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

Fifteenth Meeting
Montreal, 13-16 December 1994

PROJECT PROPOSALS: CHINA

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

Foam

- Elimination of CFC-12 in the manufacture of XPE foam sheet and netting at Feicheng Plastic Products Factory	UNDP
- Elimination of CFC-12 in the manufacture of XPS/XPE foam sheet at Foshan No. 3 Plastic Factory	UNDP
- Elimination of CFC-12 in the manufacture of XPS foam sheet at Guangxing Plastics Products Co., Hubei	UNDP
- Elimination of CFC-12 in the manufacture of XPS foam sheet at Guizhou Jinchang Plastics Products Co. Ltd.	UNDP
- Elimination of CFC-12 in the manufacture of XPS/XPE foam sheet at Hailun Plastic Packaging Material Factory	UNDP
- Elimination of CFC-12 in the manufacture of XPE netting at Hebei Sixing Polypack Products Co. Ltd., Shijiazhuang	UNDP
- Elimination of CFC-12 in the manufacture of PE/PS foam sheet at Shanghai Jianhua Electro-Mechanical and Mechanical Company	UNDP
- Conversion to CFC-free technology in the manufacture of extruded polystyrene foam sheet at Jinan	UNDP
- Conversion to CFC-free technology in the manufacture of extruded polystyrene foam sheet at Jinfeng	UNDP
- Elimination of CFC-12 in the manufacture of EPS foam sheet at Sino-Foreign Joint Stock Shenyang Shenrong Co.	UNDP
- Elimination of CFC-12 in the manufacture of XPS foam sheet at Shenzhen Shentie Plastics Tableware Products Company, Shenzhen	UNDP
- Elimination of CFC-12 in the manufacture of PE foam tubing at Suzhou Plastic Works No. 7	UNDP
- Elimination of CFC-12 in the manufacture of XPS foam sheet at Shijiazhuang Plastic Cement General Factory	UNDP
- Conversion to CFC-free technology in the manufacture of extruded polyethylene and polystyrene foam sheet	IBRD
- Conversion to CFC-free technology in the manufacture of extruded polyethylene and polystyrene foam sheet at Cangzhuo No. 2 Plastic Plant	IBRD
- Conversion to CFC-free technology in manufacture of extruded polyethylene and polystyrene foam sheet	IBRD
- Conversion to non-CFC technology in the manufacture of integral skin polyurethane foam at Hubei Auto Engineering	UNDP

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China
PROJECT TITLE:	Elimination of CFCs in the Manufacturing of Polystyrene/Polyethylene foam sheets at thirteen enterprises
BUDGET:	US $5,495,000
INCREMENTAL COSTS:	US $5,495,000
ODS PHASE-OUT:	1,309 MT CFC-11/yr.
COST EFFECTIVENESS:	US $4.20 per Kg. ODP saved
PROJECT DURATION:	18 months
IMPLEMENTING AGENCY:	UNDP
NATIONAL COORDINATING AGENCY :	National Environment Protection Agency (NEPA)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. The project proposal covers thirteen enterprises manufacturing extruded polystyrene/polyethylene foam sheets. Implementation of this project will lead to the phase-out of 1,309 MT CFC-12 per year.

2. Under this project, 13 enterprises will switch to the use of butane as alternative blowing agent. Butane is highly flammable and its usage requires extensive safety measures. The process conversion to butane will include retrofitting of existing extruders, installation of butane storage tanks, building modifications, exhaust and ventilation systems and gas detection systems. Technology transfer and trials are also essential elements of the conversion.

3. Incremental costs requested under this project cover only the capital costs of conversion since operating costs are not requested In calculating the operational costs, UNDP/Government of China estimated that overall savings amount to US $21,000 due to the fact that some enterprises will incur net operating costs and others will realize net operating savings. Furthermore, the Government of China (NEPA/NCLI) proposes to forego incremental operating costs/savings in future ODS phaseout projects concerning extruded polystyrene/polyethylene foam sheets.

4. The project is very cost-effective.

SECRETARIAT'S RECOMMENDATIONS

5. The Secretariat recommends final approval of this project and of the requested amount of US $5,495,000.

6. The Secretariat further recommends that operating costs/savings should be continued to be calculated in the future in compliance with Executive Committee decisions and guidelines.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China
PROJECT TITLE:	Investment project to phaseout CFC-12 at: a) Cangzhou No. 2 Plastic Plant b) Lanzhou Plastic packaging Factory c) Zhengzhou Plastic Plant
TOTAL BUDGET:	US $997,400(See attached Table)
INCREMENTAL COSTS:	a) US $394,000 b) US $222,100 c) US $267,100
ODS PHASE-OUT:	a) 140 tonnes CFC-12 b) 200 tonnes CFC-12 c) 260 tonnes CFC-12
COST EFFECTIVENESS[1]:	a) US $0.42/kg/year b) US $0.03/kg/year c) US $0.08/kg/year
PROJECT DURATION:	1 year
IMPLEMENTING AGENCY:	World Bank
NATIONAL COORDINATING AGENCY:	National Environmental Protection Agency
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

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

PROJECT COSTS			
Project Cost	Cangzhou No. 2 Plastic Plant	Lanzhou Plastic Packaging Factory	Zhengzhou Plastic Plant
Capital Cost (US $)	429,000	401,000	434,000
Operational Cost (US $)	(51,000)	(198,000)	(173,000)
Sub-total	378,000	203,000	261,000
10% Contingency	42,900	40,100	43,400
Financial Agent Fee	13,000	7,000	9,000
TOTAL	433,900	250,100	313,400

SECRETARIAT'S COMMENTS

1. These are three of a total of 16 projects in this foam subsector being presented to the Fifteenth Meeting by the World Bank and UNDP (13 projects are being submitted by UNDP).

2. The project will be executed through the National Council of Light Industries (NLCI). All the projects will employ butane as the blowing agent. Thus the investment costs related mainly to extruder retrofitting and extensive safety and fire prevention measures.

3. The implementation of a large body of projects through one national body should make for rationalization of project implementation and hence reduction in technology transfer costs.

4. Following discussions with the consultants of the Implementing Agency, some minor adjustments were made to some of the cost items to reflect the potential for rationalizing procurement and technology transfer.

SECRETARIAT'S RECOMMENDATION

5. The Fund Secretariat recommends approval and funding of the projects as follows:

Cangzhou No. 2 Plastic Plant:	US $394,000
Lanzhou Plastic Packaging Factory:	US $222,100
Zhengzhou Plastic Plant:	US $267,100

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China
PROJECT TITLE:	Conversion to CFC-free technology in the Manufacture of Flexible Polyurethane Foam (7 enterprises)
BUDGET (Total):	US $2,447,000
INCREMENTAL COSTS:	US $2,355,000
ODS PHASE-OUT:	736 tonnes ODP
COST EFFECTIVENESS:	US $1.0 per Kg. ODP saved
PROJECT DURATION:	1 year
IMPLEMENTING AGENCY:	UNDP (4 projects) and World Bank (3 projects)
NATIONAL COORDINATING AGENCY :	National Environmental Protection Agency (NEPA)
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. Three of the enterprises are to phase out the use of CFC-11 in the manufacture of slabstock flexible polyurethane foam, two others in the manufacture of flexible polyurethane foam for automotive back cushions, two in the manufacture of integral skin polyurethane foam, while one enterprise will phase out CFC-11 in both the manufacture of slabstock polyurethane foam and integral skin polyurethane foam.

2. For the slabstock foam, methylene chloride is the blowing agent of choice. Depending on the foam density and softness, various complementary technologies or measures would be adopted to ensure production safety and acceptable quality of the foam, leading to increased investment costs. The quality of the locally available methylene chloride appears to be at the base of the production problem and the relatively higher cost of flexible foam production using methylene chloride. The locally available methylene chloride is said to be unstable and causes severe scorching in low density foam requiring high water formulations, thus necessitating additional cost in providing accelerated cooling system. The availability of foam grade methylene chloride and the cost-effectiveness of its application may be worth examining by the implementing agencies, notably UNDP in view of the widespread use of the methylene chloride technology.

3. In one project (Beijing Foam Plastic), the cost of the accelerated cooling system (US $450,000) was 64 per cent of the capital cost. Thus, during the project review, the possibility of exploring ways of improving the production technology at the plant in a way that would lead to cost reductions was considered (to be undertaken by the World Bank's consultant).

4. The other major cost component of the slabstock foam production is modifications to existing buildings to enable the use of mainly ancillary systems relevant for the current level of development of the methylene chloride technology. The Gaofeng Plastic Plant, for instance, is required to construct an extension to the second floor to allow the use of accelerated cooling system on vertifoam machine. In this instance also, it was considered that possible ways to reduce project costs by adopting measures that might make the change in the layout unnecessary could be explored by the World Bank's consultant prior to implementation of the project.

5. For the integral skin polyurethane foam HCFC-141b is chosen as the blowing agent using existing high pressure foam machine. Thus, investment costs are relatively low. For the moulded back cushions alternative chemistry (high resilience (HR) foam) was selected. This technology entails no capital cost (as no modifications are required) or foam quality deficiencies and could potentially be implemented rapidly. The Technical Reviewer therefore recommends project duration of six months for the Faw-Trim project since the proposed changes can be made in six months instead of one year.

SECRETARIAT'S RECOMMENDATIONS

6. To approve all seven projects and their corresponding levels of funding as follows

Beijing Yanxi	US $125,000
Faw-Trim	US $143,000
Hubei Auto Engineer	US $150,000
Dalian No. 1	US $490,000
Beijing Foam Plastic General Factory	US $720,000 (including US $21,000 Agent Fee)
Dongfeng Plastic Plant	US $268,000 (including US $7,900 Agent Fee)
Gaofeng Plastic Plant	US $458,400 (including US $13,400 Agent Fee)

7. To approve US $118,000 as support costs to UNDP for the four projects presented by UNDP.

8. To request the World Bank to report to the Executive Committee on the findings of its consultant regarding the issues relating to possible reduction in the project costs of Beijing Foam Plastic General Factory and Gaofeng Plastic Plant, prior to the implementation of the two projects.

9. To request UNDP to take account of the comments of the Technical Reviewer regarding the duration of the Faw-Trim project, with the view to accelerating its implementation.

TABLE 1: FLEXIBLE POLYURETHANE FOAM PROJECTS (CHINA)

Project Title	Budget US$ Capital Cost	Budget US $ Operational Cost	Incremental Cost	Support Cost	ODS Phase-out (tonnes)	Cost-Effectiveness (per kg/per yr.)	Duration
UNDP:							
Conversion to non-CFC technology in the manufacture of flexible polyurethane foam at Beijing Yanxi	85,000	40,000	125,000	16,250	25	1.47	1 year
Conversion to non-CFC technology in the manufacture of flexible polyurethane foam at Faw Trim	130,000	13,000	143,000	18,590	28	1.0	1 year
Conversion to non-CFC technology in the manufacture of integral skin polyurethane foam at Hubei Auto Engineering	150,000	20,000	150,000	19,500	20	1.60	1 year
Conversion to non-CFC technology in the manufacture of flexible polyurethane foam (slabstock) (Dalian No. 1)	490,000	-	490,000	63,700	100	0.8	1 year
WORLD BANK:							
Conversion to CFC-free technology in the manufacture of flexible polyurethane foam (slabstock) at Beijing Foam Plastic General Factory	72,000	-	720,000	NA[1]	100	1.19	1 year
Conversion to CFC-free technology in the manufacture of flexible polyurethane foam (slabstock) in Gaofeng Plastic Plant	527,000	-	458,400	NA[1]	180	0.48	1 year
Conversion to CFC-free technology in the manufacture of flexible polyurethane foam (slabstock) at Dongfeng Plastic Plant	292,000	-	268,600	NA[1]	110	0.44	1 year

1. Not applicable. However, the project costs include 3% Financial Agent fee.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	People's Republic of China
PROJECT TITLE:	Conversion from Halon 1211 to ABC dry powder and foam/water spray at Nanjing Fire Fighting Equipment Factory
BUDGET:	Capital Costs: US $551,954 Operating Costs: US $147,292
INCREMENTAL COSTS:	US $699,246
ODS PHASE-OUT:	370 MT of halon 1211 (1480 ODP MT)
COST EFFECTIVENESS:	US $0.41/kg ODP saved
PROJECT DURATION:	2 years
IMPLEMENTING AGENCY:	UNIDO
NATIONAL COORDINATING AGENCY:	National Environment Protection Agency
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. The project proposal will convert existing halon 1211 filling line at the Nanjing Fire Fighting Equipment Factory for the production of ABC dry powder filled extinguishers. It will also replace the existing production line of halon fixed fire fighting systems with a new line to produce foam/water system.

2. The Executive Committee approved at its Seventh Meeting a similar project for Zhejiang (China) to be implemented by the World Bank.

3. The conversion will result in the avoidance of 370 MT of halon-1211 per year (1480 ODP weighted MT).

4. Nanjing is currently producing ABC powder-filled extinguishers, and should be able to modify the existing halon line for the filling of extinguishers with ABC powder at a minimal additional cost. Thus a minimum amount of incremental costs is requested.

5. A foam/water fixed system will replace the existing fixed halon system. The incremental costs include both capital costs for the procurement of new equipment and net incremental operating costs. The latter were adjusted to reflect the saving which would result from the conversion to the cheaper ABC powder.

6. Nanjing will undertake to replace the old equipment at a considerably higher cost than the requested incremental costs.

SECRETARIAT'S RECOMMENDATIONS

7. The Secretariat recommends final approval of the project and approval of incremental costs in the amount of US $699,246.

8. The Secretariat further recommends that both the Zhejiang and Nanjing projects should be integrated in a national strategy for the phase out of halon 1211 filled extinguishers.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	People's Republic of China		
PROJECT TITLE:	a)	Conversion of Small Semi-Hermetic CFC-12 Refrigeration Compressor Production to HCFC-22 Production at Jiangsu Taizhou Commercial Machinery Factory	
	b)	Conversion of Small Semi-Hermetic CFC-12 Refrigeration Compressor Production to HCFC-22 Production at Nanjing Refrigerator General Works	
	c)	Conversion of Medium sized Open-type CFC-12 Refrigeration Compressor Production to HCFC-22 Production at Shanghai Refrigerating Machine Works	
	d)	Conversion of Small Open-type CFC-12 Refrigeration Compressor Production to HCFC-22 Production at Anhui Provincial Refrigerating Machinery Factory	
	e)	Conversion of Small Open-type CFC-12 Refrigeration Compressor Production to HCFC-22 Production at Beijing Refrigerating Machinery Factory	
	f)	Production of Small and Medium Sized Ammonia Refrigeration Compressors at Yantai Refrigeration Machinery Works	
BUDGET:	a)	Jiangsu Taizhou:	US $3,395,000
	b)	Nanjing:	US $3,507,000
	c)	Shanghai:	US $3,289,000
	d)	Anhui:	US $2,699,000
	e)	Beijing:	US $3,760,500
	f)	Yantai:	US $3,488,000
INCREMENTAL COSTS:	a)	Jiangsu Taizhou:	US $2,797,500
	b)	Nanjing:	US $2,890,000
	c)	Shanghai:	US $2,710,000
	d)	Anhui:	US $2,224,000
	e)	Beijing:	US $3,098,000
	f)	Yantai:	US $2,874,000

COST EFFECTIVENESS:	N/A
PROJECT DURATION:	3 Years
IMPLEMENTING AGENCY:	The World Bank
NATIONAL COORDINATING AGENCY:	The National Environmental Protection Agency (NEPA) The Ministry of Machine Industry (MMI)

TECHNICAL REVIEW COMPLETED: YES _X_ NO _

SECRETARIAT'S COMMENTS

1. These projects represent the first phase of conversion of the commercial refrigeration and air-conditioning sector in China to non-CFC technology. It is understood that proposals for replication of the five HCFC-22 projects and an ammonia project in 18 other factories will be brought forward, in due course, to complete the conversion of the sector.

2. Two projects are for conversion of small open-type CFC-12 compressors to HCFC-22 compressors. Three projects are for conversion of small semi-hermetic CFC-12 compressors to HCFC-22 compressors.

3. One project will expand the current production of ammonia compressors to produce additional small to medium sized ammonia compressors, with the closure of other plants currently producing CFC-12 compressors.

4. All projects including the ammonia compressor plant, are requesting technology transfer fees totalling about US $1,580,000.

5. Three projects, including the ammonia compressor plant, are requesting payment of royalties to technology licensers amounting to US $785,000.

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. Indications of equipment to be scrapped are provided in five of the project documents.

7. Each project acknowledges that there is an element of upgrading of technology involved and a uniform level of 20 per cent reduction in capital cost has been incorporated in the proposals when calculating proposed incremental cost. Incremental operating costs have not been sought in any of the six projects.

8. At the Taizhou Factory the conversion will increase capacity by a factor of three to 30,000 units per year (the closure of 6 other plants with an equivalent capacity is indicated in the proposal). At the Anhui factory, production capacity is proposed to be doubled to 20,000 units per year after the fourth year. At the Shanghai factory, production capacity is planned to increase by 10 per cent per year above present levels. Incremental costs were not adjusted to take into account the increase in capacity.

9. None of the projects make any provision to reduce incremental costs to compensate for the replacement of a total of some 80 old machine tools with over 70 items of new equipment.

10. There is insufficient detail in project documentation to derive accurate estimates in relation to the above issues. However, given that allowance has not been made for all the increased capacity in these projects, for benefit derived from "new-for-old" replacement, and only a 20 per cent allowance made for technology upgrade, capital costs for each project should be reduced by substantially more than 20 per cent currently included for technology upgrade.

11. The total budget for trial production in the six proposals is US $938,500.

12. Costs of testing equipment amount to US $400,000.

13. Costs of installation amount to US $500,000.

14. It should be noted that the Nanjing project was considered by the Executive Committee at its Eighth meeting. The Committee approved US $300,000 for the World Bank to develop the project further. In the proposal submitted to the Eighth Meeting the project document indicated that Nanjing factory was already producing small quantities of semi-hermetic HCFC-22 compressors and that the new technology developed there would be shared with other compressor manufacturers.

