recycling/recovery equipment proposed in reducing the unwanted 1211 emissions depends on where and how the current emissions are arising. If the emissions are due to vapor heels in bulk containers, 1211 production losses or filling losses at the factory, the proposed equipment will be of little or no value in reducing the current 350 tons/year emission estimate.

(2) The use of recycling/recovery equipment such as the unit proposed is primarily for servicing fire extinguishers. That is to allow the recovery of agent from the extinguisher, perform the necessary inspections, and then refill the extinguisher with the agent which was just removed. The degree to which the equipment can be used to reduce emissions given other loss mechanisms is dependent on by whom, how, and where the equipment will be used. Hence, some additional information on how exactly the equipment will be used, by whom, and where is of significance.

(3) Without external government regulatory control or price controls, "recycled" Halon 1211 will cost more than newly produced. What is the incentive for the use of recycled 1211 given the current cost/regulatory structure on the use of newly produced 1211?

(4) The need for 1,000 sets of recovery equipment has not been demonstrated. For a total emission control of 400 tons/year, this implies a very low (0.4 tons/year) utilization per set.

B. Production Transfer of Xylene Alkyl 1211 Extinguishant

This project involves changeover from Halon 1211 manufacture to Class A foam manufacturing.

(1) The efficacy of Class A foam as a portable fire extinguisher agent has not been demonstrated. It, by definition, is only applicable to Class A fires, and comparisons with plain water indicate marginal benefit on these types of fires. Without additional information on the type of foam and specific performance data on portable extinguisher use with such foam, it is not possible to recommend proceeding.

(2) The use of Class A foam on Class B (flammable and combustible liquid) fires cannot be supported given the availability of dry chemical extinguishers and/or AFFF extinguishers.

(3) Technology transfer with a company called HUNCR in the U.S. is proposed. There is no recognized portable fire extinguishant/extinguisher manufacturer by that name in the U.S. I have not personally heard of the company.

(4) The economic justification seems problematic; payment for a dismantled 1211 production unit as well as its lost revenue and profit seems excessive.

(5) There is no description of how the Class A foam is to be used. The proposal concerns manufacture of the foam not the extinguish. Who will manufacturer the extinguisher in which the foam is used? Are there further proposals along this line?

C. **Conversion of Halon 1211 Extinguisher Production (to DPE), Benxi Iron and Steel Corporation**

This project involves conversion of an extinguisher manufacturing plant from Halon 1211 to ABC dry powder. In general, ABC dry powder is an acceptable alternative to Halon 1211, and hence, such conversion makes sense. The following specific comments and questions apply to this proposal.

(1) This proposal is one of several aimed at converting from the manufacture of Halon 1211 portable extinguishers to the manufacture of ABC powder extinguishers. Are these proposals being coordinated relative to supply/demand or technology transfer issues?

(2) There is a somewhat perverse economic argument that comprises a major cost item in the proposal. The lost revenue and profit associated with selling and manufacturing a less expensive, but equally effective portable extinguisher is deemed an economic cost. Actually, it is a benefit (equal protection, less cost) and should not be accounted as a cost of changeover. In the limiting case, the plant could sell the ABC portables at the same price as 1211 portables. There is the recurring problem here of trying to economically introduce alternatives while the production of new Halon 1211 continues unregulated.

(3) The technology transfer scheme and associated costs needs to be further developed and resolved.

(4) Since apparently the Zhuzhou Factory possesses the necessary DPE technology, obtaining the necessary technology from this source should be evaluated.

D. Halon 1211 Fire Extinguisher Replacement at Zhuzhou Factory

This project involves replacement of Halon 1211 portable fire extinguisher manufacturing capability with ABC dry powder and AFFF (light water) portable fire extinguisher manufacturing.

(1) Apparently, this factory has the existing capability to manufacturer ABC powder and extinguishers utilizing this powder. Perhaps this technology could be transferred internally to other factories seeking international technology transfer for the same purpose (e.g., Benxi Iron and Steel Corporation).

(2) One of the technical problems associated with this project is the requirement for corrosion resistant extinguisher tanks for the AFFF extinguisher. It is my understanding that AFFF portables manufactured in the U.S. use the same construction as those for plain water. There is no need for special corrosion resistant shells; only stainless steel shells need be used. The primary U.S. manufacturer of AFFF portables is Amerex Corporation, not Ansul as indicated in the proposal. Ansul does not manufacture a handheld AFFF portable extinguisher.

(3) It is not clear whether or not the Factory has existing capability to manufacture or procure locally the AFFF concentration. It is a central issue regarding the efficacy of this technology. This will have a substantial bearing on the economics of the replacement extinguisher.

(4) As previously indicated, replacement of Halon 1211 portable extinguishers with ABC dry chemical is appropriate. For some applications, the use of AFFF/water portables is also appropriate. I am unable to comment on the economic analysis, but further evaluation of items (2) and (3) above may change the cost structure.

(5) Is the reduction in halon use 250 tons/year of agent or 250 tons/year ODP? Both terms are used, I believe it is 250 tons (agent)/year or approximately 1000 tons (ODP)/year.

If you have any questions, please feel free to contact me.

Very truly yours,

Philip J. DiNenno, P.E.
Vice President

PJD/cdp

THE MONTREAL PROTOCOL ON
SUBSTANCES THAT DEPLETE THE OZONE LAYER
CHINA ODS PHASE OUT PROJECT

Cover Note on Halon Projects: Benxi and Zhuzhou

The two halon phase out project submissions for China, "Fire Extinguisher Production Conversion from Halon 1211 to ABC Dry Chemical" at Benxi Fire Equipment Factory (Benxi) and "Fire Extinguisher Production Conversion from Halon 1211 to ABC Dry Chemical" at Zhuzhou Fire Equipment Factory (Zhuzhou), are an integral part of China's phase out strategy for this sector. Overall, China's strategy to phase out halons aims to gain acceptance of halon alternatives by: (1) changing market perception; and (2) revising codes and standards that may require halon use while phasing out both the production of halon as well as its consumption in extinguishers and fixed systems. As noted in the project proposals, halons' clean agent property and historical quality problems with dry powder extinguishants have resulted in a strong perception in the Chinese market that Halon 1211 is a superior agent. The current fire protection product price structure reflects this perception.

Incremental Operating Costs (IOC)

The Benxi and Zhuzhou projects address both aims of China's halon phase out strategy. The projects seek to gain market acceptance of halon substitutes by pricing them competitively while eliminating halon use in the production of extinguishers. Thus, the incremental cost calculations include both the incremental capital costs required to convert the enterprises to production with halon substitutes as well as requests for four years of IOC based on reduced cash flow which will result from product pricing required to gain market acceptance of the halon substitute extinguishers. Like the aerosol filling center projects approved by the Executive Committee for Tianjin and Shanghai, Benxi and Zhuzhou will need to pass operating savings on to their customers to give customers sufficient incentive to use a non-ODS product. However, unlike Tianjin and Shanghai where circumstances meant that only a portion of savings were passed on, halon substitute extinguishers must be priced so low that the cash flows of Benxi and Zhuzhou would actually be reduced as a result of project implementation. In other words, the incremental capital costs would be insufficient compensation to allow the enterprises to price their halon substitute products such as to gain market acceptance. Without considering lost profits as IOC, customers would continue to buy halon.

These two projects request four years of incremental operating costs based on China's Country Program goal to eliminate production of Halon 1211 extinguishers by 2000. As halon extinguisher production is curtailed, we expect that by 1998 halon substitute extinguishers will have sufficient market acceptance to allow for a more favorable price structure. The closure of Halon 1211 production facilities (see Tongxiang project initiative) will, of course, better position Zhejiang, Benxi and Zhuzhou to promote halon substitutes.

