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

Twentieth Meeting
Montreal, 16-18 October 1996

PROJECT PROPOSALS: CHINA

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

Foam

- Elimination of CFCs in the manufacture of rigid PUF products at Handan Plastics #8 World Bank
- Conversion to CFC-free technology in the manufacture of flexible (slabstock) polyurethane foam at Chengdu Plastics No.7 World Bank

Refrigeration

- Phasing out ODS at the household refrigerator compressor factory of the Guangzhou Wanbao Compressor Group UNIDO
- Conversion of medium-sized semi-hermetic CFC-12 refrigerating compressor production to HCFC-22 production at Tianjin Tian Shan Refrigeration Equipment Co. World Bank
- Conversion of small semi-hermetic CFC-12 refrigerating compressor production at Shanghai General Machinery (Group) Corp. (SGMC) World Bank
- Conversion of CFC-12 small open-type and semi-hermetic refrigerating compressor to HCFC-22 refrigerating compressor at Zhenjiang Refrigerating Equipment Factory (ZREF) World Bank
- Conversion of CFC-11 and CFC-12 centrifugal refrigerating compressor to HCFC-134a centrifugal technology at Chongqing General Machinery Factory World Bank

PROJECT EVALUATION SHEET **CHINA**

SECTOR: FOAM ODS use in sector (1991): 17,773 ODP tonnes

Sub-sector cost-effectiveness thresholds: Flexible slabstock polyurethane US \$6.23/kg
 Rigid polyurethane US \$7.83/kg

Project Titles:

- (a) Conversion to CFC-free technology in the manufacture of flexible (slabstock) polyurethane foam at Chengdu Plastics No. 7
- (b) Elimination of CFCs in the manufacture of rigid PUF products at Handan Plastics No. 8

(Project Data)	Flexible slabstock	Rigid
	Chengdu	Handan
ODS phase-out (ODP tonnes)	120	110
Proposed project duration (Yrs)	1.5	1
Incremental capital cost (US\$)	385,000	138,000
Contingency (%)	10	10
Incremental operational cost (US\$)	87,000	127,000
Total project cost (US\$)	472,000	265,000
Local ownership (%)	100	100
Export component (%)	0	0
Amount requested (US\$) {Original	472,000	265,000
{Revised	301,000	265,000
Cost effectiveness (US\$/kg)	3.93	2.41
National Coordinating Agency	NEPA	NEPA
Implementing Agency	World Bank	World Bank
Technical review completed?	Yes	Yes

Secretariat's Recommendations		
Amount recommended (US \$)	301,000	265,000
Project impact (ODP tonnes)	120	101.64
Cost effectiveness (US \$/kg)	2.51	2.61
Implementing Agency support cost (US\$)	39,130	34,450
Total cost to Multilateral Fund	340,130	299,450

PROJECT DESCRIPTION

Flexible Slabstock Polyurethane Foam Project

- (a) Conversion to CFC-free technology in the manufacture of flexible (slabstock) polyurethane foam at Chengdu Plastics No. 7

1. Chengdu manufactures flexible slabstock polyurethane foam using both slabstock and Vertifoam equipment. It produced 860 tonnes of foam, about 14% of its installed capacity.
2. The project was first submitted and reviewed for the 18th Meeting of the Executive Committee among a group of seven flexible slabstock polyurethane foam projects for China. The project was reviewed and recommended for approval at the level of funding of US \$301,000. However, the project was withdrawn prior to its consideration by the Executive Committee.

Rigid Polyurethane Foam Project

- (b) Elimination of CFCs in the manufacture of rigid PUF products at Handan Plastics No. 8

3. Handan No. 8 Plastics factory produces metal faced sandwich polyurethane foam panels for construction and cold storage and pre-formed pipe sections. It operates a continuous line using an Elastogran high pressure foam dispenser. The enterprise also has spray foam production activities using mobile low pressure foam dispenser. The output of the company in 1994 was 78,000 M² of panels, 38,000 M of pre-formed pipe sections and 1,800 M² of spray foam.
4. Handan will phase out the use of CFC-11 in its rigid polyurethane foam production by converting to the use of a combination of water and HCFC-141b based formulations. It will eventually switch to full water based systems when the technology becomes mature in the production of the panels and pre-formed sections. The existing high pressure foam dispenser will continue to be used. A closed system pre-mix station will be provided. In the production of spray foam the mobile low pressure dispenser will be replaced with a high pressure variable ratio dispenser of equivalent capacity.
5. Capital cost of conversion, therefore includes the cost of one mobile high pressure foam dispenser (US \$25,000), closed system premix station (US \$65,000), technology transfer and training, trials and start up (US \$35,000). The total incremental capital cost amounts to US \$138,000. The project will incur incremental operating cost (US \$127,000).