15. The Yantai factory does not currently produce CFC-12 compressors and might thus be considered ineligible for funding. However, seven CFC-12 compressor producers are targeted for closure; their combined production is estimated at 7,000 units per year. The proposal can thus be legitimately considered for the funding of incremental costs.

SECRETARIAT'S RECOMMENDATION

The Fund Secretariat recommends as follows:

16. Since the six projects are proposed to be replicated in 18 other factories, three of the projects should be approved for demonstration purposes. The three proposed projects are: Anhui (open-type CFC-12 to HCFC-22), Nanjing (semi-hermetic CFC-12 to HCFC-22) and Yantai (ammonia). These projects should be approved subject to satisfactory resolution of the following issues prior to the meeting of the Project Review Sub-Committee:

(a) The technology transfer fees for Nanjing (US $519,000) are excessively high. Nanjing currently produces HCFC-22 compressors. Technology transfer fees for the project should be renegotiated as suggested by the technical reviewer. The technology transfer fee requested for Yantai may not be incremental and should be deleted given the fact that China has had 30 years of experience in the use of this technology.

(b) Cost of trial production should be revised downward.

17. The Committee may wish to consider the issue of technology transfer and whether to approve funding for one technology transfer package per technology only, irrespective of the number of factories which will apply it.

18. The Committee may wish to consider the issue of payment of royalties and its possible implications for the Fund.

19. To request the Government of China to develop a strategy for this important sub-sector. The strategy should rationalize the number of factories planned for conversion given the fact that the new equipment is very advanced and would significantly enhance production capacity.

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

COUNTRY	People's Republic of China		
PROJECT TITLE	Conversion from Halon 1211 to ABC dry powder and foam water spray at Nanjing Fire Fighting Equipment Factory		
SECTORS COVERED	Halon (fire protection)		
ODS USE IN SECTOR	4,400 MT (17,600 MT ODP-weighted) of Halon 1211 and 660 MT (10,600 MT ODP-weighted) of Halon 1301 in 1991		
PROJECT IMPACT	Phase out annual consumption of 370 MT of Halon 1211 (total 1480 ODP-weighted MT)		
PROJECT DURATION	24 months		
PROJECT ECONOMIC LIFE	10 years		
TOTAL PROJECT COST	Investment (capital) costs, US$		521,954
	Incremental operating costs/savings, US$		147,292
	Project preparation costs, US$		30,000
	Total Project Costs, US$		699,246
	Agency overhead (13 per cent)		90,902
OWNERSHIP STRUCTURE	100 per cent Chinese		
PROPOSED MF FINANCING	US$	790,148	including Agency overhead (13 per cent)
UNIT ABATEMENT COST	US$	0.12	per kg of phased-out ODS
COUNTERPART ENTERPRISE	Nanjing Fire Fighting Equipment Factory		
IMPLEMENTING AGENCY	UNIDO		
COORDINATING MINISTRY	The Ministry of Public Security		
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)		

PROJECT SUMMARY

This project will phase out the annual use of 370 MT of Halon 1211 (ODP=4.0, that is, total 1,480 MT ODP-weighted ODS) as fire extinguishing media in portable fire extinguishers and in fixed fire fighting installations produced by the Nanjing Fire Fighting Equipment Factory, one of the largest manufacturers of fire fighting equipment in China.

The phasing out of the halon will be accomplished by a total change of the production facilities where instead of portable Halon extinguishers, ABC dry powder extinguishers will be produced. The Halon in the fixed fire fighting systems will be replaced with production of foam/water system. The selection of alternative extinguishing agents is based on the strategy given in the China Country Program for the Phaseout of Ozone Depleting Substances.

The requested Multilateral Fund grant for the project is US$ 790,148. The project document also indicates the investment commitments made by the Nanjing Fire Fighting Equipment Laboratory.

This project was appraised by the SINTEF NBL (Norwegian Fire Research Laboratory). Their comments are incorporated in this version.

Contents

1. Project overview

This project will phase out the annual use of 370 MT of Halon 1211 (ODP=4.0, that is, total 1,480 MT ODP-weighted ODS) as fire extinguishing media in portable fire extinguishers and in fixed fire fighting installations produced by the Nanjing Fire Fighting Equipment Factory.

The Nanjing Factory is a specialized manufacturer assigned by the Public Security Ministry of PR China to produce fire extinguishing equipment, systems and supplies. The factory is one of the largest manufacturers of fire fighting equipment in China.

At present, production in the factory is concentrated around four main products:

a) Portable Halon 1211 fire extinguishers;

b) Fixed Halon 1211 fire extinguishing systems;

c) Water sprinkler systems; and

d) Fixed CO_2 fire extinguishing systems.

The phasing out of the halon will be accomplished by a total change of the production facilities where instead of portable halon extinguishers, ABC dry powder extinguishers will be produced. The halon in the fixed systems will be replaced with foam water spray fire fighting systems. The production of present fixed CO_2 fire extinguishing systems will be continued.

The alternatives have been selected mainly for two reasons:

- There is no extinguishing media available today which could replace halon 1211 as a drop-in agent. It is therefore necessary to offer the market a wider variety of products in order to cover the same areas of fire hazards as Halon 1211 does today. The selected alternatives have proven and well documented effectiveness against most types of fires and it will, from a technical point of view, be relatively easy to start a production with the new type of extinguishing media. With the exception of foam mixing equipment for the foam/water spray systems most of the necessary equipment for the production is available in China.

- The management and the staff at the Nanjing factory have a long experience in the production of portable fire extinguisher and fixed fire fighting systems. It is therefore of great advantage if a similar production technology can be selected for the replacement products.

In order to accomplish the necessary changes in the products (or introduce new products), new manufacturing processes and new technologies have to be introduced in some areas. This will require new production facilities. The factory will move to a suburban area, more suitable for this type of industrial production. The project has full support both from the Ministry of Public Security and from the local authorities.

The total estimated cost for the project is US$ 1.138.786. The approach adopted here is in accordance with the strategies described in the China Country Programme[1].

[1] China Country Programme, section 3.7 "Halons", January 1993.

2. Project objective

The objective of the present project is to totally phase out the use of Halon 1211 as fire extinguishing media in the production of portable fire extinguishers and fixed fire fighting installations at the Nanjing Fire Fighting Equipment Factory.

The halon will be replaced with the following fire extinguishing media:

a) ABC dry powder:

ABC dry Powder is normally based on a mixture of Ammonium phosphate and Ammonium sulphate. This type of powders is very effective against almost all types of fires and very common as fire extinguishing media in portable fire extinguishers. The effect is well proved both from tests and practical experience. ABC dry powders will soon be produced in China[2].

b) Foam/Water:

The use of AFFF (Aqueous Film Forming Foam)/Water spray is widely spread in the world and has proven to be an effective fire extinguishing media. The selected technology is based on the National Fire Protection Association standard "NFPA 16, Deluge Foam Water Sprinkler and Foam Water Spray Systems." The purpose of the standard is to provide a reasonable degree of protection for life and properties from fires through installation requirements for Foam Water Deluge Sprinkler Systems and Foam Water Spray Systems based upon sound engineering principles, test data and field experience. This type of fire fighting systems is effective against a variety of fire hazards but is mainly installed in areas with a high risk for fires in hydrocarbons or with special foam also in areas with a risk for fires in chemicals.

c) CO_2

The Nanjing Fire Fighting Equipment Factory already produces carbon dioxide fixed systems. The Factory will continue to offer this option. Carbon dioxide is a well proven fire extinguishing media very suitable for certain applications. The disadvantage with carbon dioxide is the increased risk of accidental death caused by discharge of the systems. This means that in areas where CO_2 systems are installed very strict safety precautions have to be taken.

3. Sector background

The "China Country Program for the Phase out of Ozone Depleting Substances under the Montreal Protocol" shows that the total consumption of Halon 1211 was 4,000 MT during 1991 (including 500 MT imported Halon 1211). With an ODP of 4.0 for Halon 1211, this means that the ODP-weighted annual consumption is equivalent to 16,000 MT of ODS.

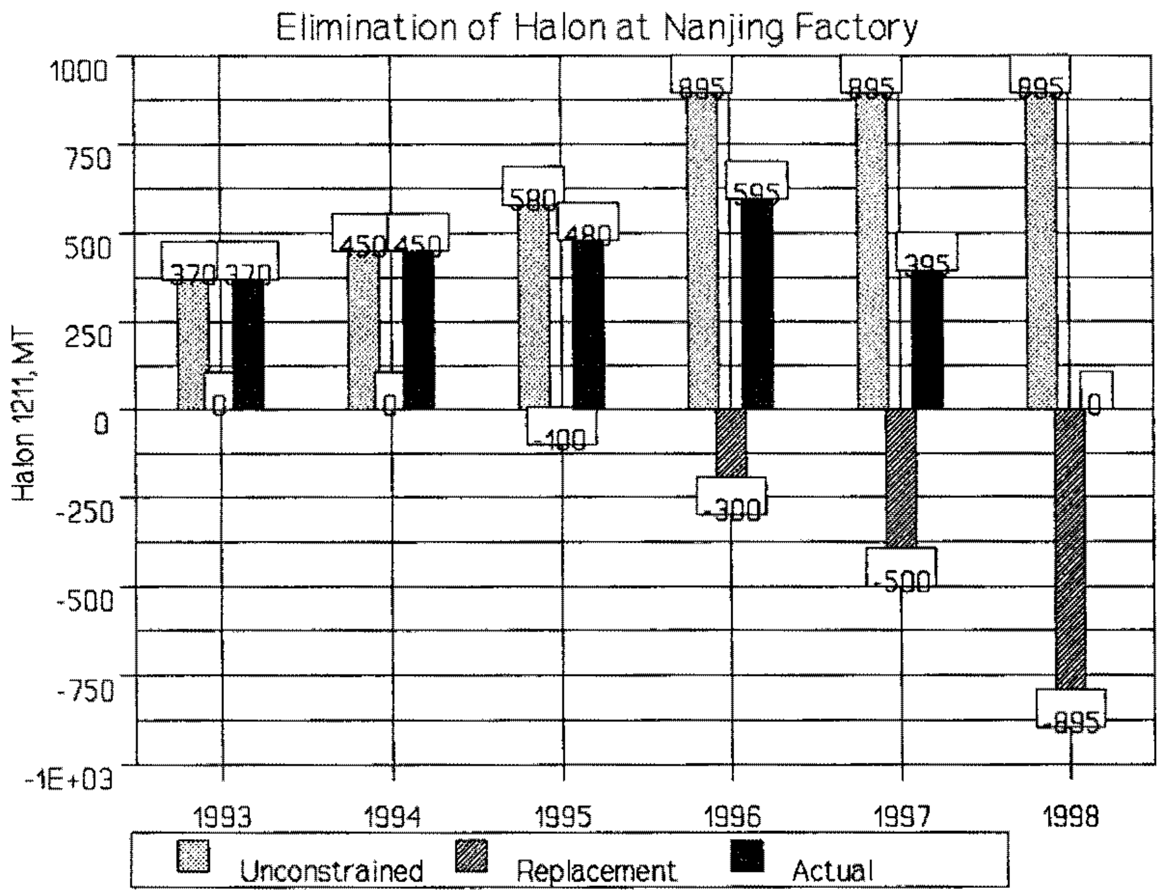
The strategy of the Chinese Government for replacement of halon is also given in the Country Program mentioned above. The proposed project for the Nanjing Factory fully complies with the strategy given in the Country Program.

As shown in the "Report on the Selection of Halon Technology 1990", prepared by the UNDP and UNEP, the world consumption of Halon 1211 is 13,200 MT in 1990 of which 3,500 MT is the annual consumption of China alone.

[2] A project to start the production of 3,000 MT of ammophos (ABC) dry powder at the Beijing Fire protection Equipment Factory has been approved by the Executive Committee of the Multilateral Fund.

China is under rapid economic development and therefore the halon consumption increased by a high rate during 1991-1993. It is estimated that the Chinese consumption almost covered half of the total world consumption of Halon 1211 in 1993.

During 1993 the Nanjing Factory consumed 370 MT of Halon 1211. The production plan for 1994 shows that the consumption will increase to 580 MT for 1995 and 895 MT for 1996. Because of this high rate of increase, it will be very cost effective if the replacement can start as soon as possible.



4. Enterprise background

The Nanjing Fire fighting equipment Factory is one of the largest manufacturers of fire fighting equipment, systems and supplies in China. The factory has 1000 employees and is under the Ministry of Public Security. In 1993 the Nanjing factory earned an annual income of RMB21.0 million (US$2.4 million) which showed an 80 per cent increase over 1992. The factory produced 240,000 portable fire extinguishers in 1993. This is about 10 per cent of the total production of portable fire extinguishers in China. Besides the portable fire extinguishers, the Nanjing factory also produced 2,400 fixed Halon 1211 fire extinguishing systems. The total Halon 1211 consumption during 1993 was 370 MT. The planned production output value of the Nanjing Factory will be RMB 30.0 million (US$ 3.45 million) for 1994 and the Halon consumption for the same year will be approximately 450 MT.

5. Project description

The Nanjing Factory will accomplish the goal to replace all halon-based production by changing over to ABC dry powder for the portable fire extinguishers and foam/water spray for the fixed fire fighting systems. This means that the two new products will be introduced and manufactured in the future. There is no single drop-in agent available today to replace the Halon 1211. Therefore, it is necessary to replace the present production with more than one type of extinguishing media.

The selection of the replacement agents is based on the present production experience at the factory as well as the need to offer the market new fire extinguishing products which together cover the same areas of fire hazards as halon covers today.

The present production capability is utilized to its full capacity. The factory and the equipment for production are in many cases more than 20 years old. Only a limited number of the machines will be suitable to use for the new production. The factory is also situated in an area which is not very suitable for this type of industrial manufacturing activity. Therefore, in order to implement the project efficiently, new production equipment as well as a new factory building of around 5,000 m^2 workshop area will be necessary.

5.1 Production of portable ABC dry powder extinguishers

The portable halon fire extinguishers produced at the Nanjing factory today are made according to Chinese standards. The design and quality of the extinguishers are good and comparable with many similar products available outside China.

The technology for producing ABC dry powder portable fire extinguishers is well known in China and about 65 per cent of the necessary new equipment and machinery for the production are available from domestic suppliers.

All the mechanical components of the new extinguisher will be manufactured at the Nanjing Factory except the pressure gauges and the ABC dry powder which have to be purchased from other suppliers in China. The new manufacturing processes are still based on manual manufacturing and assembling of the extinguishers.

The main production stages for portable ABC dry powder and CO_2 extinguishers is shown in Exhibit 1.

The lists of equipment absolutely needed for the project are prepared by the Nanjing Factory and are given in Annex 6. These lists include equipment to be funded by the Multilateral Fund grant and equipment to be purchased directly by the factory.

Referring to Annexes 1 (total investment costs), 2 (incremental operating costs/savings) and 6.a (list of equipment for portable ABC extinguisher), the cost of the conversion of manufacturing plant for portable ABC dry powder fire extinguishers is given in Exhibit 2. (Please note that this is a part of the whole project and, in reality, may not be implemented in isolation.)

The unit abatement cost of eliminating halon used in portable extinguishers through dry ABC powder technology is given in Annex 4.b.

Exhibit 1. Principal production line for dry powder portable fire extinguishers

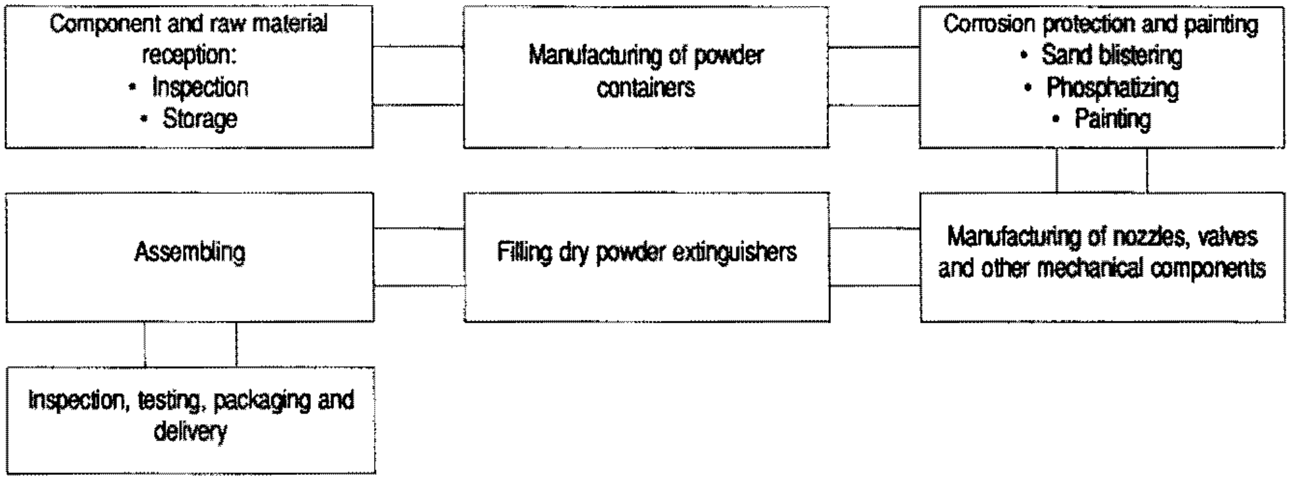


Exhibit 2. Costing of the production of portable ABC dry powder fire extinguisher

	Item	RMB	US$
i	Total investment costs (Annex 1)	4,429,000	509,080
ii	Annual incremental operating costs/savings (Annex 2 and 4.b)	(214,667)	(24,674)
iii	Incremental operating costs/savings for 4 years (4*ii)	(858,667)	(98,697)
iv	NPV of incremental operating costs/savings for 4 years [iii*(317/400)]	(680,493)	(78,218)
v	Net incremental cost (i+iv)	3,748,507	430,863

The net incremental cost for replacement of 140 MT of Halon 1211 with ABC dry powder fire extinguishers is US$ 430,863.

5.2 Production of foam/water spray fire fighting systems

The foam/water spraying system the Nanjing Factory plans to produce should technically be based on the US National Fire Protection Association standard NFPA 16. This standard gives the basic requirements for design and installation of the systems.