The Zhuzhou and Benxi projects are similar in scope and content to the Zhejiang Halon Extinguisher Conversion project approved initially by the Executive Committee in June 1992, with supplemental funding approved in March, 1993. The Zhejiang project had considered two alternatives to minimize the cash flow loss that would result from a straight halon to halon substitute conversion. The option which was approved for funding by the Executive Committee included increasing production capacity from 150,000 halon units to 250,000 ABC units. The alternative, maintaining existing capacity at 150,000 units, was examined, but the additional investment costs estimated for production expansion

were less than estimates of four years of lost profits based on equivalent capacity. The incremental cost request was, therefore, based on production expansion. The Ministry of Public Security, which is responsible for overseeing China's halon phase out program, recognizes that production expansion, as a means of compensating halon extinguisher manufactures for reduced cash flows which result from the need to promote halon substitutes, is not sustainable given the limited market demand for halon or halon equivalent fire extinguishers. Thus, for the current and for future submissions, IOC requests for halon extinguisher conversion projects in China will be based on reduced cash flows (lost profits), rather than production expansion.

Discounting of IOC

Two aspects of World Bank disbursement practice for MLF financed operations have led to a request for IOC without discounting future costs: (1) Interest earned on funds deposited in the Bank's Ozone Projects Trust Fund are retained by the Bank and credited to the MLF; and (2) Disbursements for IOC are paid out over time against actual expenditures, rather than as a lump sum up-front payment. To minimize the risk of windfall profits accruing to an enterprise, disbursements are made based on actual production costs and benefits after project completion and are closely related to non-ODS production levels actually achieved. For these reasons, basing grant requests on discounted costs results in insufficient funding for future years. Therefore, IOC requests in these and future projects will not be discounted.

Should consideration of these two points, compensation for reduced cash flow (lost profits) as IOC and non-discounting of IOC, be deferred, we ask that the two China halon project proposals be considered within the existing eligibility guidelines.

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

COUNTRY:	People's Republic of China
PROJECT TITLE:	Halon 1211 Production Closure
SECTOR COVERED:	Fire Fighting Industry (Halon)
ODS USE IN SECTOR (1992):	12,500 MT ODP (4,000 MT Halon 1211 & 50 MT 1301)
PROJECT IMPACT:	Phase out 1,200 MT ODP per year (400 MT Halon 1211)
PROJECT DURATION:	6 Months
PROJECT COST:	Incremental Cost: US$ 775,000 Contingency: US$ 39,000 Financial Agent Fee: US$ 24,000
PROPOSED OTF FINANCING:	US$ 838,000
COST EFFECTIVENESS(UAC):	US$ 0.70/Kg ODP/Year
IMPLEMENTING ENTERPRISE:	Tongxiang Chemical Fertilizer Factory
COORDINATING MINISTRY:	Ministry of Public Security
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY

This project will stop annual production of 400 MT of Halon 1211, thereby eliminating annual production and consumption of 1,200 MT ODP in China. The project involves dismantling of present Halon 1211 production facilities in Tongxiang Chemical Fertilizer Factory and demolishing the Halon 1211 workshop buildings and warehouses of the factory which have not other useful purpose. Appropriate disposition of the staff and workers employed by the Halon 1211 production unit of the factory would also to be made according to Chinese law and local government regulations.

Technical Review: The project has been reviewed and supported by the OORG technical reviewer, Dr. Michael Harris. His comments have been taken into consideration in this revised version of the project summary. For example, clarifications have been provided under Project Cost paragraph on the points raised regarding the warehouse demolition and the value of the used cylinders. His comments are attached.

PROJECT OBJECTIVE:

The objective of this project is to eliminate annual production of 400 MT Halon 1211, about 10% of China's total Halon 1211 production, by dismantling and demolishing the Halon 1211 production facilities at Tongxiang Fertilizer Factory.

SECTOR BACKGROUND

Because halon extinguishants have unique properties, such as cleanliness, non-conducting, efficient, low toxicity, rapid knockdown of flames, halon use spread in widely in developed countries in the 1980's. Its use began in China in mid 1980's, along with the country's economic development. Halons have come to be used extensively to protect computer rooms, telecommunication centers, central control rooms, archives, transformer substations, oil depots, etc. Halon application in China is well accepted as the preferred fire protection system. Production of halon is a profitable undertaking in China.

In 1992, about 4,000 tons of Halon 1211 and 50 tons of Halon 1301 were consumed in producing fire fighting equipment in China. There are about 25 facilities in China of varying sizes producing Halon. Most are in the small-scale sector. Annual production of Halon 1211 of Tongxiang Chemical Fertilizer Factory alone is 400 tons which accounts for about 10 % of China's total annual production of Halon 1211.

ENTERPRISE BACKGROUND

Zhejiang Tongxiang Fertilizer Factory produces nitrogen fertilizer and Halon 1211. There are five workshops: coal gas workshop, carbonization workshop, synthetic ammonia workshop, power generating workshop and Halon 1211 workshop which began to produce Halon 1211 in 1986. Currently, there is a total of 1003 staff in the factory, including 2 senior engineers, 40 engineers, 62 technicians and 899 workers. The Halon 1211 production facilities were completed in 1986 with a total investment of 1.08 million Yuan. An area of 1,400 Sq.M of workshop buildings were built to accommodate the production equipment. Currently, the Halon 1211 Production Workshop has 1 engineer, 2 technicians and 47 workers, accounting for only 5 % of the total staff of the factory.

In 1993, the factory produced 368 tons of Halon 1211 while the capacity of the halon production is 400 MT per year and a total of 1,764 tons of Halon 1211 have been produced in seven years since June, 1986. The factory has achieved good economic and social benefits, and the profit has steadily increased over the past three years. In 1993, the total turnover of the factory is 40.04 million Yuan (RMB) of which 8.66 million Yuan (RMB) was contributed by Halon 1211, accounting for 21.62 % of the factory's total turnover, while staff associated with halon production only account 5% of the factory's total staff. Therefore, halon production to this factory is of great significance to the factory's overall financial profitability.

Therefore, in view of the economic development of the enterprise, it is reluctant to shut down its Halon 1211 production facilities and stop halon production. In order to honor China's commitment to phase out the ODS, the National Environmental Protection Agency (NEPA) and the Ministry of Public Security (MPS) jointly decided to shut down halon production in this factory as the first step toward closure of all halon production units in China. While the factory is committed to stop the halon production, the factory is requesting compensation for economic losses due primarily to foregone profits and labor displacement costs.

PROJECT DESCRIPTION

Tongxiang Chemical Fertilizer Factory will eliminate Halon 1211 production by closing its production workshop, dismantling production facilities, and demolish workshop buildings and warehouses of 1,400 Sq. M. According to Chinese regulations, the annual depreciation of the industrial facilities is 6%, so the lifetime of current

production facility is 15 years. The factory was commissioned in June 1986. Assuming January 1995 as the closure date, the facilities would be 8.5 years old and the remaining lifetime would be 6.5 years.

It is planned that, once the OTF financing is actually available to the factory, production of Halon 1211 will be immediately stopped. Within 6 months from the date of receiving OTF fund, the Halon 1211 production facilities will be dismantled and the workshop building as well as related warehouses will be demolished as these facilities can not be used for any other purpose. The halon unit occupies a relatively small portion of the factory premises and there are no present plans to use the site for other purposes.

JUSTIFICATION FOR SHUT DOWN Halon 1211 PRODUCTION FACILITY

Since ozone depletion potential of Halon 1211 is very high, stopping Halon 1211 production in Tongxiang Fertilizer Factory can ultimately eliminate 1200 MT of ODP. Thus the environmental impact of this project is of great significance. Also, since Beijing Fire Fighting Equipment Factory is going to produce ABC dry chemical powder to replace Halon 1211, future demand for halon in portable extinguishers can be met. ABC powder extinguishers can put out Class A, B and C fires and electric fires and the extinguishing performance of an ABC powder extinguisher exceeds a halon extinguisher with the same weight standard. Therefore, the shut down of 400 MT of Halon 1211 production will maintain same fire safety in China.