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

Flexible Slabstock Polyurethane Project: Chengdu Plastics No. 7

1. As indicated in the Project Description above, this project is being resubmitted following its withdrawal from consideration at the 18th Meeting of the Executive Committee.
2. The review of the project showed that the objectives, the phase out technology as well as the capital costs, remain the same as originally submitted to the 18th Meeting. However, the prices of chemicals used for the calculation of incremental operational costs/savings have been revised, but the new prices are neither consistent with the prices used for the group of projects submitted to the 18th Meeting, nor the prices for the projects submitted to the present meeting. Hence, the incremental operational cost of US \$87,000 was realized against incremental operational savings of US \$84,000 in the original project document, resulting in net increase in the project cost of US \$171,000.
3. Since the circumstances of the project have not changed, the Secretariat recommends the same amount of US \$301,000 which was originally recommended for approval. Agreement was reached between the Secretariat and the World Bank concerning this approach.

Rigid Polyurethane Foam Project: Handan Plastics No. 8

4. The project was discussed between the Secretariat and the World Bank and all the costs were agreed.

Reasons for Using HCFCs

5. The implementing agency listed the range of available technologies and advised that fully water-based systems are proposed as the permanent technology. However, until the commercial introduction of mature water-based systems, (which is expected in up to 2-3 years) a combination of water and HCFC-141b based systems will need to be used to maintain product standards and acceptability. No additional investments are foreseen to be needed to convert to fully water-blown technology after this interim period. In regards to the interim use of HCFC-141b, the implementing agencies advised that it met the following requirements:

- Proven and reasonably mature technology.
- Cost effective conversion.
- Easy availability of pre-blended systems at favorable pricing.
- Enables critical properties to be obtained in the end product (thermal conductivity, dimensional stability, closed cell content, surface properties and strength).

- Facilitates compliance with (local and international) standards on safety and environment.
- Provide the most acceptable insulation value and energy efficiency, and the lowest investment and operating costs vis-à-vis other options.
- No major changes in the auxiliary equipment/tooling, such as mold redesign are needed

The agency noted that pentane based systems require extensive safety related provisions/investments that may only be justified for large scale users.

RECOMMENDATIONS

1. The Fund Secretariat recommends blanket approval of the projects and associated support costs at the level of funding indicated in the table below:

	Project Cost US \$	Support Cost US \$	Implementing Agency
(a) Conversion to CFC-free technology in the manufacture of flexible (slabstock) polyurethane foam at Chengdu Plastics No. 7	301,000	39,130	World Bank
(b) Elimination of CFCs in the manufacture of rigid PUF products at Handan Plastics No. 8	265,000	34,450	World Bank

PROJECT EVALUATION SHEET CHINA

SECTOR: MAC & COMPRESSOR ODS use in sector : N/A ODP tonnes

Sub-sector cost-effectiveness thresholds: N/A

Project Titles:

Phasing out ODS at the household refrigerator compressor factory of the Guangzhou Wanbao Compressor Group

Project Data	Compressor
	Guangzhou Wanbao
ODS phase-out (ODP tonnes)	N/A
Proposed project duration (Yrs)	3
Incremental capital cost (US\$)	4,084,300
Contingency (%)	10
Incremental operational cost (US\$)	N/A
Total project cost (US\$)	4,084,300
Local ownership (%)	100
Export component (%)	0
Amount requested (US\$) { Original	4,084,300
{ Revised	2,250,000
Cost effectiveness (US\$/kg)	N/A
National Coordinating Agency	NEPA
Implementing Agency	UNIDO
Technical review completed?	Yes

<i>Secretariat's Recommendations</i>	
Amount recommended (US \$)	2,250,000
Project impact (ODP tonnes)	N/A
Cost effectiveness (US \$/kg)	N/A
Implementing Agency support cost (US\$)	292,500
Total cost to Multilateral Fund	2,542,500