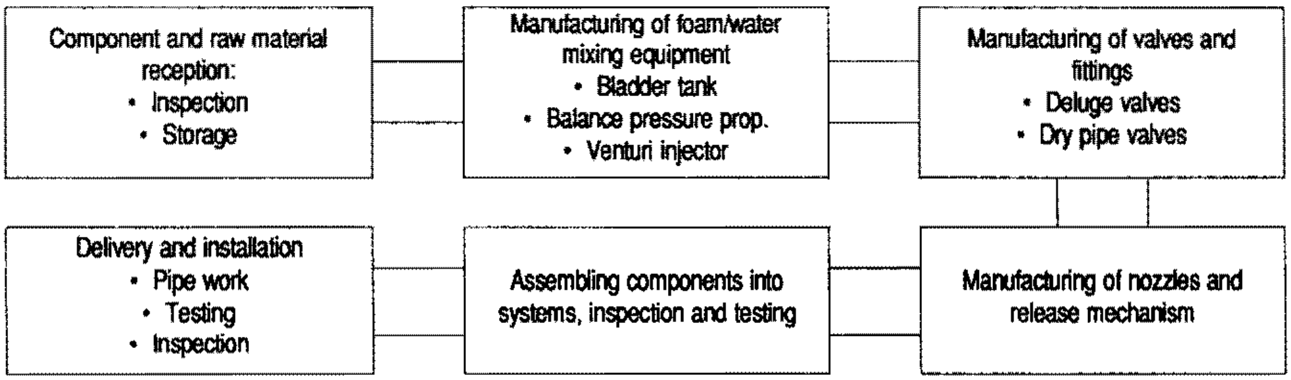
The foam/ water spraying fire extinguishing systems replace halons for fixed fire fighting installations in e.g. chemical industry, power stations and oil refineries.

The Nanjing Factory plans to produce foam /water spraying systems with two different types of extinguishing foams: The AFFF (Aqueous Film Forming Foam) for oil fire hazards and ARC (Alcohol Resistant Compound) for fire hazards in chemical industries.

Many of the components in a foam/water spraying system are of standard types and could easily be purchased in China. The important components for the Nanjing Factory to manufacture themselves are the foam mixing equipment, valves and nozzles. AFFF concentrate is already under production in China, but ARC concentrate either has to be imported or manufactured under license in China. The operational cost calculations here are based upon the price for imported concentrate. In the future, the Factory plans to build up facilities for the production of ARC foam concentrate.

The principal production line for the manufacture of foam/water spraying systems is shown in Exhibit 4.

Exhibit 4. Principal production line for foam/water spray fixed fire extinguishing systems



There are institutes and a number of companies in China that are specializing in the development and production of automatic foam/water fire extinguishing systems. For example, Tianjing Fire Fighting Research Institute possesses a rather strong capacity in research and development of new foam/water systems. The institute has a good knowledge about both the international and the domestic technologies in the fire fighting equipment sector.

Nanjing Fire Fighting Equipment Factory and the Tianjing Fire Fighting Research Institute are both managed under the Public Security Bureau. Therefore, close cooperation between these two institutions is quite easy to achieve. At present, NFFEF has already established contacts with Tianjing Fire Fighting Research Institute through the Public Security Bureau for the technology transfer. The programme of cooperation and the schedule of the development work, including the costs involved, is given Annex 6.b. These costs will be borne by the NFFEF.

The list of equipment needed for the project is given in Annex 6.

Exhibit 5 gives the necessary investment needed for the manufacturing of foam/water spraying systems.

Exhibit 5. Costing of the production of fixed foam/water spray fire fighting systems

	Item	RMB	US$
i	Total investment costs (Annex 1)	3,936,000	452,414
ii	Annual incremental operating costs (Annex 2 and 4.c)	618,907	71,139
iii	Incremental operating costs/savings for 4 years (4*ii)	2,475,627	284,555
iv	NPV of incremental operating costs/savings for 4 years [iii*(317/400)]	1,961,934	225,510
v	Net incremental cost (i+iv)	5,897,934	677,923

The net incremental cost for replacement of 120 MT of Halon 1211 with foam/water spray systems is US$ 677,923. In order to cover industrial fire hazards which today are protected by halon, the foam /water spraying systems have characteristics which make them superior compared to CO_2 based systems. Therefore, it is necessary to offer the market at least two alternative systems which together cover almost all fire hazards today protected by halon.

5.3 Production of fixed CO_2 systems

The Nanjing Factory has a long experience in the production of fixed CO_2 fire fighting systems. The present type of system is, however, not suitable as a halon replacement system. Therefore, it is outside of the discussion here. However, the Nanjing Factory will continue to offer these systems.

6. Justification of selection of alternative technology

In the fire fighting sector mainly three types of ozone depleting agents are used: Halon 1211 CF_2ClBr and Halon 1301 (CF_3Br). For some specific fire hazards also Halon 2402 ($C_2F_4Br_2$) is used. So far there is no drop-in substitute available on the market. The selected replacement agents for the Nanjing Factory, that is ABC dry powder and foam/water spray, are well known fire extinguishing media and they have proved to be effective against a variety of fires. In order to cover the demand of the market, both the portable and fixed type of fire fighting products must be replaced with more than one substitute. The market for halon based fixed fire extinguishing systems is still growing very fast in China. The orders to the Nanjing Factory have increased by more than 100% during 1994. In order to break this development, the market must be offered acceptable alternatives. The selected agents give this possibility. Another aspect justifying the selection of agents is the manufacturing capability at the Nanjing Factory. The new production is well in line with the present manufacturing experience of the staff and management at the factory. This is important also from a quality and training point of view.

7. Project cost

The total incremental cost of the project is US$ 669,246 (see Exhibit 8 below).

Exhibit 8. Total cost of project

	US$
Total investment costs (Annex 1)	521,954
Annual incremental operating costs (Annex 2)	46,464
NPV incremental operating costs for 4 years (3.17*46,464)	147,292
Total incremental cost	669,246
Project preparation costs	30,000
Total project cost	699,246
Agency overhead (13 per cent)	90,902
Total MF grant	790,148

8. Project implementation

The Jiangsu Provincial Environment Bureau and the Nanjing Municipal Environment Bureau will oversee the implementation of the project. The United Nations Industrial Development Organization will provide technical assistance to the Nanjing Factory during the project. The final implementation schedule will include the new factory building and will be made later and attached to project as an annex.

9. Required regulatory actions

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

10. Results

The present project will be completed within 2 years. One year after the completion of the project, the consumption of halons will be completely eliminated at the Nanjing Factory.

11. Overview of annexes

Annex 1:	Breakdown of investment (capital cost)	
Annex 2:	Breakdown of the total incremental operating costs/savings	
Annex 3:	Breakdown of incremental benefits	
Annex 4:	Calculation of total unit abatement cost	
	Annex 4.a:	Calculation of UAC for the complete project
	Annex 4.b:	Calculation of UAC for portable ABC dry powder extinguishers
	Annex 4.c:	Calculation of UAC for fixed foam/water spray systems
Annex 5:	Environmental assessment	
Annex 6:	List of equipment	
	Annex 6.a:	List of equipment for portable ABC dry powder extinguishers
	Annex 6.b:	List of equipment for fixed foam/water spray systems

Annex 1. Breakdown of total investment (capital) cost

	Description of cost items	Unit	Unit Cost RMB	Qty	Total Cost RMB	Total Cost US$ (8.70)
1	Portable ABC Dry Powder Extinguisher					
1.A	Equipment produced in China	set	240,000	1	240,000	27,586
1.B	Equipment to be imported	set	465,000	1	465,000	53,448
1.C	Technology acquisition and training	set	400,000	1	400,000	45,977
	Sub-total				*1,105,000*	*127,011*
2	Fixed Foam/Water Spray Fire Fighting System					
2.A	Equipment produced in China	set	1,740,000	1	1,740,000	200,000
2.B	Equipment to be imported	set	1,696,000	1	1,696,000	194,943
2.C	Technology acquisition and training	set	0	0	0	0
	Sub total				*3,436,000*	*394,943*
	TOTAL				**4,541,000**	**521,954**

Annex 2. Breakdown of total incremental operating cost (US$1.00=RMB8.70)

	Description of cost items	Unit	Unit Cost RMB	Quantity	Pre-project total cost		Post Project Total Cost	
					RMB	US$	RMB	US$
A	Portable Halon Extinguisher							
1	Consumption of Halon 1211 per annum	MT	30,000	240	7,200,000	827,586		
2	Annual steel consumption	MT	4,500	384	1,728,000	198,621		
3	Consumption of external structural components per year	set	18.50	240,000	4,440,000	510,345		
4	Annual consumption of packaging materials	pc	3.60	240,000	864,000	99,310		
5	Annual consumption of welding and painting paste	pc	3.60	240,000	864,000	99,310		
	Sub-total				15,096,000	1,735,172		
B	Fixed Halon System							
1	Annual consumption of Halon 1211	MT	30,000	120	3,600,000	413,793		
2	Annual steel cylinder consumption	pc	650	2,400	1,560,000	179,310		
3	Annual consumption of flexible metal tubes used for starting device	set	1,970	2,400	4,728,000	543,448		
4	Annual consumption of other materials used for manufacturing starting device	set	2,157	480	1,035,360	119,007		
5	Annual consumption of painting paste	set	1,530	480	734,400	84,414		
	Sub-total				11,657,760	1,339,972		
C	Additional costs							
1	Electricity				200,000	22,989		
2	Labour	per	6,000	1,000	6,000,000	689,655		
3	Equipment maintenance				96,000	11,034		
	Sub-total				6,296,000	723,678		
D	Portable ABC dry powder extinguisher							
1	Annual ABC dry powder consumption	MT	5,500	480			2,640,000	303,448
2	Annual steel consumption	MT	4,500	840			3,780,000	434,483
3	Annual consumption of external structural components	set	24.50	240,000			5,880,000	675,862
4	Annual consumption of packaging materials	pc	2.80	240,000			672,000	77,241
5	Annual consumption of welding and painting paste	pc	4.50	240,000			1,080,000	124,138
	Sub-total						14,052,000	1,615,172
E	Fixed foam water system							
1	Material consumption per year for 400 m2 foam water system	set	54,750	120			6,570,000	755,172
2	Material consumption per year for 200 m2 foam water system	set	44,100	120			5,292,000	608,276
	Sub total						11,862,000	1,363,448
D	Additional common costs							
1	Electricity						400,000	45,977
2	Labour	per	6000	1,100			6,600,000	758,621
3	Equipment maintenance						540,000	62,069
	Sub total						7,540,000	866,667
	Total Pre-project costs/year				33,049,760	3,798,823		
	Total Post-project costs/year						33,454,000	3,845,287
	Total incremental costs/year						404,240	46,464

Annex 3 Breakdown of incremental benefits

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

Annex 4. Calculation of unit abatement cost (UAC)

Annex 4.a Calculation of total unit abatement cost of overall project (US$1.00=RMB8.70)

		Unit		Unit	
A.0	ODS phase out				
A.1	Average use of Halon 1211 per year	MT/year	370	MT/year	370
A.2	ODP of Halon 1211		3		3
A.3	ODP-weighted Halon 1211 phase out (A.1*A.2)	MT/year	1,110	MT/year	1,110
B.0	Annualized capital cost				
B.1	Total investment costs from Annex 1	RMB	4,541,000	US$	521,954
B.2	Equipment life	year	10	year	10
B.3	Discount rate	%	10	%	10
B.4	Annualized capital cost B.1*0.1627	RMB/year	738,821	US$/year	84,922
C.0	Annual incremental operation cost from Annex 2	RMB	404,240	US$	46,464
D.0	Unit abatement cost				
D.1	Annualized capital cost per kg ODS (B4/A.3/1000)	RMB/kg	0.67	US$/kg	0.08
D.2	Annual incremental operation cost ODS phase out (C.0/A.3/1000)	RMB/kg	0.36	US$/kg	0.04
D.3	Unit abatement cost (D.1+D.2)	RMB/kg	1.03	US$/kg	0.12

Note: The actual ODP-weighted phaseout is actually higher than 360 MT which is used for new equipment. Because 10 to 20 MT of Halon 1211, that is 30 to 60 MT of ODP-weighted ODS used for maintenance in existing installations will also be eliminated.

Annex 4.b Calculation of unit abatement cost for portable dry ABC powder extinguisher (US$1.00=RMB8.70)

		Unit		Unit	
A.0	ODS phase out				
A.1	Average use of Halon 1211 per year	MT/year	240	MT/year	240
A.2	ODP of Halon 1211		3		3
A.3	ODP weighted Halon 1211 phase out (A.1*A.2)	MT/year	720	MT/year	720
B.0	Annualized capital cost				
B.1	Investment cost for portable ABC dry powder extinguishers from Annex 1	RMB	1,105,000	US$	127,011
B.2	Equipment life	year	10	year	10
B.3	Discount rate	%	10	%	10
B.4	Annualized capital cost B.1*0.1627	RMB/year	179,784	US$/year	20,665
C.0	Annual incremental operation savings according to note given below	RMB/year	(214,667)	US$/year	(24,674)
D.0	Unit abatement cost				
D.1	Annualized capital cost per kg ODS (B.4/A.3/1000)	RMB/kg	0.25	US$/kg	0.03
D.2	Annual incremental operation savings ODS phase out (C.0/1000/A.3)	RMB/kg	-0.30	US$/kg	-0.03
D.3	Unit abatement cost (D.1+D.2)	RMB/kg	-0.05	US$/kg	-0.01

Note:

Annual operating cost for portable ABC dry powder extinguishers from Annex 2 (Part D)	14,052,000
2/3 of post-project annual additional common operating costs from Annex 2 (Part F)	5,026,667
(minus) Pre-project annual operating costs for portable Halon extinguishers from Annex 2 (Part A)	(15,096,000)
(minus) 2/3 of pre-project annual additional common operating costs from Annex 2 (Part C)	(4,197,333)
Annual incremental operating savings for portable ABC dry powder extinguishers	(214,667)

Annex 4.c Calculation of unit abatement cost for fixed foam water spray fire fighting system (US$1.00=RMB8.70)

		Unit		Unit	
A.0	ODS phase out				
A.1	Average use of Halon 1211 per year	MT/year	120	MT/year	120
A.2	ODP of Halon 1211		3		3
A.3	ODP weighted Halon 1211 phase out (A.1*A.2)	MT/year	360	MT/year	360
B.0	Annualized capital cost				
B.1	Investment cost for fixed foam water spray fire fighting system from Annex 1	RMB	3,436,000	US$	394,943
B.2	Equipment life	year	10	year	10
B.3	Discount rate	%	10	%	10
B.4	Annualized capital cost B.1*0.1627	RMB/year	559,037	US$/year	64,257
C.0	Annual incremental operation cost according to note given below	RMB/year	618,907	US$/year	71,139
D.0	Unit abatement cost				
D.1	Annualized capital cost per kg ODS (B.4/A.3/1000)	RMB/kg	1.55	US$/kg	0.18
D.2	Annual incremental operation costs ODS phase out (C.0/1000/A.3)	RMB/kg	1.72	US$/kg	0.20
D.3	Unit abatement cost (D.1+D.2)	RMB/kg	3.27	US$/kg	0.38

Note: (All figures are in RMB)

Annual operating cost for fixed foam water spray system from Annex 2 (Part E)	11,862,000
1/3 of post-project annual additional common operating costs from Annex 2 (Part F)	2,513,333
(minus) of pre-project annual operating costs for fixed Halon extinguishers from Annex 2 (Part B)	(11,657,760)
(minus) 1/3 of pre-project annual additional common operating costs from Annex 2 (Part C)	(2,098,667)
Annual incremental operating costs for fixed foam water spray system	618,907

Annex 5. Environmental assessment

In the proposed project, the manufacturing processes are well-established and have easy-to-implement environmental pollution control methods. These are related to metal forming and machining industries, including surface finishing and painting. The new factory building, will have the necessary waste treatment facilities.