PROJECT COST

Closing of a halon production facility is different from conversion of the production facility in terms of project cost calculation. Since the factory is claiming foregone profits for the remaining life of the factory, the depreciated value of the facilities would be zero and nothing is claimed for the facilities and building.

Due to the corrosive nature of Halon 1211, the warehouse buildings would not be appropriate for other uses and would be completely demolished. Likewise, the used cylinders would have no remaining value since there is no market for them. Existing halon producers already have their own cylinders and would not purchase additional cylinders from Tongxiang. Furthermore, the value of used cylinders is too insignificant to warrant its inclusion in the calculation.

Total project incremental costs of US$775,000 include the following items:

1. <u>Cost of dismantling halon production facilities and workshop buildings:</u>

The facilities will be dismantled/demolished and the site cleared. There will be a small amount of scrap value for materials as shown below:

Table 1: Breakdown of Cost of Demolishing and Dismantling

Items of The Cost	US $
Cost of Demolishing existing workshop building/warehouse	8,095
Cost of Dismantling existing halon production facility	5,780
Less: Scrap value of equipment/spares	6,455
TOTAL	7,420

2. Financial losses to the factory from stopping halon production:

Table 2: Average Annual Profit in the Past 3 Years
(US$)

Year	Production/MT	Sales Income/USD	Factory Cost/USD	Sales Cost/USD	Taxes to State/USD	Profit (USD)
1991	350.00	942,330	767,995	21,664	29,637	123,000
1992	367.60	999,626	795,082	17,250	34,773	153,000
1993	368.00	1,000,747	795,947	23,102	34,816	147,000
Average	**Annual**	**Profit of**	**The Halon**	**1211**	**Production**	**141,000**

The above table shows that the average annual after-tax-profit of halon production is US$141,000. Assuming the actual closure date is January 1995 and the factory has a remaining life of 6.5 years, the factory is requesting a compensation of US$663,337. This amount is calculated by discounting the average profit of US$141,000 by 12% for 6.5 years (Annex 3).

3. Compensation to the staff and workers of halon production workshop:

When production of Halon 1211 ceases, the 50 staff and workers of the Halon Production will have to be retrained and wait for other jobs. During this period of two years workshop as required by Chinese regulations, their normal incomes, according to local government requirement, should be no less than the factory worker's 1993 average monthly income level of 751.51 Yuan ($86.88/month). Thus the total salary compensation for staff and workers is:

50 men x US$86.88/mo. x 24 mos. = US$ 104,256

The Factory is not replacing the halon production unit with other facilities and the labor will be kept and retrained for other positions. If no positions become available, they would be eventually displaced. Given the low labor mobility and high unemployment rate, the two year period for labor costs that would also be inclusive of any costs of retraining, is considered reasonable under Chinese conditions.

4. Other Costs:

A 5% contingency (US$39,000) was included to cover any unforseen risks of the further losses of the enterprise caused by closing of halon production. An additional US$24,000 was added to the grant to cover the fee for services of the financial agent that will appraise the project and oversee disbursement and audits.

Requested Funding. The proposed OTF grant for Tongxiang is US$838,000 and was calculated as sum of the following: (1) demolition cost of US$7,420, (2) profit loss of US$663,337, (3) salary compensation of US$104,256, and (4) other cost of US$63,000 (contingency and financial agent fee).

ANNEX 1

Breakdown of Project and Financing
US$

ITEMS OF THE COST	AMOUNT
NPV of Existing Facilities and buildings	$ 0
Cost of Dismantle Equipment and Demolishing the Buildings	$ 7,420
Profit Reduction Due To The Shut Down of the Halon Production	$663,337
Salaries of staff & Workers of halon production for two years	$104,256
Subtotal of the Project Net Cost (PNC) (rounded)	$775,000
Contingency: 5% of PNC (rounded)	$ 39,000
Subtotal	$814,000
Financial Agent Fee: 3% of PNC	$ 24,000
Proposed OTF Grant	**$838,000**

ANNEX 2

Calculation of Unit Abatement Cost

Since this project is different from other production facility conversion project which will have incremental cost after the conversion, this project is the closure of the facility to stop the ODS production. The calculation method and equation used for other projects can not therefore be applied in this project.

The calculation of Cost Effectiveness of this project is as follows:

CE == C(F)/ODP, US$/Kg ODP/Yr
== 838,000/1,200,000 Kg ODP/Yr == $0.70/Kg ODP/Yr

ANNEX 3

Calculation of Compensation for Profit Loss

The total amount of compensation for profit loss is:

$$C == @sum\{[1- 12\%]^{(n-1)}\}P + P/2[88\%]^{(n-1)}$$

Where: C is total amount to be compensated for 6.5 years of profit losses;

P is avg annual after-tax-profit of halon production during past three years;

n is number of years of remaining lifetime of facilities at 6.5 years.

For this project, P == $140,812
n == 6.5 years

Thus: $C == @sum\{[1- 12\%]^{(6.5-1)}\}P + P/2[1-12\%]^{(6.5-1)}$
$== \$140,812 \times 4.7108 == \$663,337$

M:\Projects\ODS3\PS\Tongxiang

SUBJECT: OORG TECHNICAL OPINION - TONGXIANG HALON 1211 PLANT CLOSURE PROJECT

Scope

The project is the first plant *closure* project submitted to the OORG production sector. It involves the closure, without replacement, of a 400 te Halon 1211 plant at the Zhejiang Tongxiang Chemical Fertiliser Factory, with an associated ODS abatement of 1200 ODP-tonne per year for some 6 years.

Recommendation

The project is recommended for approval subject to satisfactory clarification of certain points, and amendment of the Unit Abatement Cost (UAC) from $0.52/ODP-tonne to $0.70/ODP-tonne (see below).

Relevance/Adequacy of Information Provided

The information is adequate for a final recommendation. It should, however, be recognised that there are considerable, if unavoidable, uncertainties around some of the key assumptions - in particular those regarding social costs and those relating to the market price of Halon 1211.

Technical Soundness

1. The proposal appears to miscalculate all ODP-dependent figures. The ODPs to be used should be those in Annexe I of the Montreal Protocol, ie 8.0 for Halon 1211 and 10.0 for Halon 1301. Using the correct ODP values leads to the following quantitative changes in figures cited on the Project Cover Sheet:

-	ODS use in sector = (4000 * 3) + (50 * 10) = 12,500 ODP-te	(*not* 16,800 ODP-te)
-	Project Impact = (400 * 3) = 1200 ODP-te/year *for 6 years*	(*not* 1600 ODP-te/yr)
-	Cost Effectiveness = US $0.70/ODP-kg/yr	(*not* $0.52/ODP-kg/yr)

Accordingly the relative UAC should be judged on the basis of the $0.70 figure vs other calls on finance for China. However, the project can still be approved even on this less favourable basis.

2. The Bank's comment (Chan, 15 April 1994) that the remaining life is better calculated as 6.0 years, not 6.5 years, is valid and supported so far as the chemical plant is concerned.

3. The proposal is to demolish warehouses which are claimed to be just 8.5 years old and to have a 15 year life. While a 15 year life is reasonable for a chemical plant, a much longer life - perhaps 30 years would have been expected for warehouses. As the Halon 1211 plant represents such a small proportion of the overall site it seems very unusual that the warehouse buildings are deemed redundant, especially against the background of a rapidly growing economy. Clarification should be sought.