PROJECT DESCRIPTION

Phasing out ODS at the household refrigerator compressor factory of the Guangzhou Wanbao Compressor Group

1. There are 18 local compressor producers in China which satisfy the demand of the domestic refrigeration sector. Total annual output is about 6 million units. Two projects have been approved by the Executive Committee to convert two compressor manufacturing companies to HFC-134a technology with total production capacity of 1,850,000 units per year.
2. The current annual production at Guangzhou Wanbao factory is 1,750,000 units. An additional production line with an output of about 500,000 units per year has been established in 1996. However, this additional capacity is not covered by the project. The project covers the conversion of production of CFC-12 based compressors to HFC-134a based technology. In total the production capacity of 3,550,000 units per year of HFC-134a based compressors, will be established in China after the submitted project is implemented.
3. The Executive Committee approved 4 projects to convert domestic refrigerator and freezer manufacturers to HFC-134a technology. Additionally, three projects are being submitted to the 20th Meeting of the Executive Committee. In total about 2,200,000 units per year of production of domestic refrigerators and freezers will be converted using HFC-134a based compressors after the approved projects are implemented.
4. The Wanbao proposal includes: redesign, prototyping and testing, modification of existing equipment where applicable, procurement and installation of new equipment, retooling and modification of assembly lines.
5. The proposal is included in the strategy of the Government of China for the phase out of CFCs in the domestic refrigeration sector.
6. Technical assistance of the conversion will be provided by the original technology supplier.
7. Guangzhou Wanbao company will provide its own inputs and cost-sharing during the implementation of the project.
8. No incremental operating costs are requested in the project proposal.

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

1. The chosen technology is proven.
2. The Secretariat discussed with UNIDO the eligibility and incrementality of all cost items. The cost of stamping dies, washing machines, vacuum pumps and testing equipment was adjusted reflecting the cost of retrofitting of part of existing equipment and the equality with similar costs approved for other compressor manufacturing companies in Article 5 countries.

RECOMMENDATIONS

1. The Fund Secretariat recommends blanket approval of the project with associated support costs at the funding level shown in the table below:

	Project Cost US \$	Support Cost US \$	Implementing Agency
Phasing out ODS at the household refrigerator compressor factory of the Guangzhou Wanbao Compressor Group	2,250,000	292,500	UNIDO

PROJECT EVALUATION SHEET CHINA

SECTOR: MAC & COMPRESSOR ODS use in sector (1995): 13,000 ODP tonnes

Sub-sector cost-effectiveness thresholds: Commercial Refrigeration US \$15.21/kg ODP

Project Titles:

- (a) Conversion of medium-sized semi-hermetic CFC-12 refrigerating compressor production to HCFC-22 production at Tianjin Tian Shan Refrigeration Equipment.
- (b) Conversion of small semi-hermetic CFC-12 refrigeration compressor production at Shanghai General Machinery (Group) corp. (SGMC).
- (c) Conversion of CFC-12 small open-type and semi-hermetic refrigerating compressor to HCFC-22 refrigerating compressor at Zhenjiang Refrigerating Equipment Factory (ZREF).
- (d) Conversion of CFC-12 centrifugal refrigerating compressor to HFC-134a centrifugal technology at Chongqing General Machinery Factory.

Project Data	Compressor			
	Tianjin Tian Shan	SGMC	ZREF	Chongqing
ODS phase-out (ODP tonnes)	275.5	209	294.5	220
Proposed project duration (Yrs)	3.5	3.5	3.5	3.5
Incremental capital cost (US\$)	2,658,400	2,405,700	3,742,800	3,124,500
Contingency (%)	15	15	15	15
Incremental operational cost (US\$)	2,900	307,000	78,900	175,900
Total project cost (US\$)	3,003,300	2,723,500	4,303,900	3,675,900
Local ownership (%)	100	100	100	100
Export component (%)	0	0	0	0
Amount requested (US\$) {Original {Revised	2,400,000	2,170,000	3,380,000	2,800,000
Cost effectiveness (US\$/kg)	8.70	10.38	11.5	12.73
National Coordinating Agency	NEPA	NEPA	NEPA	NEPA
Implementing Agency	World Bank	World Bank	World Bank	World Bank
Technical review completed?	Yes	Yes	Yes	Yes