Annex 6. List of equipment

Annex 6.a List of equipment for portable ABC dry powder fire extinguisher production line

New equipment to be provided by the Multilateral Fund

	Type and description of equipment	Unit	Qty	Unit price RMB	Total price RMB	Total price US$
A. Domestic equipment (equipment manufactured in China)						
A1	Hardening furnace	pc	1	150,000	150,000	17,241
A2	Duct head tightening machine	pc	2	14,000	28,000	3,218
A3	Cylinder head tightening machine	pc	2	31,000	62,000	7,126
Sub-total (A. Domestic equipment)					240,000	27,586
B. Imported equipment						
B1	Automatic dry powder filling machine	pc	2	130,500	261,000	30,000
B2	High pressure hydraulic testing facility (fixed)	pc	1	204,000	204,000	23,448
Sub-total (B. Imported equipment)					465,000	53,448
C. Technology acquisition and technical training						
C1	Technical training on automatic filling machines (abroad, 2-4 weeks, 6-8 people)	set	1	400,000	400,000	45,977
Sub-total (C. Technology acquisition and technical training)					400,000	45,977
TOTAL					1,105,000	127,011

Annex 6.a (continued)

List of equipment for portable ABC dry powder fire extinguisher production line

New equipment to be provided by the Nanjing Fire Fighting Equipment Factory

	Type and description of equipment	Unit	Qty	Unit price RMB	Total price RMB	Total price US$
A. Equipment manufactured in China						
A1	Sheet metal shearing machine	pc	1	52,000	52,000	5,977
A2	100T single column press: Blank cutting	pc	1	105,000	105,000	12,069
A3	Open type high performance press with fixed table (1,600 kN)	pc	1	245,000	245,000	28,161
A4	Open type high performance press with fixed table (630 kN)	pc	1	95,000	95,000	10,920
A5	Open type high performance press with fixed table (250 kN)	pc	1	68,000	68,000	7,816
A6	Feeding manipulators and conveyor	set	4	98,000	392,000	45,057
A7	Cylinder air tightness tester	pc	1	100,000	100,000	11,494
A8	Phosphatizing and cleaning facility	set	1	200,000	200,000	22,989
A9	Assembly area conveyor	set	2	175,000	350,000	40,230
A10	Automatic packaging machine	pc	1	28,000	28,000	3,218
A11	Spot welding machine	pc	1	12,000	12,000	1,379
Sub-total (A. Domestic equipment)					1,647,000	189,310
B. Jigs, fixtures, dies and tools for all manufacturing processes						
B1	Drawing dies, tightening dies, welding fixtures, etc. (around 60 pieces)	set	1	250,000	250,000	28,736
Sub-total (B. Jigs, fixtures, dies and tools)					250,000	28,736
TOTAL					1,897,000	218,046

Annex 6.b List of equipment for fixed foam/water fire fighting system production line

New equipment to be provided by the Multilateral Fund

	Type and description of equipment	Unit	Qty	Unit price RMB	Total price RMB	Total price US$
A. Domestic equipment (equipment manufactured in China)						
A1	Nozzle assembly line	pc	1	320,000	320,000	36,782
A2	Valve body machining	pc	1	920,000	920,000	105,747
A3	Valve body spinning machine	pc	1	300,000	300,000	34,483
A4	Air-tightness tester	pc	1	200,000	200,000	22,989
Sub-total (A. Domestic equipment)					1,740,000	200,000
B. Imported equipment						
B1	N filling machine	pc	1	217,000	217,000	24,943
B2	DM type frozen storage	pc	1	1,044,000	1,044,000	120,000
B3	N stoppage	pc	1	435,000	435,000	50,000
Sub-total (B. Imported equipment)					1,696,000	194,943
TOTAL					3,436,000	394,943

Annex 6.b (continued)

List of equipment for fixed foam/water fire fighting system production line

New equipment to be provided by the Nanjing Fire Fighting Equipment Factory

	Type and description of equipment	Unit	Qty	Unit price RMB	Total price RMB	Total price US$
A. Domestic equipment (equipment manufactured in China)						
A1	Vertical milling machine	pc	1	124,000	124,000	14,253
A2	Universal knee-type milling machine	pc	1	100,000	100,000	11,494
A3	Single column hydraulic press (fitting)	pc	1	80,000	80,000	9,195
A4	Engine lathe	pc	1	90,000	90,000	10,345
A5	CNC lathe	pc	6	70,000	420,000	48,276
A6	Hydraulic pressure tester for spray nozzles	pc	2	5,000	10,000	1,149
A7	Fatique testing device for water spray nozzles	pc	1	50,000	50,000	5,747
A8	Hydraulic pressure and water tightness tester	pc	1	50,000	50,000	5,747
A9	Fire fighting pump	pc	1	12,000	12,000	1,379
A10	Sluice valve	pc	4	1,000	4,000	460
A11	Back pressure valve Hydraulic water tank	pc	4	1,000	4,000	460
A12	Hydraulic water tank	pc	1	10,000	10,000	1,149
A13	Rotor-type flow meter with read-out	pc	1	5,000	5,000	575
A14	Calibrated water distribution tank	pc	1	5,000	5,000	575
A15	Test tank for water spray nozzle	pc	1	5,000	5,000	575
A16	Air tightness tester	pc	1	5,000	5,000	575
A17	Static operating temperature tester	pc	1	6,000	6,000	690
A18	Universal hydraulic tester	pc	1	20,000	20,000	2,299
A19	Impact testing stand	pc	1	50,000	50,000	5,747
A20	Vibration testing stand	pc	1	48,000	48,000	5,517
A21	Chemical environment corrosion testing tank	pc	1	15,000	15,000	1,724
A22	Valve body hydraulic pressure tester	pc	1	9,000	9,000	1,034
A23	Valve body air-tightness tester	pc	1	250,000	250,000	28,736
A24	Valve body action tester	pc	1	8,000	8,000	920
A25	Hydraulic sand blasting	pc	1	28,000	28,000	3,218
A26	Vertical valve body machining	pc	1	300,000	300,000	34,483
A27	N filling machine	pc	2	243,600	487,200	56,000
A28	Horizontal machining centre	pc	1	2,000,000	2,000,000	229,885
Sub-total (A. Domestic equipment)					4,195,200	482,207

	Type and description of equipment	Unit	Qty	Unit price RMB	Total price RMB	Total price US$
B. Design modification and adoptation equipment						
B1	PC workstation	pc	1	20,000	20,000	2,299
B2	Printer	pc	1	5,000	5,000	575
B3	Plotter	pc	1	80,000	80,000	9,195
B4	Basic CAD software	pc	1	25,000	25,000	2,874
Sub-total (B. Design modification and adoptation equipment)					130,000	14,943
C. Test equipment						
C1	Mechanical tension tester	pc	1	150,000	150,000	17,241
C2	Reed's hardness tester	pc	1	12,000	12,000	1,379
C3	Thickness tester	pc	1	6,000	6,000	690
C4	Digital coating thickness tester	pc	1	5,000	5,000	575
C5	Spectrometer	pc	1	15,000	15,000	1,724
C6	Ultrasonic flaw detector	pc	1	15,000	15,000	1,724
C7	Metallurgical microscope	pc	1	100,000	100,000	11,494
C8	Carbon/sulphur determination equipment	pc	1	3,000	3,000	345
C9	Colorimeter	pc	1	10,000	10,000	1,149
C10	Microscope with readout	pc	1	1,000	1,000	115
C11	Roughness tester	pc	1	40,000	40,000	4,598
Sub-total (C. Test equipment)					357,000	41,034
D. Services						
D1	630 kVA transformer and associated electricity distribution equipment to cope with the increased power demand	set	1	340,000	340,000	39,080
D2	Air compressor	set	2	100,000	200,000	22,989
Sub-total (D. Services)					540,000	62,069
TOTAL					5,222,200	600,252

To be provided by the Nanjing Fire Fighting Equipment Factory:

Technology development and transfer programme of the Nanjing Fire Fighting Equipment Factory on fixed foam/water fire fighting system production line

1. Development and application of automatic foam/water fire extinguishing systems in China

It was as early as in the 1960s that China first developed and/or assimilated the technologies of manufacturing and application of automatic water fire-extinguishing systems. At present, almost all of the Chinese provinces have this kind of technology.

There are a number of companies in China that are specializing in the development and production of automatic water/foam fire-extinguishing systems. Their products can be classified into two groups:

a) The first is a foam fire-extinguishing system that can have high, medium and low intensity. The key end-users are mainly large scale oil tank fields, airports and storage for chemical material. This technology was adopted for use by the Beijing Capital Airport and the "Meidao" corporation at Shanghai airport.

b) The second is a AFFF (aqueous Film Forming Foam) fire-extinguishing system. Important protection objects are: car carriages, carriages, diesel generators, boiler rooms (houses), and places with easy burning liquid.

A fire extinguisher factory in Shanghai (under the supervision of the Public Security Bureau) has adopted a complete water/foam system through a technology transfer arrangement with the Tianjin Fire Fighting Research Institute (also under the Public Security Bureau). This system has already been put into operation for several years.

With regard to the AFFF hydrogenic film stuff production factories, there are, for example, only in Jiangsu province already two factories: Yangzhou Factory and Changzhou Factory. With regard to Nanjing Fire Fighting Equipment Factory (NFFEF), the factory will in short develop and supply a new foam/water system.

2. Development of a foam/water system at the Nanjing Fire Fighting Equipment Factory

Tianjing Fire Fighting Research Institute possesses a rather strong capacity in research and development of new foam/water systems. The institute has a good knowledge about both the international and the domestic technologies in the fire fighting equipment sector.

Nanjing Fire Fighting Equipment Factory and the Tianjing Fire Fighting Research Institute are both managed under the Public Security Bureau. Therefore, close cooperation between these two institutions is quite easy to achieve. At present, NFFEF has already established contacts with Tianjing Fire Fighting Research Institute through the Public Security Bureau for the technology transfer. The programme of cooperation and the schedule of the development work, including the costs involved are given in the exhibit below. These costs will be borne by the NFFEF.

3. Workplan for developing an automatic water/foam fire extinguishing system:

Projects to be developed	Time of implementation	Cost (RMB)	Cost, $
Software	Oct. 1994 - Feb. 1996	380,000	43,678
Wet alarming system	June 1994 - Begin. 1996	500,000	57,471
Rain valve system	Begin. 1995 - end 1996	1,200,000	137,931
Closed nozzle	June 1994 - begin 1996	60,000	6,897
Open nozzle	June 1994 - begin 1996	40,000	4,598
Foam nozzle	Jan. 1995 - end 1996	160,000	18,391
Foam storage tank	Jan. 1995 - end 1996	80,000	9,195
Rubber storage bag	Jan. 1995 - end 1996	120,000	13,793
Foam proportion	Jan. 1995 - end 1996	280,000	32,184
General testing equipment	Jan 1995 - end 1996	450,000	51,724
Special-purpose testing equipment	Jan - Oct. 1995	320,000	36,782
Market survey	Beginning 1995	100,000	11,494
TOTAL		3,690,000	424,138

R E P O R T

STF05 F94009

Technical Review of Project Proposal from the Nanjing Fire Fighting Equipment Factory

Industrial Development
July 1994

SINTEF
Industrial Development

CONTENTS

1. Introduction

This is a technical review of a project proposal from the Nanjing Fire Fighting Equipment Factory in China. The review is conducted by SINTEF Industrial Development on behalf of United Nations Industrial Development Organization, UNIDO. SINTEF NBL, Norwegian Fire Research Laboratory, has been consulted on questions regarding fire technology.

This report builds entirely on the information given in the project proposal documentation. No other sources of information about the Nanjing project has been seen or used.

The report is structured according to the format for technical reviews given by UNIDO.

2. Relationship to country programme

The project is consistent with the China Country Programme and constitutes part of an articulated sectoral/sub-sectoral strategy.

3. Technology

We fully agree on the basic objectives of this project. Replacing of halon with ABC dry powder, foam/water and CO_2 will give the Chinese home market a possibility to choose between different extinguishing media, depending on the objects to be protected against fire.

Many companies are working with development of new gaseous media as substitute for halon, but the uncertainties related to environmental impacts and even human exposure are still not fully investigated. These facts strengthens the choice that has been made for the new production at Nanjing Fire Fighting Equipment Factory. Another important factor is the similarity of production going from portable halon extinguishers to ABC dry powder. The factory will benefit on the already existing experience amongst the staff, thus decreasing the need for training and education.

Based on this we consider the technology described in the project proposal to be the most cost effective technology available for this conversion. The selected technologies are also optimal from an environmental soundness and safety point of view.

The technologies in question are all considered transitional. Although no formal agreements on licensing or technology transfer seem to have been made, we consider the acquirement of the equipment specified in Annex 6 of the project proposal to be reasonably straight forward. The associated training of personnel should also go well.

We do, however, find reasons to question the proposal to start production of thin-wall type CO_2 containers at the factory. The production technology is quite new and expensive, and almost one third of the total project cost is related to purchasing of this equipment. We do not have doubts about the necessity of high pressure containers, but the costs of the obvious alternative, to by such containers from producers in Germany or the USA, should be thoroughly discussed in the project proposal. Another alternative could be to establish a company in China that focuses on producing such containers for a number of domestic users. This is an important strategic "make or buy issue" that should not be omitted from the project proposal.

Exactly the same line of arguments could be made about the decision to make or buy glass bulbs. It might be cheaper and/or more strategically sound to buy glass bulbs from abroad/domestic producer then to acquire a glass bulb production line as proposed. This is also a major cost in the project proposal.

4. Environmental impact

The selection of alternative agents will continue to fulfil both the international and the national regulations for replacements of halon. The new agents will have no impact on the environment as long as we can consider the production of CO_2 to be negligible.

The project proposal does not say anything about the amount of stored halon in the factory. We assume that the elimination of halon at the factory follows the change of production as described in the report. Destruction of stored halon should therefor not be necessary.

We agree that the proposed manufacturing processes are well established with easy-to-implement environmental pollution control methods. Future environmental legislation might however demand special treatment of ABC powder waste containing phosphate.

5. Project costs

Project costs and cost of equipment
All the specified equipment in the project proposal is to our knowledge necessary for the production of the 4 extinguishing products. The list of equipment given in annex 6 also seems to be complete.

There is little or no information in the report about what will be done with the existing equipment. Much of the equipment specified in annex 6a and 6c is expected to be in the facility prior to the conversion. The technology to produce ABC dry powder containers is not much different than for halon containers (eg. A1 and A4 in annex 6a), and some of the equipment for fixed CO_2 fire fighting systems production (eg. A1, A3 and A5 in annex 6c) must also be present before the conversion.

We do recognize the information that much of the existing equipment is "more than 20 years old" (page 3) and that there is a need for modernization. The total cost of the needed equipment might therefor not be much different from the sums given in annex 6a and 6c, but there is a need for more information. In particular, two questions should be answered:

1. What is the salvage value of scrapped equipment?
2. To what extent can existing equipment be modified to perform functions needed in the conversion, and if so, what is the cost of these modifications?

The new equipment will result in an increase in existing capacity. This is recognized in the project proposal where the factory is prepared to self-finance 50%. The calculated unit abatement cost in annex 4 is also conservative (to high) in this respect because only replacement of halon according to today's production level is considered. Both of these facts strengthens the project proposal.

Start-up/commissioning cost

Training costs are included in the project proposal, but they could be underestimated. We are not referring to technology acquisition in terms of design drawings, manufacturing documentation, testing and so on, but to post "D2 Technical training" in annex 6b (portable CO_2 fire extinguisher production line) and 6d (foam/water fire fighting system production line). Both of these production lines involves technology the factory has no or limited experience with. Estimated training costs is about 3% of total investment costs. We believe 6-10% (at least) would be more realistic, including redundant production costs and contingency costs.

If production of glass bulbs and thin-wall type CO_2 containers is outsourced, training cost as given (3%) is probably realistic.

The experience of the management and the staff at the Nanjing factory is an important asset. Will moving the factory to a new suburban area mean major personnel changes?

Operating costs

We have little basis for judging the appropriateness of costs of different materials, energy, labour etc., but the amounts specified does not seem unreasonably high. Beside from this, the calculation of operating costs has several weaknesses:

1. Annual incremental operating savings/costs (notes in annex 4) are calculated as though the conversion from halon to the new extinguishing media happens instantaneously from day 1 of the project. Rather, it must be a gradual transition with perhaps different introduction speeds for the 4 new products. Such a detailed introduction plan, specifying volumes each year for all the 4 products, must be the basis for calculating annual incremental operating costs/savings. This is also a basis for any marketing plan, see section 6 "Other comments".

2. Costs are generally divided after a "share of halon"-key amongst the 4 new products. From a profit analysis perspective we doubt that this would be correct, but since the issue here is halon replacement, it is acceptable. However, we argue that one should

not consider all of the additional common costs (labour, electricity equipment maintenance) as part of the operating costs related to conversion. A substantial share of the increase in common costs must be associated with the production increase, and not only with the conversion.

3. We would also expect so called learning curve effects, in the respect that operating costs should decline over time. Learning curve effects can be hard to predict, but a reduction of operating costs of 3-10% (proportionate to production volumes) from year 1 to year 4 might be realistic. As an example of learning curve effects, a decrease in quality related costs can be mentioned. We are not familiar with the quality level at the factory, but the change of production gives a good opportunity to raise the level of quality assurance.

We do not know how these changes in the way of calculating annual incremental operating savings/costs will affect the total project costs, other than that a reduction is likely.

Other costs

As mentioned above, contingency costs could be included in the start-up/commissioning cost. The project proposal gives little information about institutional costs. Costs associated with mitigation of adverse environmental impact is to our knowledge not relevant in this project.

Cost effectiveness

We assume that the relevant "cost effectiveness" for this project is not related to the future income of the factory, but to the reduction of ODP for each dollar spent. The calculation of unit abatement costs in annex 4 addresses the question of cost effectiveness in a thorough and conservative manner.

The calculation of unit abatement cost is conservative (to high) for 3 reasons. One reason is given in the project proposal and relates to elimination of halon used for maintenance purposes. The second reason is that a factor of 3 ODP per MT halon 1211 is used, while some institutions use a factor of 4. The third reason why the calculation of abatement cost is conservative, is that only phase out of today's use of halon is considered (360 MT per year), and the project also hinders an expected increase of halon (more than a doubling) in a fast growing market for fire extinguishers.

We have no experience in assessing the size of unit abatement cost (0.59 US$/kg) for a project like this. We would however be highly surprised if many projects could come up with numbers that matches this project. Nanjing Fire Fighting Equipment Factory is a major producer in a fast growing and big market.

In terms of reduction of ODP we conclude that the project is cost effective.

Implementation time

4 years should be sufficient implementation time for the conversion. Conversion to ABC powder extinguishers could probably be done in one year, while conversion to CO_2 portable fire extinguishers and foam/water spray fire fighting systems is more complicated. We would again like to mention the need for a more detailed project plan with estimates of the timetable/volumes for the conversion of the 4 different extinguishing products.

6. Other comments

The project proposal is highly production oriented and gives very little information about the market environment or about the market strategy of the Nanjing Fire Fighting Equipment Factory. This is in our opinion a clear weakness that should be corrected.

As a minimum the following questions should be answered:

1. What is the targeted market share for the Nanjing factory in portable and fixed fire fighting equipment in China?
2. What are the expected production volumes of the 4 replacements products in the coming years?
3. What market position, in terms of price and satisfaction of specified customer demands, does the factory consider necessary in order to reach the targeted market share(s)?
4. What market strategy, in terms of product characteristics, price, distribution and promotion is intended? In particular, does the factory own or have access to relevant distribution channels in line with the planned expansion? Are there any plans for training of sales people in the new products?

The report does not consider if the factory should participate in service activities for portable fire extinguishers. It is quite common that manufacturers of portable fire extinguishers perform service on their equipment. The factory could also establish a training centre for maintenance personnel that could carry out service on the products. The factory will have the necessary knowledge and equipment to establish this activity without cost investments. Therefor, a fifth question should also be answered:

5. What are the plans, if any, related to service and maintenance of the fire extinguishers in general, and portable fire extinguishers in particular?

7. Recommendations

We recommend that the project is approved after modification. The proposals for modifications are as follows:

A. A market strategy for the Nanjing Fire Fighting Equipment Factory should be sketched, covering at least the 5 questions given in section 6.