4. The proposal claims that the stock of Halon 1211 cylinders is of no terminal value and will have to be disposed of. This is very surprising as the reduction in Halon 1211 production at this plant represents only 10% of national Halon 1211 production. The availability of additional cylinders would normally represent a real benefit to the remaining producers. It is also possible to use these cylinders for other gases of approximately similar (or lower) vapour pressure and/or

in particular for the recovery and recycling of Halon 1211 itself (which would otherwise be likely to require purchase of new cylinders as material for recycling or recycled material would need to be segregated from virgin product. A realistic residual value should therefore be applied to the cylinder stock.

5. Apart from the above comments, the project appears technically and environmentally sound and cost-effective. There are no unusual associated risks, and no special training should be required.

Lessons from Experience

As developed world halon producers have recently closed Halon 1211 plants there is experience available, and there is also cost information available. Has this been sought? The present project will provide local experience for the closure of the remaining Halon 1211 production facilities in China in due course.

Environmental Issues

No special issues.

Safety Issues

No special issues.

Cost-effectiveness

The UAC, even when amended, appears to be attractive.

Other

1. The Project Cover Sheet cites project duration as 6 months. This is the correct duration for the *physical* demolition aspect of the project - although proposal claims social costs for a period of up to 24 months. Disbursement patterns will determine whether the administrative costs of project monitoring are incurred for 6 months only, or for a longer period.

2. Data cited in the 'Sector Background' is at variance with that in the NEPA/UNDP Mission Report (UNDP Project Nr CPR/89/029) which cites the Ministry of Public Security (MPS) as giving the number of halon factories in China as 30-40, not 25 as in the present proposal. The figure is important in determining the *ultimate* cost to the MLF of closing *all* the plants and should be clarified.

3. The same NEPA/UNDP reference cites (Project No. h4' - Beijing Fire Fighting Equipment Manufacture) as eliminating 500 tc of Halon 1211 by *conversion* to ABC Powder at a cost of $470k. This is rather less than the present project which is for *closure* only - with no investment in replacements. It is possible that the NEPA/UNDP reference is to the manufacture of *extinguishers* (rather than *extinguishant*), but in such case it is not clear that there is any associated reduction in Halon 1211 production in a rapidly growing market direct ODS abatement from the NEPA/UNDP project may be nil. Clarification is needed. Closer correlation between UNDP and World Bank projects would be helpful, especially if it were within an overall country plan for the elimination of Halon production and (ultimately) use.

THE MONTREAL PROTOCOL ON
SUBSTANCES THAT DEPLETE THE OZONE LAYER
CHINA ODS PHASEOUT PROJECT

PROJECT COVER SHEET

COUNTRY:	The People's Republic of China
PROJECT TITLE:	China Aerosol industry Southern Filling Center (Zhongshan Fine Chemical Industrial Limited Aerosol CFC-12 Substitution and Conversion Engineering Project).
SECTOR COVERED:	Aerosol
ODS USE IN SECTOR:	9,720 tons CFCs in 1992 (of which Guangdong Province consumed 3,620 tons).
PROJECT DURATION:	Two years.
PROJECT COST:	Incremental Investment Cost US$3,332,000 Contingency US$ 500,000 Incremental Operating Benefit US$2,139,000 Financial Agent Fee US$ 51,000
PROPOSED OTF GRANT	US$1,744,000
COST EFFECTIVENESS (UAC):	US$(0.01)/Kg/ODP/Year
IMPLEMENTING ENTERPRISE:	Zhongshan Fine Chemical Industrial Limited.
COORDINATING MINISTRY:	The National Bureau of Environment Protection.
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY

The most common alternative propellant, HAPs (hydrocarbon aerosol propellant) is not a viable alternative in Guangdong Province, where imported material is very expensive and no feedstock exists suitable for purification (see section on "JUSTIFICATION FOR ALTERNATE TECHNOLOGY SELECTION" for a full explanation). This project will substitute CFCs for imported dimethyl ether (DME) in a total of 35,000,000 aerosol cans per year, 20,000,000 of Zhongshan's brands and 15,000,000 for other marketers by offering filling center services to companies that are now filling small quantities of aerosols with CFCs and cannot convert to a flammable propellant.

The slight operating savings obtained in the substitution will be apportioned in the same manner as in the case of the previously approved filling centers at Tianjin and Shanghai, i.e. all of the operating savings on Zhongshan's products and 33% of the savings on the "filling center" products filled for others will be included in recurring operating savings, and used to reduce the amount of grant requested. The other two-thirds of savings will go to the independent marketers as an incentive to bring their products to the filling center.

This project is included in the "China Country Program for ODS Phaseout" (hereafter referred to as ("C.C.P"), and its implementation is required to eliminate CFC 12 usage as an aerosol propellant in China.

Technical Review: The project has been reviewed and supported by the OORG technical reviewer, Dr. Montfort Johnsen. His comments are attached.

PROJECT OBJECTIVES

Eliminate the use of 4,067 tons of CFC 12 as an aerosol propellant. Comply with the C.C.P. for the elimination of CFC 12 in the southern section of China, which will enable China to achieve its national goal of CFC phaseout in the aerosol sector.

SECTOR BACKGROUND

China's aerosol market developed late, and its aerosol products represent only 1% of those produced worldwide. The industry developed almost completely on the basis of CFC 12 as a propellant. With a strongly prosperous economy, aerosol demands have increased rapidly in recent years, and many jobs are now related to the filling of aerosol containers.

National consumption of CFC propellant (largely CFC 12) was 7,090 tons in 1991, and increased to 9,720 tons in 1992. According to the C.C.P. consumption will increase to 23,584 tons in 1996 if no substitution occurs.

To combat this and comply with the requirements of environmental protection, it is necessary to eliminate CFC usage in the aerosol sector. To this end, the C.C.P. specifies the use of three large "filling centers" in the north (Tianjin), center (Shanghai) and south of China (Guangdong Province, this project). At this time there are 56 plants using CFCs to produce aerosols in Guangdong Province.

ENTERPRISE BACKGROUND

Zhongshan Fine Chemical Industrial Limited is a comprehensive state-owned enterprise which deals mainly with aerosol products, aerosol cans (including valves) and fine chemical products. In 1993, its gross industrial output is US$64.497 million.

The enterprise started to develop aerosol products in 1982. In 1993, the annual output of aerosols reached up to 41.92 million cans (about 60% of which is used CFC propellants), which was more than twenty percent of the national output. There are more than twenty kinds of products spreading widely in domestic market. In 1993, the consumption of CFC 12 was 2085 tons, of which about 70% is hair sprays and air fresheners.

There is an aerosol technology developing center in the enterprise as the scientific research organization to develop new products, while the manufacturing technology is mainly developed by the enterprise itself. Up to now, nine kinds of products have been awarded as high quality products of national, ministerial or provincial grade.

PROJECT DESCRIPTION

This project will substitute an annual consumption of 4,067 tons of CFCs used to fill 35,000,000 cans of aerosols with DME which can be purchased from nearby Taiwan. There are 20,000,000 cans with Zhongshan brand that are to be filled. Another 15,000,000 cans will be available at filling center services to companies that are now filling small quantities of aerosols with CFCs, and cannot convert to a flammable propellant.

This project includes the retrofitting of the filling equipment for the use with a flammable gas propellant. This involves the substitution of hoses, seals, and gaskets that are compatible with DME. Four outside explosion proof filling rooms will be imported to assure that the filling operations compiling with all international safety standards.

In order to phase out all CFC being used by the company, five automatic filling lines and four manual filling lines must be retrofitted. This project covers retrofitting three automatic filling lines (each operating at 40-50 cans per minute) and two manual filling lines (10 cans per minute). The company has already initiated the retrofit of the other lines on their own, as a contribution to the world ozone protection program.