Secretariat's Recommendations				
Amount recommended (US \$)				
Project impact (ODP tonnes)				
Cost effectiveness (US \$/kg)				
Implementing Agency support cost (US\$)				
Total cost to Multilateral Fund	Pending			

PROJECT DESCRIPTION

- (a) Conversion of medium-sized semi-hermetic CFC-12 refrigerating compressor production to HCFC-22 production at Tianjin Tian Shan Refrigeration Equipment.
- (b) Conversion of small semi-hermetic CFC-12 refrigeration compressor production at Shanghai General Machinery (Group) corp. (SGMC).
- (c) Conversion of CFC-12 small open-type and semi-hermetic refrigerating compressor to HCFC-22 refrigerating compressor at Zhenjiang Refrigerating Equipment Factory (ZREF).
- (d) Conversion of CFC-12 centrifugal refrigerating compressor to HFC-134a centrifugal technology at Chongqing General Machinery Factory.

1. The Chinese commercial refrigeration sector consumes about 13,000 tonnes of CFC refrigerant per year. This is predominately CFC-12. The strategy for eliminating the use of CFCs in this sector was presented to the Executive Committee at the 17th Meeting. The strategy was developed on the following fundamental concepts:

- (a) That the industry should be converted to the use of HCFC-22. This was considered a transitional measure. Non-ODS refrigerants would be ultimately used. The Chinese service infrastructure was deemed inadequate to handle the difficult HFC refrigerants then being introduced with their hygroscopic Polyol Ester oils. Transition to zero ODS refrigerants would have to wait on service sector improvements. The choice of HCFC-22 as a transitional solution was influenced by the problems experienced with HFC refrigerant use in developed countries. About 70% of new commercial refrigeration equipment produced in Europe is specified for HCFC-22 use. The cost price of HFC-134a, which is one of the potential substitutes, is very high in China. Presently, China does not produce HFC-134a domestically, and does not have the technologies that meet the requirements for design and service of a HFC-134a based product. At present, it appears likely that the Chinese would use HFC designs based on imported blends with little subsequent modification required. If this option proves to be viable, then the ultimate transition to zero ODS refrigerants can be achieved at negligible additional expense. However, in any event, China has agreed that the eventual conversion to non-ODP technology in the commercial refrigeration sector will be at China's cost.
- (b) That imported technology should be used as the basis for projects. Chinese compressor manufacturers would receive funding to buy foreign technology and production equipment necessary for production of these designs. This approach was considered the most reliable. Conversion of traditional Chinese designs was considered to involve more risks. Ultimate success could not be guaranteed; neither costs nor time taken could be reliably determined.
- (c) To achieve phase out in the commercial refrigeration sector, China is limiting its funding requests to incremental costs of compressor conversion only. The costs of

converting other refrigeration system components is being met from the Chinese side. The cost of factory closures is being met entirely from the Chinese side. 49 factories are scheduled for closure in an effort to rationalize the industry and reduce the cost to the Multilateral Fund. Closure of the 49 enterprises will proceed in parallel with the implementation and operation of the 24 new conversion projects.

2. At its 15th Meeting in December 1994, the Executive Committee approved US \$16 million for six representative demonstration projects to phase out 1,390 tonnes of ODS by converting six manufacturers to HCFC and ammonia designs. These projects covered virtually all of the compressor types used in the Chinese commercial refrigeration sector and the design of these projects and negotiations with technology suppliers have served as models for the preparation of projects for conversion of the remainder of compressor factories in the sector.

3. The four projects submitted to the 20th Meeting of the Executive Committee represent the second phase of conversion of the commercial refrigeration and air-conditioning sector in China to non-CFC technology.

4. Two projects are for conversion of small semi-hermetic CFC-12 compressors to HCFC-22 compressors. One of these two projects (ZREF) incorporates conversion of one production line of small open type CFC-12 compressors to HCFC-22 compressors. One project (Tianjin) is for conversion of 22-140 kW semi-hermetic CFC-12 compressors to HCFC-22 compressors. The fourth project (Chongqing) will phase out CFC-11 and CFC-12 used in the manufacture of centrifugal compressors. The project consists of technology transfer and equipment purchase necessary to convert existing CFC-11/CFC-12 compressor production to a new HFC-134a design.