B. The investments in a glass bulb production line and a thin-wall type CO_2 containers production line should be reconsidered. A discussion of the alternative of buying CO_2 containers and glass bulbs from foreign or domestic producers (could be established) is necessary. These are very important strategic decisions that should be taken on a solid foundation.

C. Depending on the outcome of B, training costs as given i annex 6b and 6d should be reevaluated. In the case of internal production of glass bulbs and CO_2 containers, we recommend that training costs are at least doubled.

D. The questions on salvage value and possible modification of existing equipment should be addressed.

E. Annual incremental operating costs/savings should be recalculated according to point 1-3 in section 5.

PROJECT COVER SHEET

COUNTRY:	Peoples' Republic of China
PROJECT TITLE:	The Conversion of Medium sized Open-type CFC-12 Refrigeration Compressor Production to HCFC-22 Production
SECTOR COVERED:	Commercial and Industrial Refrigeration and Air-Conditioning
ODS USE IN SECTOR:	11,900 tonnes CFC-12 in 1993 (11,900 tonnes ODP)
PROJECT IMPACT:	Phase out 170 tonnes CFC-12 (162 tonnes ODP)
PROJECT DURATION:	3 Years
PROJECT ECONOMIC LIFE:	10 Years
TOTAL PROJECT COST:	Investment Cost US$3,289,000 Incremental Operating Cost US$ 0 Total Project Cost US$3,289,000
PROPOSED MP GRANT:	US$ 2,631,000 79,000 (financial agent fee) **US$ 2,710,000**
IMPLEMENTING ENTERPRISE:	The Shanghai Refrigerating Machine Works (SRMW)
COORDINATING MINISTRY:	Ministry of Machine Building Industry (MMI), National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY:	The World Bank
UNIT ABATEMENT COST:	US$ 3.30/kg.ODP/yr

Technical Assessment: OORG reviewer Mr. Martien Janssen recommends approval of this project (review attached), but notes that two cost items (building modifications and new painting system) should not be included in the funding request. The building modification cost of $161,000 was excluded. The new painting system is also excluded from the proposed costs.

PROJECT SUMMARY:

This project will phaseout CFC-12 consumption in the production of medium sized open-type compressors at the Shanghai Refrigerating Machine Works by converting the production to HCFC-22 based compressors. Since the amount of CFC-12 used in the initial charge of these systems totals about 100 tonnes, a further 70 tonnes average annual leakage loss will be saved giving a total annual reduction in CFC-12 use of 170 tonnes per year when the plant is at full capacity.

This project employs commercially available and mature technology in one of the country's largest CFC use sectors. Previous country study investigations have identified this as a high priority project. The China Country Program (CP) approved by the China State Council and accepted by the MPEC, has listed this as a priority project for implementation in 1993.

PROJECT OBJECTIVES

The objectives of this project are to:

(i) introduce HCFC-22 based medium sized open-type compressor technology and

(ii) convert the enterprise's medium sized open-type compressor production to HCFC-22 based units.

SECTOR BACKGROUND

China's commercial, industrial and air conditioning industries consumed about 11,900 tonnes of CFC-12 in 1993. It is estimated that 60-85% of this consumption (7,140 to 10,100 tonnes) was used in servicing existing equipment. This amount will continue to grow unless equipment based on CFC alternatives is introduced. In 1995 CFC-12 consumption is expected to reach 13,000 tonnes for commercial, industrial and air conditioning applications.

ENTERPRISE BACKGROUND

The total annual ODS consumption associated with SRMW's compressor production is 170 tonnes per year. 100 tonnes is used directly in charging equipment produced by the enterprise. Production capacity is 6,000 units per year. Actual production is 4,000 sets. Most of current production is assembled onto condensing units and water chillers in the factory, the remainder are sold to other concerns. Open-type compressors of 12-72 kW capacity are widely used in China. Demand in 1992 reached 13,000 sets per year. SRMW's market share of this sector is about 15%. The CFC-12 open-type compressors currently produced are of Chinese design. The enterprise exports a small portion of production to Hong Kong, Macao, SE Asia, Africa and Eastern Europe. The enterprise is a 100% wholly state-owned Chinese enterprise.

PROJECT DESCRIPTION

For this project SRMW will introduced mature medium open-type HCFC-22 compressor from abroad and convert its production line. Conversion will include equipment purchase and installation, training, trail production and scaling-up to full-scale production.

SRMW has concluded an agreement in principle with York International (US). This company produces a well established design of open type compressor which can be used at medium and low temperatures in addition to air conditioning duties and which matches the enterprise's current production well. There is an inevitable degree of modernization to SRMW's product and production facilities by virtue of the fact that dated existing technology is being replaced by modern designs. However this is more than compensated by the significant portion of project costs that are being borne by SRMW (USD 657,900, or 20% of total project costs).

JUSTIFICATION OF ALTERNATIVE TECHNOLOGY SELECTION

There are three potential alternatives technologies for this project - HCFC22, HFC134a, and Ammonia. HCFC-22 was selected as the preferred alternative technology for this project for the following reasons:

i) It is cost effective - HFC134a and its associated polyolester lubricant are not currently available in China in commercial quantities and when and if they become available are likely to cost 2-3 times that for equivalent quantities of HCFC22. Also, 15wt.% less HCFC22 is required to accomplish the same refrigeration task as HFC134a because of its lower molecular weight.

ii) Technology is readily available - Foreign suppliers are reluctant to transfer HFC134a technology while HCFC22 technology is readily and immediately available at a reasonable cost. China does not have indigenous technology for making HCFC22 compressors and therefore must purchase it from abroad.

iii) HFC134a technology requires sophisticated servicing procedures for the large scale facilities envisioned in this project. China does not have trained skilled manpower to service such compressors. It will take some time to implement a service sector training project to ensure adequate service and maintenance standards for HFC134a. Current servicing practices are adequate for HCFC22.

iv) The use of R-717 (Ammonia) would require considerable modification of the systems on which these compressors are used, and R-717 use would simply not be suitable for many of the applications for which HCFC22 is used because of its toxicity and flammability.

A number of zero-ODP HFC based refrigerant blends intended as direct drop-in replacements in HCFC-22 systems are currently being developed in the West. Provided service levels improve sufficiently and these were available at a reasonable price in China, use of these could provide a direct transition to zero-ODP refrigerants with no change required to the technology being proposed in this project.

According to the Montreal Protocol agreement, China will phase out CFC use by the end of 2005. The China CP, recently accepted by the Montreal Protocol Executive Committee (MPEC) gave HCFC-22 a key role in phasing out CFC-12 use in this sector.

It is therefore concluded that on balance, given the conditions in the PRC, HCFC-22 is the best choice for CFC-12 replacement in this sector. Successful implementation of this project will lead to the replication of this technology to other enterprises.

PROJECT COSTS AND GRANT REQUEST

Summary

The total project cost is $3,288,900 US of which $2,631,000 million is considered eligible for MP financing. The grant request of $2,710,000 includes eligible project costs as well as financial administration costs. There are no net incremental recurrent costs or benefits associated with this project.

Capital Costs

The capital costs of US$ 3,288,900 includes capital investment in technology transfer fees, production equipment, training, and performance test equipment, and production costs for trial production. 20% of capital costs will be locally financed to cover inevitable process modernization which results from replacement of dated equipment. A breakdown of costs is given in Annex 1.

Incremental Recurrent Costs/Savings

In addition to the up-front technology transfer fee of $200,000, SRMW will pay 4% royalty payments on all sales of new HCFC-22 equipment. However, this expense (beyond the 20% of capital costs noted above) will be borne by the enterprise and no request is made of the Fund to compensate SRMW for this incremental recurring cost.

Benefits

No net incremental benefits are expected.

Local Ownership Fraction

SRMW is a 100% state-owned company.

Contingencies and Other Costs

A 15% contingency was added to all capital cost estimates. A 3% financial administration fee was included in the grant request.

UNIT ABATEMENT COST:

US$ 3.30 US/kg ODP/year. A detailed calculation is given in Annex 2.

PROJECT IMPLEMENTATION:

The Ministry of Environment (NEPA) and the Ministry of Machinery (MMI) will oversee the successful implementation of this project. The project will be carried out at the SRMW's factory. Local technical support will be provided by the General Machinery Research Institute. The project will be implemented in three years as detailed in Annex 3.

REQUIRED REGULATORY ACTIONS

The following will be undertaken to ensure the success of this project:

i) Voluntary agreements from the Enterprise with MMBI to phaseout CFC-12 production

ii) Supervision and coordination of the project by NEPA

iii) Bans and Taxes

The following are measures that will be adopted to ensure that new non-CFC products become established in the marketplace at a sufficient rate for the phaseout goals to be achieved. These have been proposed by MMI and GMRI to the responsible ministries.

i) Tax Policy

The selling price of non-ODS products will be slightly higher than current CFC-12 based production. From 1998 differential tax rates will be applied to each to ensure that non-CFC based products become established in the market.

The State Environmental Protection Agency (NEPA), State Economy and Trade Commission, the Ministry of Finance and the Dept. of General Tax Administration will be responsible for drafting these tax measures with input from MMI and MIT.

ii) Import and Export Controls

From 2001 the same bodies listed above in conjunction with the General Customs Administration will institute import and export policies to prevent the import of CFC based equipment.

iii) Production Licenses

From mid-1998 production licenses will be issued by MMI to control the total supply of compressors to the market. This measure will be used in conjunction with (i) above to ensure that HCFC-22 based equipment becomes established in the Chinese market.

The aim of these measures will be to cease production of all CFC based refrigeration equipment by January 1, 2004.

Considerable excess production capacity exists in this sector in the Chinese refrigeration industry. The danger exists that if uncontrolled existing CFC-12 compressor manufacturers may undercut SRMW's new production in an effort to retain their market share. Introduction of HCFC-22 would thereby be delayed. The output of other plants producing similar equipment will be controlled via a system of production licenses and taxes implemented by MMI.

RESULTS

Direct Project Impacts

This project will remove 100 tonnes of CFC-12 in 1994 or the first year of full operation. The amount of CFC-12 will increase to 170 tonnes annually over subsequent years as the servicing needs of machines equipped with HCFC-22 compressors are re-charged with HCFC-22 instead of CFC-12.

Indirect Project Impact

This project concerns the direct replacement of SMRW's CFC-12 compressor production. Since production is not being increased above that planned for CFC-12 compressor production, no other plants will need to reduce their production or close. Production from existing CFC-12 compressor manufacturers will be controlled as described above.

When this technology has been established at SRMW, it is intended to replicate it to other similar enterprises as detailed in the China CP, namely Chongqing Refrigerating Machinery Factory and Shaoxing Refrigerating Machinery Factory. HCFC-22 open-type medium compressor technology will thus be spread to all companies supplying these compressors in China. Funding will be requested for these enterprises in due course.

ENTERPRISE COMMITMENT

Once MP funding is available, SRMW will carry out the activities relating to the production of HCFC-22 compressors as described in this document and assume responsibility for project implementation.

For Shanghai Refrigerating Machinery Works:

Project Executive Chairman: Huang Bing Tong
Date: September 1994.

ANNEX 1

Investment Costs and Equipment Justification

Investment Costs Summary

a)	Technology Transfer Fee	$ 200,000
	Local cost of adapting technology	$ 90,000
b)	Equipment Costs	
	Imported Equipment	$2,024,100
	Local Equipment	$ 440,300
c)	Installation Costs	$ 48,000
d)	Commissioning	$ 57,500
e)	Contingency	$ 429,000
Total		**$3,288,900 USD**

Of which:

Montreal Protocol Fund	$2,631,000
Chinese Govt. Loan/Enterprise	$ 657,900

Equipment that will be purchased for the project is listed below:

Parts	No	Equipment Type	Name	Supplier	Price (1000's)	US$ (1000s)
Body	1	XH768	Processing Centre	Shanghai No. 4 Machine Tool Works	1500 RMB	172.4
	2	SL-4000 (three sets)	Processing Centre	Danobat (Spain)	219,965 Pts	1,765.4
	3	Scirocco 100907	Three Dimensional Inspection Machine	DEA (Italy)	310 DM	208.1
	4	MBA4125Z	Vertical Grinding Machine	Dahe Machine Tool Works	150 (RMB)	17.2
	5		Tools for Processing Centre	Shanghai No 1 Machine Tool Accessories	150 RMB	17.2
	6	V520/PC40	Measuring Tool	Zoller (Germany_	53 DM	35.6
Valve Plate Cylinder Head End Plate Crankshaft	7	X7016	Milling Machine	Beijing no.1 Machine Tool Works	180 RMB	20.7
	8	TH 5625.4A (2 sets)	Drilling Machine	Dahe Machine Tool Works	120 RMB	13.8
	9	DK 420	Multiple Shaft Drilling Machine	Dalian Machine Tool Works	160 RMB	18.4
	10	M7132A	Flat Surface Grinding Machine	Hangzhou Machine Tool Works	50 RMB	5.8
	11	MM7132A	High Precision Flat Surface Grinding Machine	Hangzhou Machine Tool Works	70 RMB	8.1
	12	CB3263B (two sets)	Digitally controlled lathe	Shenyang No. 3 Machine Tool Works	1300 RMB	149.4
	13	Stajet 404	Manual Static Spray System	Binks Co. (UK)	15 USD	15.0
	14		Process Control Software		50 RMB	5.8
Ancillary Equipment	15		PC based Measuring Device		100 RMB	11.5
			Total			**$2,464,400**

New Equipment Justification

Note: Extracted from Section 5 of the Project Feasibility Study

Purpose of New Equipment Purchase

New production and test equipment is required to raise production standards required by the new compressor design whilst at the same time maintaining production rates.

Equipment Selection

Four additional pieces of equipment will be used, three horizontal processing centres and one vertical grinding machine. These will be used for semi-finishing and finishing. These are necessary to ensure the machining accuracy required by the new design whilst maintaining the production rate at the current level.

Nine digitally controlled machines will be used to meet the new processing requirements. These comprise lathes, grinding, milling and drilling machines. Other items such as painting and pressure testing equipment. Process control software will also be required.

Selection of Processing Centres

i) Existing production equipment at SRMW comprises dedicated equipment for manufacture of the present open drive compressor design.

The design of the new compressor is fundamentally different therefore this equipment needs to be replaced. The accuracy required by the new designs is 5-10 times that of the existing design. The crankcase must be machined to an accuracy of ISO H6, whereas current equipment is only capable of H7. Similarly, checking of the crankcase dimensions requires new measuring equipment. The current manual methods used would not be suitable for checking the new tolerances in a production situation.

ii) In theory each existing production line could be modified to produce the new HCFC-22 compressor, but each size product needs a separate line, requiring 35 pieces of high accuracy machining equipment. The cost of machinery to do this would be about 50% higher than for the processing centres. Also the construction costs would be higher and the unit production time would be longer.

iii) Three types of processing centre have been selected. This is based on the need to maintain the current production capacity (6,000 units/year) which is expected to increase by 10% annually.

iv) The acquisition of processing centres is crucial to successful production of the HCFC-22 compressor. This will enable the technical specification to be met. Because these machines can be programmed a number of different components can be carried out on a single machine.

Acquisition of this equipment will enable production costs to be kept down and the compressor sold for a comparable price to the current product.

Three Dimensional Inspection Machine

These are necessary to check that machining has been carried out to the more demanding tolerances required by the new design.

Tools for the Processing Centre

This is necessary ancillary equipment for the processing centres.

Pre-setter and Tool Measuring Machine (V520/PC40)

On every machining process the accuracy of the tool will change with time and affect the quality of the workpiece. This equipment enables the condition of the tool to be checked at any time.

Process Control Software

This enables the processing centres to be individually programmed. This enables the machining centres to change rapidly from making one component to another. The full flexibility of these machines is thus exploited.

Vertical Honing Machine

This is the key tool that ensures the accurate machining of the cylinder.

Surface Machining Equipment

i) Milling machine (X7016)

This is used for the machining parts. such as the cylinder head and valve plate.

ii) Surface Grinding Machine

This is required for finishing machining of the components in (i) above.

iii) High Precision Surface Grinding Machine (MM77132A)

This enables the surface of the valve plate to be machined to the required accuracy, as well as other components.

Drilling Machine

The existing machine is old and capable of only limited precision. It cannot meet the requirements of the new compressor.

i) TA5625.4A

This will be used for forming holes arranged in a matrix

ii) Multi Shaft machine (DK420)

This is used for holes arranged in a circle.

Lathe

Based on the arguments given in above digitally controlled lathes will be used to machine various circular components on the new compressor.

i) CB3263B (2 off)

This is used for machining the oil pump body, shaft seal and bearing of the HCFC-22 compressor.

ii) This is used for machining the compressor crankshaft to the required accuracy.

PC Based Measuring Device

This is important for ensuring the quality of units assembled from individual components. Current manual measuring methods are not suitable for checking the new tolerances during production.

Use of Existing Equipment

i) Some general machines will be refurbished and retained for machining ancillary parts, tools etc. required for the new production.

ii) Existing production lines will be modified for the new production. Redundant machines will be sold for scrap and the value set against the project costs.

ANNEX 2

Calculation of Unit Abatement Cost

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

Where:

C	=	$3,289,000
C (F)	=	$535,270 (annualized over 10 years at 10%)
OC	=	$0
OS/R	=	$0
0DP	=	162 kg ODP
UAC	=	**$3.30/kg ODP/yr**

ANNEX 3

Project Implementation Schedule

The implementation phase will take 3 years.

Year 1

- Import alternative technology
- Develop manufacturing process and build prototype compressor
- Carry out building modifications
- Order new production equipment

Year 2

- Modify existing production equipment and import new equipment
- Commence installation of equipment and modification of production line
- Commission production line.
- Produce test batch of 500 compressors

Year 3

- Fine-tune production process and produce approx. 2,000 compressors
- Carry out technical training of participating staff

Year 4

- Capacity production of 6,000 compressors is anticipated.

ANNEX 3

Environmental Assessment

Note: Translation of Chinese Documents

This is an Ozone Layer protection project.

Waste water will be treated to the standard required by local regulations. Dust emissions will be treated in a similar way.

A full assessment will be carried out.

Shanghai Machinery Bureau

Date: 1994.3.1

Provided coolant and waste water are treated to the required standard, this project is allowed.