Storage facilities for DME will be needed, but as the supply is nearby,size of these facilities will be limited in size. Utility production (water, electricity, steam, and compressed air) must be increased, and the warehouse for finished goods must be upgraded for storage of large quantities of aerosols with flammable propellants. Some safety and laboratory equipment is required.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION

The most common alternative propellant, HAPs (hydrocarbon aerosol propellant) is not a viable alternative in Guangdong Province. This was established during the initial survey (Leo Laine, "Report of the UNDP Mission to China-Aerosols," December, 1991) and subsequently supported by work done by Mr. Raimo Multala and Mr. Geno Nardini, aerosol consultants to the World Bank, and is elaborated in Annex 1.

With HAPs discarded for the above stated reasons, DME is the most viable alternative to allow Zhongshan to fulfill its role as the filling center for the southern region of China.

DME has a distinct quality advantage over HAPs and it is known that clients that fill cosmetic aerosols will pay slightly more to obtain it. Countries in Europe routinely pay much more for DME than for HAP because it has better qualities as a propellant. In China, as long as the price does not exceed the price of CFC, a very good market can be found. As the studies indicated, over 70% of all aerosols filled in the southern section of China are cosmetic aerosols (principally hair spray and hair mousse), which are the very products where DME has found acceptance in Europe.

The World's annual output of DME exceeds 170,000 tons, of which almost half is used as an aerosol propellant. The distinct technical advantages of DME that permit it to be sold at a premium are:

1) DME is miscible with water up to about 35%, and it is easy to develop water based aerosols which substitute for CFCs and produce low quantities of "volatile organic compounds (VOCs), an additional benefit as far as the environment is concerned.

2 While DME is also very flammable, the use of water can decrease drastically the flammability of the finished aerosol.

3) DME is soluble in both polar and non-polar concentrates which makes it ideal for use in multi-component formulations.

4) DME has a slightly sweet odor which is acceptable to the consumer in cosmetic products, and also very easy to modify with a wide range of fragrances.

DME is recognized by the 1991 UNEP Technical Options Report on Aerosols, Sterilants, and Miscellaneous Uses and Carbon Tetrachloride as an approved alternate substance, although normally HAPs are recommended as the principal alternate.

PROJECT COST

The total project cost of US$1,693,000 was calculated based on incremental investment cost, including 15% contingency minus incremental operating benefits.

Investment costs of US$3,332,000 includes civil construction of storage facilities, conversion of aerosol filling systems and purchase of equipments for DME storage station and some imported equipments/facilities, etc. (Annex 2)

Incremental operating benefits of US$2,139,000 were estimated based on the cost savings achieved by using DME instead of CFC for filling 35,000,000 aerosol cans (Annex 3). Over four years discounted at 10% with 2/3 of savings passed on to filing center customers to encourage use of the filling center. This amount was deducted from the investment cost. Beyond four years the profit margin is expected to shrink as the aerosol business becomes more competitive and enterprise will be forced to pass savings on to customers.

Other costs. A 15% contingency (US$500,000) was added to the investment cost and an additional US$51,000 (3%) was added to the grant request to cover the fee for services of the financial agent that will appraise the project and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Zhongshan is US$1,744,000 and was calculated as the sum of the following: (1) investment cost, (2) plus 15% contingency, minus (3) incremental operating benefit. The resulting total project cost was increased by 3% to account for the financial agent fee.

OWNERSHIP

The project carrier is a state-owned enterprise (100% local ownership.)

UNIT ABATEMENT COST

UAC = ($0.01)

Total Investment cost including contingency is US$ 3,832,00. Using a 10% recovery rate, this investment was annualized over a 10 year economic project life. Annual benefits of $675,000 were deducted from the annualized investment cost. The total annualized incremental costs were then divided by 4,067,000 kg ODP. the UAC is negative because investment costs were annualized over the economic life of the project, which operating benefits were only considered for the first four years of the project.

PROJECT MANAGEMENT & SCHEDULE

The National Bureau of Environment Protection will act as the project supervisor. Zhongshan Fine Chemical Industrial Limited is responsible to carry out this project.

According to the national regulations of construction process, the work is divided into two periods: the preliminary period and construction period.

Project Completion will take two years with one year for each period (Annex 4).

PROJECT EFFECTS

(1) To phaseout completely the use of CFC in the current biggest aerosol manufacturer in China-The Zhongshan Fine Chemical Industrial Limited.

(2) To provide filling service for many small enterprises, eliminating environmental pollution caused by heavy leakage due to the inferior equipment of the small enterprises. To convert the products of small enterprises to be "Ozone-friendly" ones, saving the big amount of capital investment that would be required to convert the small enterprises for application of a flammable propellant.

(3) To develop DME-water formulated products, reducing the use of alcoholic solvent, as a preparation of solving the potential VOC problems in future China.

ANNEX 3
Page 1

CALCULATION OF INCREMENTAL OPERATING BENEFIT

Annual incremental benefits of using DME as substitute for CFCs are calculated as follows:

Zhongshan Company's own product:

(1) Hair Sprays, 10,000,000 cans per year.

Base line	US$0.593/can (see appendix B-1)	
Project	US$0.560/can	
Incremental benefits = 10,000,000x(0.560-0.593)		US$-330,000

(2) Air Fresheners, 10,000,000 cans per year

Base line	US$0.477/can	
Project	US$0.456/can	
Incremental benefits = 10,000,000x(0.456-0.477)		US$-210,000

Filling service for small enterprises:[1]

(3) Hair Sprays, 7,500,000 cans per year enterprises.

Base line	US$0.593/can	
Project	US$0.560/can	
Incremental benefits = 7,500,000x(0.560-0.593)x1/3		US$- 82,500

(4) Air Fresheners, 7,500,000 cans per year.

Base line	US$0.477/can	
Project	US$0.456/can	
Incremental benefits = 7,500,000x(0.456-0.477)x1/3		US$- 52,500
Total incremental benefits		**US$675,000**

Net present value for the incremental benefit of US$675,000 discounted at 10% for four years is US$2,139,075.

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[1] The benefits derived from filling service for small enterprises will be splitting between Zhongshan and the small enterprises at 1/3 to Zhongshan and 2/3 to the small enterprises.

ANNEX 4

BREAKDOWN OF PROJECT COST AND FINANCING

Incremental investment cost		US$3,332,000
Contingency (15%)		US$ 500,000
Subtotal incr. investment cost		US$3,832,000
Sources of financing:		
OTF Grant	US$1,693,000	
Counterpart financing	US$2,139,000	US$3,832,000
Less: Incremental operating benefits		US$2,139,000
Subtotal project cost		US$1,693,000
Financial agent fee (3%)		US$ 51,000
Proposed OTF Grant		US$1,744,000

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY

It is known that there is no feedstock in the southern region of China that is adequate for purification to produce HAPs, and the entire region suffers from a shortage of supply of imported LPG for fuel usage. Moreover, local our roads and railroads are not adequate to safely transport odorless HAPs long distances, and safety regulations would not permit this.

Transportation of LPG with odor would be permitted, but no source of sufficient tonnage of acceptable feedstock has been identified. Use of LPG would thus be very costly, and competitive of forces (competition with aerosols produced at the Tianjin and Shanghai filling centers) would require that Zhongshan sells it below cost, which is not permitted under current Chinese law. Zhongshan's studies indicated that since there would be no operating savings, the entire cost of purification equipment and storage tanks for an LPG based project would be incremental, increasing the grant request to an unacceptable amount.

CO_2 is already being used as a propellant in small amounts, and its use cannot be increased due to its poor qualities as an aerosol propellant. Some hydrocarbon is also being filled, but very little as the company does not have the proper facilities for this, and the quality is irregular.

The imported HAPs that reaches Guangdong Province is not really "hydrocarbon aerosol propellant," in that it has a slight odor. It is more expensive than both CFCs and imported DME. It appears that it comes from Singapore through Hong Kong, but with a country of origin of either the Persian Gulf or Europe. Return of the empty transport cylinders long distances through various hands makes this option more expensive than imported DME, which originated from Taiwan.