5. All projects are requesting technology transfer fees totaling about US \$1,580,000.

6. All projects involve the installation of high precision advanced technology machine tools to replace, in most cases, equipment incapable of meeting required tolerances specified by the supplier of the technology.

7. Indications of machinery equipment with a remaining lifetime of up to 8 years, which is to be scrapped, are provided in four project documents.

8. Each project acknowledges that there is an element of "modernization" involved and a uniform level of 20 per cent reduction in capital cost has been incorporated in the proposals when calculating proposed incremental cost. The 20% discounting factor was calculated on the basis of the benefit to the enterprises from postponement of expenditure to replace the existing, old equipment. None of the projects make any separate provision to reduce incremental costs to compensate for the replacement of outdated machinery and tools with state-of-the-art computer controlled equipment. Incremental operating costs have not been sought.

9. The total budget for trial production in the four proposals in US \$528,500.

10. Costs of testing equipment in the three proposals amount to US \$374,000.
11. Cost-effectiveness of each project has been calculated on the basis of elimination of CFC consumption for initial refrigeration system charge and for service in the first year.

SECRETARIAT'S COMMENTS

1. The chosen technologies are proven. The use of HCFC-22 technology has been explained.
2. The Secretariat has discussed with the World Bank all the four submitted projects. Several issues have been raised by the Secretariat related to establishment of the baseline installed capacity and CFC phase out schedule, to determine the responsibility of the Fund for technological upgrade, machinery equipment for open type compressors, performance and pressure testing equipment. In each project, CFC-12 consumption is calculated on the basis of initial system charge, plus the amount used for service in the first year. It was identified by the Fund Secretariat that the amount of ODS used for initial charge exceeds four fold the initial charge of refrigerant in similar systems in projects approved by the Executive Committee.
3. It was identified that design changes for open-drive compressors of 1 to 5 kW capacity resulting from conversion from CFC-12 to HCFC-22 may not be as significant as presumed in the project document. The World Bank is in the process of obtaining more technical information from ZREF regarding the existing compressor design. If it is confirmed that existing CFC-12 open-drive compressors can be used with HCFC-22 refrigerant with minor design changes, then replacement of machinery and equipment for ZREF 1 to 5 kW open-drive compressor line might not be necessary. This would result in the cost of the ZREF project being reduced by approximately half.
4. Using the figures supplied in the project documents and the methodology approved by the Executive Committee at its 18th Meeting, the discounting factor for technological upgrade would range from a minimum of 23.3 per cent to a maximum of 33 per cent. The upper percentage is based on the scenario that the remaining lifetime of existing equipment is 6 years and that the cost of future investments to sustain CFC-12 technology would be 60% of project costs. The difference in future benefits with and without the project is considered to be zero. The Fund Secretariat considers that use of the upper level of 33% is appropriate in this case because:
 - the assumptions on equipment life and cost of future investments are realistic.
 - The formula only considers replacement cost and does not include the value inherent in a change from a very basic to a very high level of technology.
 - Comparison of book value of the existing equipment and proposed project costs implies replacement of around 90 % of the value of the existing plant.

5. The World Bank considers that a discount for technological upgrade of 20% is generous, on the basis of its own calculations, and has produced analysis including, for instance, higher maintenance cost arising from the use of more complex equipment, which indicates a discount as low as 6%.

6. The Fund Secretariat considers cost of testing equipment should be reduced, on the basis of costings in similar approved projects.

7. The grant amounts calculated using a 33% discounting factor and deletion of one compressor line at ZREF would be as follows:

	Project Cost US \$
(a) Conversion of medium-sized semi-hermetic CFC-12 refrigerating compressor production to HCFC-22 production at Tianjin Tian Shan Refrigeration Equipment.	2,088,000
(b) Conversion of small semi-hermetic CFC-12 refrigeration compressor production at Shanghai General Machinery (Group) corp. (SGMC).	1,887,900
(c) Conversion of CFC-12 small open-type and semi-hermetic refrigerating compressor to HCFC-22 refrigerating compressor at Zhenjiang Refrigerating Equipment Factory (ZREF).	1,470,300
(d) Conversion of CFC-12 centrifugal refrigerating compressor to HFC-134a centrifugal technology at Chongqing General Machinery Factory.	2,436,000

8. Discussions on these items, between the Fund Secretariat and the World Bank are continuing. The results will be reported to the Sub-Committee for Project Review.