Shanghai Environmental Protection Bureau

Date: 1993.3.1

ANNEX 4

Safety

The new refrigerant (HCFC-22) used in production has the same exposure limit as CFC-12 currently used (1,000 ppm). No materials used in the new production process are significantly more hazardous than those currently used.

A number of new production tools are being introduced into the Factory. Comprehensive training in their use will reduce the risk to operators to a minimum.

Country of origin: CHINA

Project title: The Conversion of Medium sized Open-type CFC-12 Refrigeration Compressor Production to HCFC-22 Production at the Shanghai Refrigerating Machine Works (SRMW).

Sector/sub-sector Commercial and Industrial Refrigeration and Air Conditioning

Relationship to country program (World Bank)

Technology

In the refrigeration and air conditioning industry HCFC-22 is a well known, proven and acceptable (but transitional) technology to reduce CFC consumption. In principle the technology is not very different from CFC-12 technology. The main reason for the relatively high project costs is the fact that at present a dated Chinese designed compressor is produced which is to be replaced by a design of York International (US) which is fundamentally different and needs much higher accuracy equipment. This means that not only conversion is taking place but at the same time modernization which is the reason for claiming 80 % of the project costs for funding. Justification of this 80 % is based on financial calculations, demonstrating that the remaining 20 % to be funded by the company themselves (via bank loans) is really a maximum and which is, from economic point of view, already hardly defensible.

A technology transfer agreement exists with York International Corporation, US. for producing in license HCFC-22 compressors. Due to this agreement and the experience of the company a successful implementation of the project can be expected.

The selection of HCFC-22 technology is supported. The motivation for this support is given in the attached note "Justification for the selection of HCFC-22 technology".

Environmental impact

HCFC-22 has an ODP of 0.05 and is an acceptable, though transitional, refrigerant to reduce ODS.

Project costs

- The new, more accurate production equipment is indeed a prerequisite for the new technology imported and costs of this equipment is reasonable (also demonstrated by quotations).
- The item Building Modifications is not eligible and must be excluded.
- The costs of a new painting system are being claimed. This is not requested for the conversion process and should be excluded.
- Scrap value of redundant machinery is not taken into account.
- No operational costs are being claimed.
- The UAC value obtained is reasonable compared to other, similar, projects.

Implementation timeframe

The proposed implementation time frame is reasonable.

Relevance and adequacy of information provided

Information provided consisted of project proposals, detailed appendices directly sent from the companies, comments by World Bank officer and consultant and a Strategy Document. Altogether sufficient information for a review has been present.

Recommendations

Approval provided elimination of some costs mentioned above or additional motivation.

M Janssen

Martien Janssen, OORG MM338
Eindhoven,
The Netherlands
20-October-1994

Note
on the justification for the selection of HCFC-22 technology in the commercial refrigeration projects of
Shanghai, Beijing, Anhui, Nanjing, and Taizhou, China

The justification for the selection of HCFC-22 technology is briefly described in the five project proposals. A more thorough justification is presented in a "Strategy study on the gradual phaseout of CFC substances in Industrial and Commercial Refrigeration Industry, China" which contains essential information for the projects. Furthermore, additional information is supplied by the World Bank responsible officers and consultants involved. From this information the following is concluded:

1. In this stage HCFC-22 is absolutely essential for the rapid CFC phase out in domestic and industrial refrigeration in China, which is a very important sector regarding its CFC use. Other technologies (e.g. HFC-134a) would lead to a serious delay and increase costs in the market place. This is inline with the China Country Program.

2. The cost effectiveness of a factory conversion to HCFC-22 by transferring developed countries technology, which requests a considerable modernization, can be questioned. However, it has been demonstrated that any alternative procedure (e.g. implementing new HFC-134a technology, adjusting current technology to new refrigerants) would, if possible at all, be less cost effective already from a company point of view. From a country point of view the cost effectiveness would be even worse because these technologies would certainly increase costs in the market place (e.g. service, material costs).

The selection of HCFC-22 technology is supported for these five projects.

Martien Janssen, OORG MM338
Eindhoven,
The Netherlands
20-October-1994

PROJECT COVER SHEET

COUNTRY:	Peoples' Republic of China
PROJECT TITLE:	The Conversion of small Semi-hermetic CFC-12 Refrigeration Compressor Production to HCFC-22
SECTOR COVERED:	Commercial and Industrial Refrigeration
ODS USE IN SECTOR:	11,900 tonnes CFC-12 in 1993 (same ODP)
PROJECT IMPACT:	Phase out 255 tonnes CFC-12 (242 tonnes ODP)
PROJECT DURATION:	3 Years
PROJECT ECONOMIC LIFE:	10 Years
TOTAL PROJECT COST:	Investment Cost US$3,507,000 Incremental Operating Cost US$ 0 Total Project US$3,507,000
PROPOSED FUND FINANCING:	$ 2,806,000 US 84,000 US (financial agent fee) **$ 2,890,000 US**
IMPLEMENTING ENTERPRISE:	The Nanjing Refrigerator General Works (NRGW)
COORDINATING MINISTRY:	National Environmental Protection Agency (NEPA), Ministry of Machinery (MMI).
IMPLEMENTING AGENCY:	The World Bank
TECHNOLOGY SUPPORT:	General Machinery Research Institute (GMRI)
UNIT ABATEMENT COST:	$2.36/kg. ODP/yr

Technical Assessment: OORG reviewer Mr. Martien Janssen recommends approval of this project (review attached), but notes that three cost items (pressure test equipment, adjustments to testing devices, and the technology transfer fee) are expensive. The pressure test equipment request was adjusted to include only specified components ($8,000), the testing devise adjustments ($37,000) are considered reasonable, and the factory has excluded the additional 3% royalty payments from its technology transfer fee request, leaving only the up-front $519,000 fee as part of this proposal.

PROJECT SUMMARY:

This project will phaseout CFC-12 consumption in the production of small semi-hermetic type compressors of 1-5 kW capacity at the Nanjing Refrigerator General Works by converting the production to HCFC-22 based compressors. Since the amount of CFC-12 used in the initial charge of these systems totals about 150 tonnes, a further 105 tonnes leakage loss will be saved giving a total annual reduction in CFC-12 use of 255 ODP equivalent tonnes per year when the plant is at full capacity.

This project employs commercially available and mature technology in one of the country's largest CFC use sectors. Previous country study investigations have identified this as a high priority project. The China Country Program (CP) approved by the China State Council and accepted by the MPEC, has listed this as a priority project for implementation in 1993.

PROJECT OBJECTIVES

The objectives of this project are to:

(i) introduce HCFC-22 based semi-hermetic compressor technology

(ii) convert the enterprise's semi-hermetic compressor production to HCFC-22 based units.

SECTOR BACKGROUND

China's commercial, industrial and air conditioning industries consumed about 11,900 tonnes of CFC-12 in 1993. It is estimated that 60-85% of this consumption (7,140 to 10,100 tonnes) was used in servicing existing equipment. This amount will continue to grow unless equipment based on CFC alternatives is introduced. In 1995 CFC-12 consumption is expected to reach 13,000 tonnes for commercial, industrial and air conditioning applications.

ENTERPRISE BACKGROUND

The total annual ODS consumption associated with NRGW's actual compressor production is about 255 tonnes annually including both initial charge as well as servicing requirements. Production capacity is 12,000 units per year. Actual production is 10,000 sets. 70% of current production is assembled onto condensing units and refrigerating equipment produced in the factory, the remainder are sold to other concerns. Small semi-hermetic compressors of 1-5 kW capacity are widely used in China. Demand in 1992 reached 60,000 sets per year. NRGW's market share of this sector is about 10%. The CFC-12 semi-hermetic compressors currently produced are of Chinese design. No production is exported. The enterprise is a 100% wholly state-owned Chinese enterprise.

PROJECT DESCRIPTION

For this project NRGW will introduced mature small semi-hermetic HCFC-22 compressor technology from abroad and convert its production line. Conversion will include equipment purchase and installation, training, trail production and scaling-up to full-scale production.

NRGW has concluded an agreement in principle with Arctic Circle Ltd. (UK). This company produces a well established design of semi-hermetic compressor which can be used at medium and low temperatures which matches the enterprise's current production well. There is an inevitable degree of modernization of NRGW's product since dated Chinese technology is being replaced by the latest western designs. However this is more than compensated by the significant portion of the project costs that are being met by NGRW ($700,000 US or 20% of total project costs).

JUSTIFICATION OF ALTERNATIVE TECHNOLOGY SELECTION

There are three potential alternatives technologies for this project - HCFC22, HFC134a, and Ammonia. HCFC-22 was selected as the preferred alternative technology for this project for the following reasons:

i) It is cost effective - HFC134a and its associated polyolester lubricant are not currently available in China in commercial quantities and when and if they become available are likely to cost 2-3 times that for equivalent quantities of HCFC22. Also, 15wt.% less HCFC22 is required to accomplish the same refrigeration task as HFC134a because of its lower molecular weight.

ii) Technology is readily available - Foreign suppliers are reluctant to transfer HFC134a technology while HCFC22 technology is readily and immediately available at a reasonable cost. China does not have indigenous technology for making HCFC22 compressors and therefore must purchase it from abroad.

iii) HFC134a technology requires sophisticated servicing procedures for the large scale facilities envisioned in this project. China does not have trained skilled manpower to service such compressors. It will take some time to implement a service sector training project to ensure adequate service and maintenance standards for HFC134a. Current servicing practices are adequate for HCFC22.

iv) The use of R-717 (Ammonia) would require considerable modification of the systems on which these compressors are used, and R-717 use would simply not be suitable for many of the applications for which HCFC22 is used because of its toxicity and flammability.

A number of zero-ODP HFC based refrigerant blends intended as direct drop-in replacements in HCFC-22 systems are currently being developed in the West. Provided service levels improve sufficiently and blends become available at a reasonable price in China, use of blends could provide a direct transition to zero-ODP refrigerants with no change required to the technology being proposed in this project.

According to the Montreal Protocol agreement, China will phase out CFC use by the end of 2005. The China CP, recently accepted by the Montreal Protocol Executive Committee (MPEC) gave HCFC-22 a key role in phasing out CFC-12 use in this sector.

It is therefore concluded that on balance, given the conditions in the PRC, HCFC-22 is the best choice for CFC-12 replacement in this sector. Successful implementation of this project will lead to the replication of this technology to other enterprises.

PROJECT COSTS AND GRANT REQUEST

Summary

The total project cost is US$3,507,000 of which $2,806,000 is considered eligible for MP financing. The grant request of $2,890,000 includes eligible project costs as well as financial administration costs. No support is requested for the incremental recurrent royalty costs associated with this project.

Capital Costs

The capital costs of USD 3,507,000 include capital investment in technology transfer fees, production equipment, training, and performance test equipment, and production costs for trial production. 20% of capital costs will be locally financed to cover inevitable process modernization which results from replacement of dated equipment. A breakdown of capital costs is given in Annex 1

Incremental Recurrent Costs/Savings

In addition to the up-front technology transfer fee of $519,000, NRGW will pay 3% royalty payments on all sales of new HCFC-22 equipment. However, this expense (beyond the 20% of capital costs noted above) will be borne by the enterprise and no request is made of the Fund to compensate NRGW for this incremental recurring cost.

Benefits

No net incremental benefits are expected.

Local Ownership Fraction

NRGW is a 100% state-owned Chinese concern.

Contingencies

A 12% contingency was included in all capital cost estimates. A 3% financial administration fee was included in the grant request.

UNIT ABATEMENT COST

\$2.36/kg ODP/year. Detailed calculation is provided in Annex 2.

PROJECT IMPLEMENTATION

NEPA will oversee the successful implementation of this project. The project will be carried out at the NRGW's factory. Local technical support will be provided by the General Machinery Research Institute. the project will be implemented in three years as detailed in Annex 3.

REQUIRED REGULATORY ACTIONS

The following will be undertaken to ensure the success of this project.

i) Voluntary agreements from the Enterprise with MMI to phaseout CFC-12 production.

ii) Supervision and coordination of the project by NEPA.

iii) Considerable excess of production capacity for this category of compressor exists in China. The danger exists that existing CFC-12 compressor manufacturers would undercut NRGW's production in an effort to retain their market share. MMI control production at other factories

The following are measures that will be adopted to ensure that new non-CFC products become established in the marketplace as a sufficient rate for the phaseout goals to be achieved. These have been proposed by MMI and GMRI to the responsible ministries.

i) Tax Policy

The selling price on non-ODS products will be slightly higher than current CFC-12 based production. From 1998 differential tax rates will be applied to each to ensure that non-CFC based products become established in the market.

The State Environmental Protection Agency (NEPA), State Economy and Trade

Commission, the Ministry of Finance and the Dept. of General Tax Administration will be responsible for drafting these tax measures with input from MMI and MIT.

ii) Import and Export Controls

From 2001 the same bodies listed above in conjunction with the General Customs Administration will institute import and export policies to prevent the import of CFC based equipment.

iii) Production Licenses

From mid-1998 production licenses will be issued by MMI to control the total supply of compressors to the market. This measure will be used in conjunction with (i) above to ensure that HCFC-22 based equipment becomes established in the Chinese market.

The aim of these measures will be to cease production of all CFC based refrigeration equipment by January 1st., 2004.

RESULTS

Direct Project Impacts

This project will remove 150 tonnes of CFC-12 in 1994 or the first year of full operation. The amount of CFC-12 will increase to 255 tonnes annually over subsequent years as the servicing needs of machines equipped with HCFC-22 compressors are re-charged with HCFC-22 instead of CFC-12.

Because the servicing needs of equipment occur every year there is a large cumulative saving off CFC-12 that would have been used for service and maintenance during the course of the project life.

Indirect Project Impact

This project concerns the direct replacement of NRGW's CFC-12 compressor production. Since production is not being increased above that planned for CFC-12 compressor production, no other plants will need to close or stop production.

When this technology has been established at NRGW, it is intended to replicate it to 8 other similar enterprises as detailed in the China CP. Small semi-hermetic HCFC-22 compressor technology will thus be spread to all companies supplying these compressors in China. Funding will be requested for these enterprises in due course.

ENTERPRISE COMMITMENT

Once MP funding is available, NRGW will carry out the activities relating to the production of HCFC-22 compressors as described in this document and assume responsibility for project implementation.

ANNEX 1

Breakdown of Investment Costs and Equipment Justification

1.	New Equipment Costs			
	a)	4 Machines for Crankcase machining (including tools)		$1,619,000 US
	b)	2 Machine for Compressor Components		$309,000 US
	c)	Test Equipment:		
		i)	Coordinate Measuring Equipment	$200,500 US
		ii)	Pressure Test Equipment	$8,000 US
		iii)	Compressor Performance Test Equipment	$37,000 US
2.	Modification of Existing Equipment			$258,000 US
3.	Transport and Insurance			$53,500 US
4.	Training			$78,000 US
5.	Trial Production			$117,500 US
6.	Technology Transfer			$519,000 US
7.	Scrap Value of Existing Equipment			($11,000) US
8.	Contingencies (10%)			$318,500 US
			Total	**$3,507,000 US**

List of Equipment Selected

A. Crankcase Production Line

i) Horizontal Machining Centre (3)

ii) Bush Pressing Machine (1)

B. Compressor Component Production Line

i) CNC Lathe (1)

ii) High Precision Surface Grinder (1)

C. Test Equipment

i) Three Coordinate Measuring Device. (1)

ii) High Pressure Pump (1)

iii) Pressure Testing Equipment

iv) Compressor Performance Testing Equipment

D. Modification of Existing Equipment

8 pieces of equipment will be modified.

Justification of Equipment Selection

The HCFC-22 refrigeration compressor that will be manufactured under license from a British company (Arctic Circle) is a reciprocating machine with the cylinders arranged vertically in-line. It has three basic designs of principal components (crankcase, crankshaft and cylinder head).

Planned production is the same as current production capacity of 12,000 compressors per year.

<u>Construction</u>

The design of the existing CFC-12 Chinese designed compressor is very different to the one that will be imported owing to the difference in design fashions between the two countries.

<u>Machining Precision</u>

The tolerance requirements for the existing CFC-12 compressor are ISO H7-H8. The requirements of the new compressor design are more stringent, ISO H5-H6.

<u>Pressure Tightness</u>

Because HCFC-22 has a higher saturated pressure than CFC-12, the pressures encountered in the compressor are higher and test pressure are correspondingly higher, 3.0 MPa for the existing CFC-12 compressor, and 4.0 MPa for the new compressor.

<u>Production</u>

At present NRGW has two CFC-12 production lines, one for crankshafts and one for terminal cover, end plate, cylinder head and end plate.

The production line for the crankcase comprises 17 different dedicated machines with a production frequency of one case every 30 minutes.

The component production line consists of 12 universal machines, including 1 lathe, 2 milling machines, 6 drilling machines and 3 grinding machines of various types.

Production is 12,000 units per year.

A. <u>Crankcase Production</u>

The majority of the 17 dedicated machines will be scrapped. Some will be modified for the new compressor production.

Because the machining tolerances are greater than can be achieved by the existing dedicated machines, CNC machining centres will be acquired (see recommendations by Arctic Circle in Annex 3).

Since manufacture of dedicated machines would take longer than the 3 year project implementation period. CNC machines are deemed the best solution.

The 7 dedicated machines in crankcase production are used for machining the base, cylinder bores, and the four crankcase faces. These will be replaced by a horizontal machining centre.

The bearing for the new compressor is made from phosphor bronze. A special machine is required to press this into the bearing housing.

The double boring and vertical boring machines that carry out the third set of crankcase machining processes will be replaced by a horizontal machining entre. This equipment can machine to the tolerances required.

The four dedicated machines used between the second and third and third and fourth sets of operations are the vertical diamond boring machine, the horizontal machining centre, the vertical boring machine and the vertical milling machine. These machines will be replaced by a horizontal machining centre. This will be used for rough and final machining of the cylinder bores, the valve reed housing, suction and discharge ports and the motor opening.

The two horizontal drilling and tapping machines used in the fourth series of operations will be modified and used in the new compressor production to make cylinder head bolt holes and holes for connection of the terminal cover.