Even if direct import were arranged, the distance is very great, and HAPs is very expensive to insure and transport, and the cylinders must be returned. Because of the distance, our storage would have to be very large, with a huge investment in "isocontainers" to transport it. The following calculations from Zhongshan study on the importation of HAPs are cited:

1) 35,000,000 units at an average of 80 grams per can (hair spray uses much more, but mousse much less and this would be our average) is 2,800 tons of hydrocarbon per year.

2) Based on 3 turnarounds per year (a realistic average based on shipments from the USA or Europe), use of HAPs would require the purchase of 78 "isocontainers" of 12 tons capacity, at about $45,000.00 each, an investment of $3,510,000.00.

3) One month storage at the plant requires 233 tons or approximately 432,000 liters, which would require, under Chinese law, a huge safety system in the tank farm area, and an investment of another $2,000,000.00.

4) Both of these investments would become obsolete and largely unrecoverable as soon as propellant production begins in the southern region.

5) Taking into account the need to amortize this direct investment, plus the cost of the HAPs from the USA or Europe, plus ocean freight and insurance, customs agents, local stevedores, local freight and insurance, and all of the associated costs with the return of the isocontainers, plus a large administrative factor would amount to a cost as high for HAPs or higher than the imported DME figures. Trade with nearby area is done in small almost daily freighter where stevedore costs and custom agent charges are much less, and customs agents charges also.

6) Even if Zhongshan were able to reduce the cost of importing HAPs, this option would not allow the company to be competitive with the other filling centers.

7) Given the known risk of obsolescence of this type of investment, neither the company nor the provincial government would approve it.

List of Investment Costs

Unit: US$ 000.00

Serial No.	Item of Engineering or expense	Total
1	Civil works	
	Civil construction	370
2	Public utilities	
	Water, electricity, Compressed air	180
3	Conversion of aerosol filling system	
	3 sets of auto-filling lines	812
	2 sets of filling machines	155
4	Liquid product formulating	
	Tanks for storage	38
	Tanks for formulating	21
	Measuring, filtering appliances, etc.	15
5	DME storage station	
	Main equipment, pipes, electric apparatus	490
	Conveying system, instruments, valves	207
6	Transportation appliance	
	Cylinder transporting truck (3)	57
	Fork truck (2)	40
	Crane (2)	10
	Cargo truck (2)	17
7	Lab QC Apparatus *	
	Corrosion test & auxiliary instruments	90
	Other quality test instruments	21

8	Safety facilities	
	Safety equipment	183
	Water spray system	72
9	Transportation expenses for equipment import	
	Overseas transportation	48
	Domestic transportation	22
10	Installation & Commissioning	
	Installation	261.3
	Commissioning by foreign experts	60
	Running test & training	58
11	Engineering Costs	
	Design & Technical Assistance	50
	Project management	55
	Sub—total	3332.3
12	Other costs	
	Floating rate 5%	166.6
	Unpredicted expense 10%	333.2
	Total	3832.1

* The filling center will provide service for many small enterprises, the product varieties are very much with small capacity. The quality control for material before and after propellant filling is very important. DME water formulation will cause special corrosion issues on the can wall, therefore the lab QC apparatus and corrosion test instrument are necessary.

ANNEX 3
Page 1

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Benefits Estimation For Aerosol Products Using DME as CFC Alternative

Comparision of Hairspray Formulas

Formula with CFC

Name of raw material	Unit price of raw material (US$/kg)	Composition (%)	Quantity used (g/can)	Cost (US$/can)
ES—22	12.82	7.00	20.51	0.263
AMP—95	6.84	0.30	0.88	0.006
Ethanol	0.58	52.40	153.53	0.089
Others	48.89	0.30	0.88	0.043
CFC	1.64	40.00	117.20	0.192
Total		100.00	293.00	0.593

Formula with DME

Name of raw material	Unit price of raw material (US$/kg)	Composition (%)	Quantity used (g/can)	Cost (US$/can)
ES—22	12.82	7.70	19.48	0.250
AMP—95	6.84	0.33	0.83	0.006
Ethanol	0.58	56.34	142.54	0.083
Others	48.89	0.33	0.83	0.041
Corrossion resistant material	42.91	0.30	0.76	0.033
DME	1.61	35.00	88.55	0.142
Price difference of valve gasket				0.005
Total		100.00	253.00	0.560

By comparision, expense of formula with DME is lower than that of CFC by 0.593 − 0.560 = US$0.033 per can.

Formula of Air Freshener

Formula with CFC

Name of raw material	Unit price of raw material (US$/kg)	Composition (%)	Quantity used (g/can)	Cost (US$/can)
Fragrance essence	38.46	1.35	3.89	0.150
Ethanol	0.58	51.65	148.75	0.086
Others	2.56	7.00	20.16	0.052
CFC	1.64	40.00	115.20	0.189
Total		100.00	288.00	0.477

Formula with DME

Name of raw material	Unit price of raw material (US$/kg)	Composition (%)	Quantity used (g/can)	Cost (US$/can)
Fragrance essence	38.46	1.50	3.78	0.145
Ethanol	0.58	55.50	139.86	0.081
Others	2.56	7.70	19.40	0.050
Corrosion resistant material	42.91	0.30	0.76	0.033
DME	1.61	35.00	88.20	0.142
Price difference of valve gasket				0.005
Total		100	252.00	0.456

By comparision, the cost of formula with DME is lower than that of CFC by 0.477 − 0.456 = US$ 0.021 per can.

The capacities of the above hairspray and air freshener are both 300ml. By using DME as the composition instead of CFC, averagely US$ 0.027 will be saved for each can:

(0.033 + 0.021) ÷ 2 = US$ 0.027

PROJECT ACCOMPLISHMENT SCHEDULE

TASK	Preliminary Period (Month)												Construction Period (Month)											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Feasibility study																								
Project justification and approval																								
Equipment purchase negotiation & Technical exchange																								
Contract for imported equipment purchase																								
Preliminary design																								
Construction design for workshop and equipment																								
Building construction & Equipment purchase & manufacture																								
Equipment installation & Personnel training																								
Adjustment & Commissioning																								

JUN 10 1994

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Aerosol Consulting

10-JUN-1994

Mr. Don Brown
Ms. Helen Chan - EA2IE (Room A-7102) FAX: 202-477-1273
Operations - Industry & Energy (Asia)
THE WORLD BANK / IFC / M.I.G.A.
Washington, D.C. 20433

RE: CHINA - Zhongshan Aerosol Project.

Dear Mr. Brown & Ms. Chan:

Thank you for retaining our services in the above-captioned matter. I have carefully reviewed the FAXed 31-page reports, and find substantial agreement with the adjectival and numerical presentations. As a result, I see no persuasive or substantive reason to deny the requested funding.

There are a few areas where the report suffers a bit from omission, and some of these involve very recent activities that may not be general knowledge as yet. They do not alter the basic thrust and conclusions of the report, but should be considered by the appropriations committee for this investment project. I would like to recite them as follows:

a. The project is designed to phase out 4,067 tonnes of CFCs annually, by replacing these propellants with dimethyl ether (DME).

The Guangdong Province consumed 3,620 tonnes of CFC in 1992.

The uninhibited growth rate of CFC use for aerosols in Guangdong is:

1991	2,638 tonnes
1992	3,620 tonnes (37.2% of P.R.CHINA)
1993	4,988 tonnes
1994	6,418 tonnes
1995	7,510 tonnes
1996	8,773 tonnes

* The projections assume Guangdong consumption would remain static at 37.2% of P.R.CHINA.

The time for project completion is estimated at two years, or mid-1996.

It follows that DME could then replace 4,067 tonnes of CFCs, or about 46.4% of the projected Guangdong Province CFC requirements at that time. This would require most of the Guangdong CFC consumers to remain in that mode.