Additional equipment required to process the HCFC-22 compressor crankshaft includes three CNC machining centres and a special bush pressing machine.

Counting the 3 pieces of existing equipment that will be modified, the new production line will comprise 7 pieces of equipment.

Component Production

Components such as the terminal cover, cylinder head, and the valve plate are made on universal machines which can be adapted easily to make different designs.

Thus the existing equipment will continue to be used.

Pressure Testing Devices

Test pressures for HCFC-22 equipment is higher than for CFC-12 equipment. Thus the following is required:

High Pressure pump	\$5,000 US
Pressure Testing Devices	\$3,000 US

<u>Performance Testing Equipment</u>

Some elements of the existing performance testing equipment will be hanged owing to the higher pressures generated by HCFC-22.

i)	Refrigeration components such as expansion valves, suction and discharge valves, solenoid valve etc.	\$ 8,620 US
ii)	Pressure Measuring Devices	\$ 9,839 US
iii)	Heat Exchanger Components	\$18,390 US

ANNEX 2

Calculation of Unit Abatement Cost

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

Where:

C	=	\$3,507,000
C (F)	=	\$570,000 (annualized over 10 years at 10%)
OC	=	\$0
OS/R	=	\$0
0DP	=	242 kg ODP

UAC = \$2.36/kg ODP/yr

ANNEX 3

Implementation Schedule

Action	Year 1	Year 2	Year 3
1. Importing Technology			
Investigation and Study	X		
Contract Signing	X		
Translation of Documents	X XX	XXX	
Foreign Expert Assistance	X	X	
Machines & Equipment			
Ordering	X		
Modification of Existing Equipment	X	XXX	
Installation	X	XXX	
Trial running		XX	X
Production			
Prototype production		XXXX	
Prototype testing		XX	
Prototype appraisal		X	
Trial running of prototype line		X	XXX
Domestic Training		X	XX
Project Appraisal			X

ANNEX 4

Environmental Assessment

The new production process resembles the old one to a large degree. No greater air and water contamination than that caused at the moment is to be expected and therefore new water and air treatment equipment is unlikely to be required.

A full environmental assessment will be carried out during project implementation.

ANNEX 5

Safety

HCFC-22 has the same exposure limit as the CFC-12 currently used in production (1,000 ppm). No more hazardous materials are used in the new production than before.

Some new equipment is being introduced. A comprehensive training programme will reduce risks to the operators to a minimum.

Country of origin: CHINA

Project title: The Conversion of Small Semi-hermetic CFC-12 Refrigeration Compressor Production to HCFC-22 Production at the Nanjing Refrigerator General Works (NRGW).

Sector/sub-sector Commercial and Industrial Refrigeration and Air Conditioning

Relationship to country program (World Bank)

Technology

In the refrigeration and air conditioning industry HCFC-22 is a well known, proven and acceptable (but transitional) technology to reduce CFC consumption. In principle the technology is not very different from CFC-12 technology. The main reason for the relatively high project costs is the fact that at present a dated, Chinese design compressor is produced which is to be replaced by a design of Arctic Circle Ltd. (UK) which is fundamentally different and needs much higher accuracy equipment. This means that not only conversion is taking place but at the same time modernization which is the reason for claiming 80 % of the project costs for funding. Justification of this 80 % is based on financial calculations, demonstrating that the remaining 20 % to be funded by the company themselves (via bank loans) is really a maximum and which is, from economic point of view, already hardly defensible.

A technology transfer agreement has to be signed with Arctic Circle Ltd. (A statement of intent is present). Due to this, future, agreement and the experience of the company a successful implementation of the project can be expected.

The selection of HCFC-22 technology is supported. The motivation for this support is given in the attached note "Justification for the selection of HCFC-22 technology".

Environmental impact

HCFC-22 has an ODP of 0.05 and is an acceptable, though transitional, refrigerant to reduce ODS.

Project costs

- The equipment requested is essential for the conversion process.
- The list of costs for machining equipment is accurate, reasonable and well motivated.
- From the pressure test equipment (USD 42193) only two components (to the sum of USD 8000) are specified.
- Adjustments of the present performance testing device are expensive.
- The technology transfer fee (USD 519000) is rather high.
- No operational costs are being claimed.
- The UAC value obtained is reasonable compared to other, similar, projects.

Implementation timeframe

The proposed implementation time frame is reasonable.

Relevance and adequacy of information provided

Information provided consisted of project proposals, detailed appendices directly sent from the companies, comments by World Bank officer and consultant and a Strategy Document. Altogether sufficient information for a review has been present.

Recommendations

Approval provided a better motivation of cost items mentioned above is included

Martien Janssen, OORG MM338
Eindhoven,
The Netherlands
20-October-1994

Note

on the justification for the selection of HCFC-22 technology in the commercial refrigeration projects of Shanghai, Beijing, Anhui, Nanjing, and Taizhou, China

The justification for the selection of HCFC-22 technology is briefly described in the five project proposals. A more thorough justification is presented in a "Strategy study on the gradual phaseout of CFC substances in Industrial and Commercial Refrigeration Industry, China" which contains essential information for the projects. Furthermore, additional information is supplied by the World Bank responsible officers and consultants involved. From this information the following is concluded:

1. In this stage HCFC-22 is absolutely essential for the rapid CFC phase out in domestic and industrial refrigeration in China, which is a very important sector regarding its CFC use. Other technologies (e.g. HFC-134a) would lead to a serious delay and increase costs in the market place. This is inline with the China Country Program.

2. The cost effectiveness of a factory conversion to HCFC-22 by transferring developed countries technology, which requests a considerable modernization, can be questioned. However, it has been demonstrated that any alternative procedure (e.g. implementing new HFC-134a technology, adjusting current technology to new refrigerants) would, if possible at all, be less cost effective already from a company point of view. From a country point of view the cost effectiveness would be even worse because these technologies would certainly increase costs in the market place (e.g. service, material costs).

The selection of HCFC-22 technology is supported for these five projects.

Martien Janssen, OORG MM338
Eindhoven,
The Netherlands
20-October-1994

PROJECT COVER SHEET

COUNTRY:	Peoples' Republic of China
PROJECT TITLE:	The Conversion of Medium sized Semi-hermetic CFC-12 Air Conditioning Compressor Production to HCFC-22 Production
SECTOR COVERED:	Commercial and Industrial Refrigeration and Air Conditioning
ODS USE IN SECTOR:	11,900 tonnes CFC-12 in 1993 (11,900 tonnes ODP)
PROJECT IMPACT:	Phase out 245 tonnes CFC-12 (233 tonnes ODP)
PROJECT DURATION:	3 Years
PROJECT ECONOMIC LIFE:	10 Years
TOTAL PROJECT COST:	Investment Cost $3,760,500 US Incremental Operating Cost $ 0 US Total Project Cost $3,760,500 US
PROPOSED FUND FINANCING:	$3,008,000 US $ 90,000 US (financial agent fee) **$3,098,000 US**
IMPLEMENTING ENTERPRISE:	Beijing Refrigerating Machinery Factory
COORDINATING MINISTRY:	National Environmental Protection Agency Ministry of Machinery Industry (MMI)
IMPLEMENTING AGENCY:	The World Bank
TECHNICAL SUPPORT:	General Machinery Research Institute (GMRI), Hefei
UNIT ABATEMENT COST:	$2.63/kg ODP/year

Technical Assessment: OORG reviewer Mr. Martien Janssen recommends approval of the project (attached).

PROJECT SUMMARY:

This project will phaseout CFC-12 consumption in the production of medium sized semi-hermetic compressors at Beijing Refrigerating Machinery Factory by converting the production to HCFC-22 compressors. The enterprise will introduce advanced medium semi-hermetic compressor technology from abroad. After that the enterprise will convert its semi-hermetic compressor production line to the production of HCFC-22 compressors. Since the amount of CFC-12 used in the initial charge of these systems totals about 145 tonnes, a further 100 tonnes leakage loss will be saved giving a total annual reduction in CFC-12 use of 245 tonnes per year when the plant is at full capacity.

This project employs commercially available and mature technology in one of the country's largest CFC use sectors. Previous country study investigations have identified this as a high priority project. The China Country Program (CP) approved by the China State Council and accepted by the MPEC, has listed this as a priority project for implementation in 1993.

PROJECT OBJECTIVES

The objectives of this project are to:

i) introduce HCFC-22 based medium sized semi-hermetic compressor technology

(ii) convert the enterprise's medium sized semi-hermetic compressor production to HCFC-22 based units.

(iii) develop a strong technical base to improve product quality and servicing techniques. This will lead to a reduction of CFC loss through leaks in equipment in the field.

iv) make available the experience gained in implementing this project to other enterprises and assist them in converting their manufacturing facilities to HCFC-22 based compressors.

SECTOR BACKGROUND

China's commercial, industrial refrigeration and air conditioning industries consumed about 11,900 tonnes of CFC-12 in 1993. It is estimated that 60-85% of this consumption (7,140 to 10,100 tonnes) was used in servicing existing equipment. This amount will continue to grow unless equipment based on CFC alternatives is introduced. In 1995 CFC-12 consumption is expected to reach 13,000 tonnes for commercial, industrial refrigeration and air conditioning applications.

ENTERPRISE BACKGROUND

BRMF is situated in an eastern suburb of Beijing. It is a key state-owned enterprise and a principal manufacturer of packaged air conditioners in China. It is the largest manufacturer of the "70" series compressors in China. BRMF has 40 years of experience in the refrigeration and air conditioning field. The total factory area is 145,000 m2 with 79,000 m2 of buildings. The staff number is 1,630 of whom 170 are engineers and technicians and 38 are senior engineers. The fixed asset value are 41,540,0000 Yuan.

One hundred forty-five tonnes of CFC-12 is used directly in charging equipment produced by BRMF. Production capacity is 15,000 units per year on 6 production lines. Actual production is 5,000 sets, all of which is used on air conditioners and water chillers produced in the factory. BRMF's market share of the packaged air conditioner market is about 16%. About 75% of air conditioners over 45 kW capacity sold in China are produced in this factory. The CFC-12 semi-hermetic compressors currently produced were developed entirely by BRMF. Production is almost entirely destined for the domestic market.

PROJECT DESCRIPTION

For this project BRMF will introduce mature medium semi-hermetic HCFC-22 compressor from abroad and convert its production line. Semi-hermetic compressors of 22-140 kW capacity are widely used in China and most use CFC-12. Demand in 1992 reached 10,000 sets. These were manufactured in 10 factories.

BRMF has concluded an agreement in principle with Arctic Circle Ltd. of the U.K. This company produces a well established design of semi-hermetic compressor which can be used for air conditioning duties and which matches the enterprise's current production well. This project considers only the replacement of existing production of compressors using CFC-12 with those using HCFC-22.

There is an inevitable degree of modernization to BRMF's product and production facilities by virtue of the fact that dated existing technology is being replaced by modern designs. However this is more than compensated by the significant portion of project costs that are being borne by BRMF (752,000 US $ or 20% of total project costs).

JUSTIFICATION OF ALTERNATIVE TECHNOLOGY SELECTION

There are three potential alternatives technologies for this project - HCFC-22, HFC-134a, and Ammonia. HCFC-22 was selected as the preferred alternative technology for this project for the following reasons:

i) It is cost effective - HFC134a and its associated polyolester lubricant are not currently available in China in commercial quantities and when and if they become available are likely to cost 2-3 times that for equivalent quantities of HCFC22. Also, 15wt.% less HCFC22 is required to accomplish the same refrigeration task as HFC134a because of its lower molecular weight.

ii) Technology is readily available - Foreign suppliers are reluctant to transfer HFC134a technology while HCFC22 technology is readily and immediately available at a reasonable cost. China does not have indigenous technology for making HCFC22 compressors and therefore must purchase it from abroad.

iii) HFC134a technology requires sophisticated servicing procedures for the large scale facilities envisioned in this project. China does not have trained skilled manpower to service such compressors. It will take some time to implement a service sector training project to ensure adequate service and maintenance standards for HFC134a. Current servicing practices are adequate for HCFC22.

iv) The use of R-717 (Ammonia) would require considerable modification of the systems on which these compressors are used, and R-717 use would simply not be suitable for many of the applications for which HCFC22 is used because of its toxicity and flammability.

A number of zero-ODP HFC based refrigerant blends intended as direct drop-in replacements in HCFC-22 systems are currently being developed in the West. Provided service levels improve sufficiently and blends become available at a reasonable price in China, use of blends could provide a direct transition to zero-ODP refrigerants with no change required to the technology being proposed in this project.

According to the Montreal Protocol agreement, China will phase out CFC use by the end of 2010. The China CP, recently accepted by the Montreal Protocol Executive Committee (MPEC) gave HCFC-22 a key role in phasing out CFC-12 use in this sector.

It is therefore concluded that on balance, given the conditions in the PRC, HCFC-22 is the best choice for CFC-12 replacement in this sector. Successful implementation of this project will lead to the replication of this technology to other enterprises.

PROJECT COSTS AND GRANT REQUEST

Summary

The total project cost is $3,760,500 US of which $3,008,000 million is considered eligible for MP financing. The grant request of $3,098,000 includes both eligible project costs and financial administration costs. There are no net incremental recurrent costs or benefits associated with this project.

Capital Costs

The capital costs of US$ 3,760,500 include capital investment in technology transfer fees, production equipment, domestic training, and compressor performance test equipment, and production costs for trial production. 20% of capital costs will be locally financed to cover inevitable process modernization which results from replacement of dated equipment. A breakdown of costs is given in Annex 1. BRMF will use an existing building and some of the existing machinery will be re-used.

Incremental Recurrent Costs/Savings

These are based on planned production increases (all within present plant capacity) and projected price increases for CFC-12. The net increase/decrease in unit production costs are zero. See Annex 2 for details.

Benefits

No net incremental benefits are expected.

Local Ownership Fraction

BRMF is a 100% state-owned Chinese enterprise

Contingencies and Other Costs

A 15% contingency was included in all capital cost estimates. A 3% financial agent fee is included with the grant request.

Unit Abatement Cost

2.63 $US/kg ODP/year. A detailed calculation is given in Annex 6.

PROJECT IMPLEMENTATION

Management

BRMF is responsible for the execution of this project. NEPA and MMI will supervise the execution of the project. The General Machinery Research Institute will provide technical support.

Schedule

Providing funding is available from the OTF, the project will be completed in three years as detailed in the Annex 3.

REQUIRED REGULATORY ACTIONS

The following will be undertaken to ensure the success of this project.

i) Voluntary agreements from the Enterprise with MMI to phaseout CFC 12 production

ii) Supervision and Coordination of the project by NEPA

iii) MMI will control ODS compressor production through production licenses. Considerable excess production capacity exists for this category of compressor in China. This measure is necessary to avoid undercutting of new HCFC-22 compressor by companies still producing CFC-12 compressors.

The following are measures that will be adopted to ensure that new non-CFC products become established in the marketplace at a sufficient rate for the phaseout goals to be achieved. These have been proposed by MMI and GMRI to the responsible ministries.

i) Tax Policy

The selling price of non-ODS products will be slightly higher than current CFC-12 based production. From 1998 differential tax rates will be applied to each to ensure that non-CFC based products become established in the market.

The State Environmental Protection Agency (NEPA), State Economy and Trade Commission, the Ministry of Finance and the Dept. of General Tax Administration will be responsible for drafting this tax measures with input from MMI and MIT.

ii) Import and Export Controls

From 2001 the same bodies listed above in conjunction with the General Customs Administration will institute import and export policies to prevent the import of CFC based equipment.

iii) Production Licenses

From mid-1998 production licenses will be issued by MMI to control the total supply of compressors to the market. This measure will be used in conjunction with (i) above to ensure that HCFC-22 based equipment becomes established in the Chinese market.

The aim of these measures will be to cease production of all CFC based refrigeration equipment by January 1, 2004.

RESULTS

Direct Project Impacts

This project will remove 245 tonnes annually of CFC-12 after full production is reached. The savings generated in the service sector are cumulative, since the amount lost annually through leaks from a given piece of equipment is repeated throughout the life of the equipment.

Indirect Project Impact

This project concerns the direct replacement of BRMF's CFC-12 compressor production. Since production is not being increased above that planned for CFC-12 compressor production, no other plants will need to reduce their production or close.

When this technology has been established at BRMF, it is intended to replicate it to other similar enterprises as detailed in the accompanying strategy document and the China CP. HCFC-22 semi-hermetic medium compressor technology will thus be spread to all companies supplying these compressors in China. Funding will be requested for these enterprises in due course.

ENTERPRISE COMMITMENT

Once MP funding is available, BRMF will carry out the activities relating to the production of HCFC-22 compressors as described in this document and assume responsibility for project implementation.

For Beijing Refrigerating Machinery Factory

Director: Xu Zhaodong
Date: September 1994

ANNEX 1

Investment Costs and Equipment Justification

A. Machining and assembly equipment

A1	4 sets of Machines for crankcase	1,467.000 US$
A2	2 sets of Machines for crankshaft	74,900 US$
A3	6 sets of Machines for valve plate	270,300 US$
A4	6 sets of Machines for connecting rod	204,000 US$
A5	Toolings, moulds, and fixtures	224,000 US$
A6	Compressor assembly line	72,700 US$

B. Test equipment

B1	Pressure testing device	55,500 US$
B2	Performance checking device	85,500 US$

Sub total	2,453,900 US$
C. Transportation, insurance and installation of equipment	165,100 US$
D. Trial production	201,000 US$
E. Domestic training	15,000 US$
F. Technology transfer fee	450,000 US$
G. Scrap value of existing machines which cannot be used	(15,000 US$)
Sub total	3,270,000 US$
H. Contingencies	490,500 US$
Total	**3,760,500 US$**

Principles Governing Equipment Selection

The objective of the project is to introduce medium semi-hermetic HCFC-22 compressor technology in China. This will be carried out by modifying the existing production facilities at BRMF.

The extent of modification is based the existing production facilities. The technology supplier's stipulations on what machine tools and equipment is required are taken into account. They state that critical machining must be carried out to a high degree of precision in order for them to guarantee the performance of their compressor designs.