There may be a concern that Zhongshan Fine Chemical Industrial Limited, as the most conspicuous present CFC consumer, might have preferred access to lower cost DME, and thus an economic advantage over the 57 much smaller fillers in the Province. These fillers would have to continue self-filling.

The writer has a letter from Aastar (also in Guangdong) stating that aerosol unit production in P.R. of CHINA will increase from 218 million in 1993 to at least 500 million in 1996. This harmonizes with the above tonnage figures.

b. The amount of DME handled in Guangdong would be equivalent to 4,067 tonnes of CFC, or 2,800 tonnes of hydrocarbon (HAP) per year. I do not see any figure for the proposed output of the actual DME material.

The output is presumed to be in the general area of 3,500 tonnes per year.

Considering the hair spray — by far the largest cosmetic aerosol product in P.R.CHINA — propellant usages range from:

40 to 65% CFC
30 to 65% DME
20 to 32% HAP

If the cost of the propellant is less than that of ethanol (the major solvent) then there will be a tendency to use more propellant.

In North America the list price for HAP is currently $0.483/kg. Discounts are always afforded to larger customers. The proposed cost of DME in Guangdong is listed at $1.610/kg. This means that HAP (North America) will cost about 30% as much as DME in P.R. of CHINA, and still less with discounts.

c. If P.R. of CHINA plans to purchase about 3,500 tonnes of raw-DME per year from Taiwan, the report should indicate if Taiwan has this amount of excess capacity available.

The "boilerplate capacity" of the P.R. of CHINA storage and handling plant is unknown, but considering the rapid expansion of the aerosol industry there, a substantial excess should be installed — beyond the 3,500 tonnes or so per year. This would also presumably come from Taiwan, if they have that capacity. In my judgement, both Guangdong and Taiwan should have the ability to supply over 6,000 tonnes by 1996. The report is silent in this area.

d. The production loss of chemicals and propellant is not discussed in the report, except to note that a great loss of CFC propellants is discharged into the air by the older machines in use by most smaller aerosol fillers.

Because of its extremely high solvency, and moderate-to-high pressure, the production loss — sometimes called "shrinkage" — of DME is known to exceed losses of HAPs, and to considerably exceed losses of CFCs. In a well controlled operation, with good maintenance of gassers, propellant pumps and piping, DME production losses average about 11%. Where aerosol cans receive relatively small amounts of DME, the production losses can run even higher.

Chemical losses average about 2% for large runs and 4% for small ones. Much of this is related to over-filling cans and clean-up of equipment after completion of a production run.

In the hair spray and air freshener examples of pages 16 and 17 of the report there is no mention of propellant losses. However, since comparisons are being made, and losses will occur for both CFC and DME fillings, the effect becomes differential, and would act to decrease the difference of about $0.03 per can to between $0.01 to $0.02 per can — depending upon the characteristics of the production pumps, piping and charging equipment.

e. It is presumed that the purity of the Taiwan DME material is now well tested and found acceptable; e.g. essentially free of methanol, water and odorizing chemicals. It is noted that pure DME has a chemical (ethereal) odor that is many times stronger than that of purified HAPs, but only slightly more than CFC-11.

f. It is noted that DME has just one pressure: 4.41 kg/cm^2 at 21.1°C. On the other hand, the HAP mixtures can have pressures ranging from 1.17 to 7.00 kg/cm^2 at 21.1°C. As a result, DME may be contra-indicated for certain products, since as anti-perspirants.

In some cases the moderate to high pressure of DME may be moderated by using it in conjunction with certain other propellants, or with solvents. This formulation approach will extend its applications somewhat.

g. Because it is soluble in both oils and water, DME is generally not a good propellant choice for foam systems, such as mousse and shave cream products. Exceptions exist, but several times as much DME may be required as is needed in the case of HAPs. This is due to solvent vapor depressancy effects.

Water-based products, such as window cleaners, starches, fabric finishes, oven cleaners, disinfectant/deodorant cleaners and most air fresheners depend upon the creation of a top layer of insoluble HAP on the water-based concentrate. These products will not function properly with DME because it is soluble in these concentrates.

h. A major Joint Venture (JV) has been signed by three parties, including the state-owned Zin Development Company (Shanghai), which will act to place a major hydrocarbon purification plant in the Pudong sector of Shanghai — some 5 km. from dock-side. The output of this facility will be mixed butanes and propane, or blends, which will have purities and very low odors fully comparable to the best product of North America and Western Europe.

The availability of such HAP materials in Guangdong may be conditional on the needs of the general Shanghai/Tianjin cosmopolitan areas, the ability to ship deodorized product by iso-containers by sea, or the ability to ship deodorized or slightly reodorized (7 ppm mercaptan) product by railroad. The plant will be operational in late 1995.

i. The report (page 6) indicates that the "huge safety system" required for a HAP storage of 233 tonnes — or 432,000 liters — would cost $2,000,000 under Chinese law. In the U.S. this would equate to the use of four 120,000 liter (32,00 U.S.Gallon) standard horizontal storage tanks, placed in an earth-bermed catch-basin area that is also fitted with intensive spray "water cannons" and a flammable gas automatic sensing system. Ideally, the storage area should be fenced, kept free of plant growth or other combustibles, and positioned at least 16 m from the nearest property line, road, path or other building. The safety system alone would not normally exceed $250,000 in cost, if installed in North America.

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This completes the introductory summary and commentary. Further information will now be presented using the Ozone Operations Resource Group (OORG) Standard Technical Opinion formats, as received from Mr. Gano Bardini for this purpose.

O.O.R.G. TECHNICAL REVIEW AND OPINION

P.R.CHINA - ZHONGSHAN AEROSOL PROJECT

SCOPE The project under review covers the development and technology for the justification of replacements of CFC propellants in a major sector of

the P.R. of CHINA. The alternative technology under consideration is the installation of a fully protected storage area for the dispersement of dimethyl ether (DME) propellant, and the upgrading of facilities to handle this flammable liquified gas during the charging of aerosol dispensers. Related costs deal with safety equipment, analytical requirements, worker training and so forth.

RECOMMENDATION The proposed project is fully supported. The program should be relatively easy to put into implementation on the basis of the Zhongshan Fine Chemical Industrial Limited company's already extensive expertise in the storage and utilization of aerosol propellants. Additionally, the technology for handling potentially flammable aerosol propellants is well known to them, as well as rather fully documented in numerous technical articles, industry recommendations and regulations worldwide. Specific experts are available to Zhongshan upon their request.

Recommendations for further study or consideration are presented in the introductory commentary. However, they do not mitigate, or detract from, the acceptability of the present report.

RELEVANCE AND ADEQUACY OF INFORMATION PRESENTED The information is judged to be substantially complete and comprehensive. It is perfectly relevant to the proposed project and persuasively argues for approval.

Upon completion, the 58 aerosol fillers in Guangdong Province — representing about 37% of the P.R. of CHINA total aerosol industry at this time — would have a choice between using dimethyl ether (DME) and carbon dioxide (CO_2) gases as aerosol propellants. There would be a small economic incentive for fillers to reduce or terminate their use of CFC propellants.

Allowances should be made at the storage site for future expansion, according to the needs of a rapidly expanding aerosol industry, the possibility of producing DME (or refining it), and the possibility of providing a storage center for purified hydrocarbon (HAP) propellants that will be sourced in Shanghai.

TECHNICAL SOUNDNESS Zhongshan Fine Chemical Industrial Limited is obviously quite familiar with the technical requirements involved. This is demonstrated in the sophistication of their reports. They have been in repeated contact with major suppliers of aerosol production equipment, who also supply gassing houses or gassing areas for the safe handling and filling of potentially flammable gases.

The conversion requirements in going from CFC to DME propellants appears to be well recognized and understood.

The proposed timetable for the conversion process appears reasonable, with the correct sequence and periodicity of all developmental stages. I note that there are no specific allocations for the time required to gain various environmental, safety, regulatory and political approvals, but perhaps these periods are worked into the fabric of the PERT plan under other titles or headings.

Given the apparent dedication to correct and appropriate engineering practices, training of employees and adherance to available safety manuals for operations, safety should not be a concern except in the area of preventative maintenance. The basic technology is very safe, when utilized in a proper fashion.

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Approximately 6 billion aerosols are produced worldwide with potentially flammable propellants. About 14% of these packs utilize dimethyl ether. While hazardous events undeniably occur, they do so with extreme rarity.

The equipment visualized by Zhongshan is state-of-the-art, such as gassers, detectors and so forth. It is regarded as essential for the conversion process — to virtually eliminate hazards, prevent propellant seepage into the atmosphere, provide positive primary and back-up controls and minimize those factory costs that relate to over-filling, line down-time and quality problems.

LESSONS FROM EXPERIENCE The proposed program would learn on technology that is already well developed throughout the world. As a generalized statement, any facility that can store or fill HAPs into aerosol cans can do the same for DME. No particular extra safety measures are required. DME is actually "safer" than HAPs in some ways: for instance, about twice as much gas must be released into a fixed amount of air for the gas/air mixture to become hazardous.

A substantial number of P.R. of CHINA fillers currently produce HAP aerosols on a routine, day-to-day basis. I have not heard of any safety-related problems at these plants. Seminars held periodically by the National Aerosol Association (of China) address safety issues as a primary topic. Last year The World Bank participated on a major seminar in Beijing, where major attention was given to filler safety considerations.

ENVIRONMENTAL ISSUES The protection of the slightly thinned stratospheric ozone layer is the ultimate environmental issue underlying this conversion project. The release of CFCs also significantly promotes global warming as well. DME (and HAPs) do not cause either of these major problems when they enter the atmosphere.

On the other hand, DME (and the HAPs) are mild volatile organic compounds, capable of transiently producing excess tropospheric ozone over heavily urbanized areas. This is an extremely minor problem compared to the other two, and an easy trade-off, even for environmental groups. P.R. of CHINA may give more attention to the VOC issue in several years, but at this time it is no more than a reformulation exercise, even in the most advanced countries.

No other environmental issues are involved in changing from CFCs to DME.

SAFETY ISSUES These have been covered as parts of foregoing categories. When things are done correctly, by trained personnel, using proper equipment, the operations with DME will be quite safe. The program visualized by Zhongshan captures these precautionary elements.

COST-EFFECTIVENESS The proposal address cost effectiveness, and shows that this is a significant factor. The lower cost of DME aerosols (compared to CFC types) is a definite advantage, and is used as an economically oriented incentive to induce fillers to reduce or eliminate their current use of CFCs. The immediate goal is to replace some 4,067 metric tonnes of CFCs, which is certainly a major undertaking. The financial estimates provided in the report have been reviewed and found to be acceptable, based on experience in equivalent areas.

The Zhongshan figures are contingent upon fully realising the timetable and the various costs. Certain aspects, such as inflation and taxation, can only be estimated or taken at face value.

Submitted,

Montfort A. Johnsen, Ph.D.
President

China's Response to MPEC Recommendations
Six Domestic Refrigerator Sector Projects

Action : Permission to Proceed granted at the 12th Meeting of the Executive Committee for:

Shanghai Refrigerator Compressor Co. Ltd.
Shanghai Shangling General Refrigerator Factory
Hua Yi Electrical Appliance General Co.
Shanghai Shanglu Electrica Appliances Co. Ltd.
Wanbao Electric Appliance Industrial Corp.
Chang Ling (Group) Co. Ltd.

Recommendation 1: Refrigerator Sector Strategy

"The [six] projects would form the basis for a sectoral strategy to phaseout CFCs in some 86 related enterprises/lines in China. The strategy should include phase-out of CFCs in insulating foam"

China's refrigerator subsector is a huge industry, comparable to those in the US and Europe, but with a variety of technologies introduced from many different countries (US, Japan, Germany, Italy, etc.). China attaches key importance to the selection of proper technical directions for the sector in order to eliminate ODS use economically and effectively. While China recognizes that one or two of the technologies being adopted in the six projects may turn out to be transitional because of associated implementations costs, the country notes that the six projects will provide key information to address selection of optimal technologies and will reduce the total cost for eliminating CFC use in the manufacture of its refrigerators.

Three basic technologies are considered in the six projects included in China's demonstration program.

HFC134a- an internationally popular fully non-ODP technology which requires redesign of the compressor, thus increasing the operational cost for proper implementation. The costs associated with this change must be carefully defined.

Blends- a transitional approach to quickly reduce consumption of ODS without the necessity of redesigning the compressor. Investment and operational costs appear to be the lowest with this technology This technology will also have applications in the maintenance of older model refrigerators, thus reducing obsolescence costs.

HFC152a- a non-ODP approach which shares some of the characteristics of Blends but one where the refrigerant must be treated as a flammable substance. China has commercial quantities of HFC152a available for use thus relieving supply concerns associated with Blends and HFC134a. Compressors do not require redesign. The costs and implications of adopting this technology require demonstration in China.

China has decided to implement the six projects based on Chinese realities as well as international development trends AND the "China National Plan" (i.e., country program). They are presented as demonstration projects to fully define technical AND cost issues associated with each program in preparation for the dissemination of technology and recommendations to all other (approx. 80) enterprises in the sector. These projects are an integral part of the refrigerator sector strategy, a draft of which is currently being reviewed by government institutions and international and domestic experts. The sector strategy also includes plans, criteria and priorities for the phaseout of CFCs in foams used to insulate refrigerators, and the configuration of the refrigerator service network for accommodating various types of refrigerants. Particular attention is given in the strategy to identifying and implementing cost effective solutions within the context of Chinese conditions.

Recommendation 2: Testing Equipment

"Testing of appliances must be rationalized. Either the testing equipment requested in those projects should be used for other enterprises or centralized centers should be established within four or five existing R&D institutes"

The testing equipment requested for support of the six projects is considered to be the minimum essential requirement for meeting project objectives. Cost estimates for calorimeters at Shanghai Compressor and Shangling Refrigerator have been reduced from $200,000 to $100,000 each to reflect current expectations of competitive prices.

In general, there are two types of testing requirements: 1) production control- for sustaining safe operation and identifying refrigerant leakage conditions, and 2) data gathering- for collection of the necessary developmental information on equipment performance of new (i.e., non-CFC) models. Production control testing is considered to be essential for each enterprise in all current and future refrigerator projects. Data gathering equipment, however, will only be needed in China during the implementation of the six projects, provided regional testing facilities become operational. Consequently, the only adjustment in the six projects as originally submitted is a 50% reduction in the estimated cost ($200,000) of the two calorimeters required to support the Shanghai Compressor and Shangling Refrigerator projects.

For future projects, the sector strategy includes the establishment of several regional testing facilities to support the sector enterprises during their transition to non-CFC technologies. Consideration will be given to transferring data-gathering equipment from the six enterprises to the regional facilities when such equipment is no longer needed to support their non-CFC development programs.

Recommendation 3: Incremental Operating Costs

"Incremental operating costs of the six projects should be accurately estimated"

The incremental operating cost estimates included in the six projects were based on current projections of unit cost increases at each enterprise and the forecast annual production during the first full year of project implementation. These annualized costs were discounted at 10% for the succeeding three years. A request for funding of incremental operating costs was not included in the OTF grant request for two reasons: 1) operating data from the six projects will be necessary to accurately estimate such costs, and 2) the guidelines for calculation of such costs are currently under review by MPEC. The most accurate estimates of such costs, based on a current understanding of the cost structure in China and MPEC guidelines, are those included in the six projects.

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.

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.

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.

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 basie 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.

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.

[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 I

During Phase I, 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 I, 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 I 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.

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.

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[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.

CHANG LING

Annex A

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.