In order to minimize investment existing equipment is retained and existing buildings are used.

a) Equipment which can be re-used after modification will be retained.

b) Equipment which can be used but will not meet the required tolerances will be used for rough machining.

c) Equipment that cannot be re-used, either because of its application or for safety reasons (mostly dedicated machine tools) will be sold as scrap. The motors and hydraulic tables of the machine tools will be made use of if they can be used for making new machines.

d) New machines and equipment will added only for safety reasons, or to achieve the accuracy required by the new compressor designs as stipulated by the technology supplier.

e) Ordinarily the factory works one shift. Some new equipment will be worked for 2 shifts in order to reduce investment.

Justification of Investment Costs

A.1 Additional Machines for Crankcase

Currently machining of the compressor crankcase is carried out by 16 machine tools, of which 12 are dedicated machine tools. The general purpose tools include a horizontal boring machine, vertical lathe and arm driller. Fine machining of the main bearing housing is carried out by a general purpose machine tool. Rough machining of the main bearing housing, and rough machining and boring of the cylinder bores and machining of the cylinder block face are carried out by dedicated machine tools.

Because of the significant changes in the design of the new compressor models, most machine tools cannot be used in the new production. However 4 dedicated milling machines can be retained for rough machining of the crankcase base and cylinder bores. General purpose machine tools can also be retained for rough machining of the main bearing housing.

The remaining 8 dedicated machine tools which cannot be re-used will be sold as scrap. New equipment required is listed below:

Machine	Model	Suppliers	No	Price US	Application
Horizontal Machining Centre	MAXAM 630	Cincinnati Milacron (USA)	2	1,240,000	Cylinder and main bearing bore fine machining
Coordinate Measuring System	XCEL 7 107	Brown & Shape (USA)	1	200,000	Checking Final Dimensions
Vertical Honing Machine	MBA4 1252	Dahe Machine Tool Factory	1	27,000	Cylinder bore
		Total	**4 sets**	**1,467,000**	

Crankcase Machining:

Five designs of compressor crankcase are currently made by BRMF. Annually from 500 to 2,000 of five different designs of crankcase will be required for the new compressors. The structure of the crankcase is complicated and most operations require machining to a higher degree of accuracy than was required with the old designs.

Reasons for Purchasing 2 Horizontal Machining Centres and Accessories:

i) The level of precision required for the main bearing housing and cylinder bore is ISO H6, whereas these operations required less than H7 for the old compressors.

Arctic Circle could not give a performance guarantee for their design unless

ii) The required production capacity is 5,000 compressors per year. Bearing in mind that some models have two crankcases and some wastage, an annual crankcase production capacity of 8,500 is required. Machining the main bearing housing bore and faces takes 19 minutes per crankcase. Finishing the cylinder bores and other bores takes 24 minutes. Thus the total time required per year is 2692 and 3400 hours respectively. However only 1920 hours are available for each machining centre per year on one shift.

Two horizontal machining centres will be purchased and operated for two shifts.

Reasons for purchasing Coordinate Measuring System:

Dimensions have to be checked to ensure the new tolerances are being achieved

Reasons for Purchasing Vertical Honing Machine:

The current design of compressors uses cylinder liners, whereas the new design does not. Thus, a honing machine has to be purchased.

Note that as the old compressor production is gradually phased out, 12 of the old special machine tools will be retained for rough machining.

A2 Additional Machines for Crankshaft

The process flow chart for crankshaft machining is shown in Annex 2-2. New equipment required is listed in the Table below:

Machine	Model	Suppliers	No	Price US	Application
Cylindrical Grinding Machine	MB1 332A	Shanghai Machine Tool Factory	1	34,050	Main Bearing Pin
Crankshaft Grinding Machine	MQ1 350A	Shanghai Machine Tool Factory	1	40,850	Crank Pin
		Total	**2**	**74,900**	

Justification:

i) The precision level required is H6 for the crank pin and main bearing pin on the new designs

ii) The design of the crankshaft is different on the new compressor.

The existing machinery is not suitable for finishing but will be used for rough grinding.

A3 Additional Machines for Valve Plate

The process flow chart for valve plate machining is shown in Annex 2-3.

Additional machines are listed in the table below.

The CFC-12 compressor valve plate is circular and can thus be machined on a lathe. The surfaces are finished with a grinding machine. Valve orifices are machined by dedicated machine tools.

The new valve plate is rectangular and therefore a milling machine will be required for finishing. The valve plate is also larger on the new design where one valve plate is shared by a number of cylinders unlike the present design where each cylinder has a separate plate. This renders machining more difficult.

Machine	Model	Suppliers	No	Price US$	Application
Square Bench Surface Grinding Machine	M7130 H	Hanzhou Machine Tool Factory	2	32,700	semi-fine grinding
Square Bench Surface Grinding Machine	M7130 K	Hanzhou Machine Tool Factory	2	46,200	fine grinding
Round Table Milling Machines	X7016	Beijing First Machine Tool Factory	1	37,300	fine milling
Vertical Turret Machine	V-CNC	ATERA (Spain)	1	154,100	process valve seat and holes
		Total	**6**	**270,300**	

Justification:

i) The rectangular design of the new valve plate mean that it cannot be machined on a lathe and a milling machine is required. 15,000 valve plates will be required annually for production and spares, and each surface must be ground twice in order to achieve the flatness required. To meet this requirement, two of each type of square bench grinding machine are required.

ii) Ideally a CNC universal milling machine or a machining centre would be used for forming the holes in the valve plate, but such machines are very expensive. The vertical turret machine requested will achieve sufficient accuracy and production quantities.

iii) The orifices and sealing line of the sealing surface on the valve plate should be positioned to an accuracy specified by ISO IT8. If this is not achieved, discharge gas will leak to the suction side of the compressor and it will not perform to specification. Arctic Circle would not be able to provide a performance guarantee.

iv) Each valve plate has more than 20 holes excluding the cylinder head bolt holes. Some holes are oval and three or more machines would be required if general milling machines and jigs were employed. Maintaining the present production rate with this method would simply not be feasible and the labor cost would be much higher.

The original tools used for forming the valve plate cannot be re-used. They will be sold as scrap after modification of the production facilities.

A4 Additional Machines for Connecting Rod

Nineteen special machine tools are used to machine the present design of connecting rod. There are large design differences between the new and old connecting rods and the present equipment cannot be re-used. The differences are:

i) Material. The old rods are forged iron; the new one are of aluminum
ii) The old rod has a liner, the new one does not.
iii) Length and hole diameters are different.

Existing equipment must be replaced. 35,000 connecting rods will need to be produced annually. It is thought better to set up a production line of specially designed machines. This will comprise the following:

1 surface milling machine for rough machining
1 boring machine for rough machining
1 milling machine for fine machining
2 boring machines for fine machining
1 chamfering machine

A total of six (6) machines will be needed. These will be designed and manufactured by sub-contractors. The total cost will be $204,000 US ($32,700 for design and $171,300 for manufacturing), excluding the cost of motors and hydraulic sliding table which will be re-used from existing production after modification.

The original 19 special machines will be sold as scrap. Motors and sliding tables will be re-used after modification as described above.

A5 Additional Toolings, Moulds and Fixtures

These have to be re-designed to meet the new production requirements. Additional toolings, moulds and fixtures are given below

Machine	No	Design Cost US	Manufacturing Cost Total Cost US	
Tooling for Machining Centres	50		104,000 (purchase)	104,000
Other Special Toolings	50		73,500 (purchase)	73,500
Aluminum Moulds for Casting	15	5,500	41,000	46,500
			Total Cost	224,000

Explanation:

i) Tooling is an integral part of a machine tool but have to be purchased separately, usually from other suppliers.

ii) Changing the product means that all moulds and tooling have to be changed. They have to be custom made for the product in question.

A6 Assembly Line Selection

The assembly line will have to be modified because of the changes in the compressor design. Capacity of the modified design will not exceed the current capacity of 5,000 units per year.

The new assembly line will make use of the original transporter, but the jigs, fixtures and special toolings will have to be changed. The line will have to be re-arranged to cater for the new sequence of assembly of the new compressor.

The cost of assembly line modification is $72,700 US which includes a design cost of $18,000 and a manufacturing cost of $54,700. The transfer lines are not included. The existing ones will be re-used after modification.

B1 Pressure Testing Device

Item	Supplier	No.	Design Cost US	Manufact. Cost US	Total Cost US
Air Compressor 4 MPa 0.6 m3/min	Beijing First General Machinery Factory	2	purchased	29,000	29,000
Air Vessel & Accessories. 4 MPa	Beijing First General Machinery Factory	2	purchased	5,000	5,000
High Pressure Hydraulic Pump 6 Mpa	Zhejiang Hydraulic Pump Factory	2	purchased	5,000	5,000
Piping and Instrumentation		1	5,500	11,000	16,500
			Total	**50,000**	**55,500**

Explanation:

The test pressure for HCFC-22 compressors is 3.8 MPa for the hydraulic test and 2.8 MPa for the tightness test. These pressures are considerably higher than those for testing CFC-12 compressors. The existing pressure test equipment cannot be used at these pressures for reasons of safety.

The new pressure test system will be custom designed to suit the new production.

The old equipment will be sold as scrap.

B2 Performance Testing Device

Item	No	Design Cost US	Manufcat. Cost US	Total Cost US
Pressure Vessels Incl. oil separator, condenser, receiver, regulating vessel and chilling vessel	5	7,500	38,500	46,000
Metering Device	2	1,000	4,000	5,000
Water supply and recovery system	1	1,000	7,000	8,000
Pressure measuring instruments			1,000 (purchased	1,000
Pipework, valves and insulation		8,000	12,500	20,500
System Calibration			5,000	5,000
Total		**17,500**	**68,500**	**85,500**

Justification of Equipment Purchase:

The China National Standard GB10874-89 stipulates that a certain number of compressors have to undergo a performance test each year. According to the Chinese performance test standard (GB5773-89), two methods of performance testing must be carried out:

i) Measuring refrigerant flow rate and enthalpy change; and
ii) System heat balance.

The existing performance test equipment cannot be used because:

i) Pressure vessels on the old CFC-12 compressor testing system were rated to only 1.6 MPa. Working pressures on HCFC-22 systems are higher. The Chinese pressure vessel regulations (GB150-89 and GB151-89) require pressure vessels on HCFC-22 systems to be rated to 2.8 MPa. Thus the old vessels cannot be re-used for safety reasons.

ii) The flow rates in comparable HCFC-22 and CFC-12 systems are different. Therefore a customized orifice plate flow meter must be supplied for the new equipment.

iii) Because of the different saturated pressure/temperature characteristics of HCFC-22 compared to CFC-12, pressures have to be measured over a different range. Thus new pressure gauges are required.

The test temperatures are the same, however. The old temperature measuring equipment will be retained to minimize costs.

The performance test equipment will be calibrated by the Hefei General Machinery Research Institute.

The original equipment will be sold as scrap. Heat exchanger copper tubing will be sold separately to obtain a better price.

C. Transportation, Insurance and Installation

Prices given are FOB in the case of imported equipment and ex-factory for domestic equipment. The cost of insurance and freight is based on 6% of the total cost of imported machinery ($110,000 US), and 4% of the total cost of domestic equipment ($7,500 US).

Installation costs are based on two foreign experts and 4 Chinese technicians working for 1 month ($47,600 US). Transport and Insurance costs for custom designed equipment is included in the price.

Total costs for Freight, Insurance and Installation are $165,100 US.

D Trial Production

D1 Production Line Trial Run

D.1 Manpower

Modification and replacement of fixtures for original equipment

40 sets	1 day for two workers per set
sub-total	80 man-day

Commissioning of new general purpose machine tools

10 sets	2 days for two workers per set
sub-total	40 man-day

Commissioning of new special equipment (together with technical people from sub-contractors)

8 sets	6 days for four workers per set
sub-total	192 man-day

Commissioning of assembly line

	our workers 18 days
sub-total	72 man-day

So the total man-day is 384, ie., 8 people for 2 months (24 working days per month).

Cost: 800 US$/per man-month x 8 x 2 = 12, 800 US$

D1.2 Main raw Material

Casting for crankcase:

11 models x 5 pieces/model = 55 pieces
400 Kg/piece x 55 pieces = 22,000 Kg - 22T

The price of casting iron is 3400 Yuan per Ton
3400 x 22 = 74,800 Yuan

Casting for connecting rod:

100 pieces, 30 yuan per piece = 3,000 Yuan

Casting for valve plate:

100 pieces, 30 Yuan per piece = 3,000 Yuan = 3,000 Yuan

Total = 80,800 Yuan - $9,330 US

Assuming the power and accessories is 20% of the total cost, then the cost of production line trial run will be:

Total = 12,800+9330+1866=23,996 US$ -- **$24,000 US Approx.**

D2 Documentation

Documentation translation: 5 people work for 2 months.

Note: This will be done by an external translation agency.

US$ 2,000 per person per month

US$ 2,000 x 5 x 2 =	$ 20,000 US
plus other expenses	$ 5,000 US
Total	$ 25,000 US.

D3 Prototype Manufacturing

11 models, 2 sets for each model, total 22 sets
The unit cost of the prototype is usually 4 to 5 times of the unit cost at normal production. Assume 400%.

Unit cost = 4 x 8000 = 32,000 Yuan/set

Cost of prototype = 22 x 32,000 = 704,000 Yuan = $81,200 US

D4 Prototype testing

The prototype testing includes 500 hours of prototype testing as prescribed in the relevant Chinese Standard. Thus will be carried out at Hefei General Machinery Research Institute. The cost for each set is between 50,000 and 55,000 Yuan. Assume 52,000 Yuan per set.

The total cost for testing will be 52,000 x 11 = 572,000 Yuan. Assuming transportation and insurance is 4% of the total prototype cost (11 sets), makes 14,080 Yuan.

Total: 572,000+14,080 = 586,080 Yuan = $67,600 US

D5 Appraisal

7 Domestic experts required for 3 days.

Cost:	Subsidy	200 Yuan/man-day
	Accommodation	200 Yuan/man-day
	Food	100 Yuan/man-day
	Transportation	50 Yuan/man-day
	Sub-total	550 Yuan/man-day
		= 63.5 US$/man-day
	Total expert costs 63.5 x 7x3	= 1,334 US$
	Cost of organizing meetings	2,000 US$
	Total product appraisal cost	1,334 + 2,000 = 3,334 US$

Assume 3, 330 US$

D6 Total Trial Production Costs:

24,000 + 25,000 + 81,200 + 67,600 + 3, 300 = 201, 000 US$

E. Domestic Training Program

The project implementation will make high demands on personnel in production, technology and administration. BRMF will organize a unified program of training.

50 workers will be trained for one month each at a cost of $300 US each.

50 workers X $300 = $15,000 US

The training program is broken down below:

Item	**No Persons**	**Month**	**Man months**
CNC Machine Operator	8	1	8
CNC Machine Maintenance	4	2	8
CNC Machine Programming	2	2	4
Assembly of new compressor	24	1/2	12
After sales service	10	1	10
Management Training	16	1/2	8
		Total	**50**

Explanation:

<u>CNC Machine Operator</u>

Three CNC machines are being purchased and each requires two trained operators Because BRMF does not currently have any CNC operators, thus 6 skilled machinists will be sent for training to a Chinese factory where similar equipment is in use, along with 2 further operators of the coordinate measuring system.

Training will last one month

CNC Machine Maintenance

Two maintenance engineers and two electricians will be sent on a domestic short course at a local technical institute offering an appropriate course on CNC machine maintenance.

Training will last two months

CNC Machine Programming

Two engineers will be sent on a domestic short course at a local technical institute.

Training will last two months.

Assembly of New Compressor

24 workers are required on the new assembly line. Training will be given in the factory by senior factory engineers on the technique of assembling the new compressor designs.

Training will last two weeks

After Sales Service

10 service mechanics will receive training in the factory on:

i) Servicing the new compressors
ii) Servicing HCFC-22 based systems.

Training will be provided by senior factory engineers and lecturers from the local technical institute.

Training will last one month.

Management Training

16 managers responsible for production, planning, purchasing, quality control, performance checking etc., will receive factory training occasioned by the new production methods. Trainers will be senior engineers and accountants from the factory.

Training will last 2 weeks

F. Technology Transfer Fee

300,000 Sterling - $450,000 US

G. Scrap value of original machines

The scrap value of original machines which can not be re-used is US$15,000 and which is deducted from the total investment.

G1 Basis of Equipment Request

1. General purpose machines tools will still be used for normal processing or for rough processing.

2. Dedicated machine tools which can be modified for new compressor production will be modified and re-used.

3. Machines and equipment which can not be modified and re-used will have to be sold as scrap.

4. Because this project will reach full production in three years and the original production lines will still be in operation during these years, the scrap value will be recovered at the beginning of the fourth year.

G2 Details of Equipment that Cannot Be Re-used

Item	Quantity	Book Value US$	Weight Tonnes	Quantity of Motors	Hydraulic Sliding Tables	Air Compre ssor
Crankcase machines	8	24,070	12	15	15	
Valve Plate Machines	4	10,500	2	6	4	
Connecting Rod Machines	19	48,000	9	12	12	
Pressure Testing Equipment	2	27,300	4	2		
Performance Test Device	1	43,400	6	2		
Toolings & Fixtures		42,000	2			
Total		**195,270**	**35**	**37**	**31**	**2**

G3 Scrap value

1. The price for scrap iron is US$ 90 per ton. 90 x 35 = 3, 150 US$ will be recovered from scrap iron. The weight of the copper tubers of the performance test device is about 2 tonnes. The scrap value of the copper tubes is about US$ 850.

2. Motors are three phase conductive type with the power from 1 to 5 kw. If the average price is US$ 80, 80 x 37 = 2,960 US$ will be recovered from motors.

3. The average price of the hydraulic sliding table is about US$ 150, 150 x 31 = 4650 US will be retrieved.

4. The two air compressors with designed pressure of 2.5 MPa will be sold at about US$ 1,700 each. 1,700 x 2 = US$ 3,400 will be retrieved.

So the total scrap value is 3150 + 850 + 2960 + 4650 + 3400 = 15,010 US$.

ANNEX 2

Operating Cost Comparison

Item		Before RMB-Yuan	After RMB-Yuan
Manpower and Wages	Total	176	163
	Workers	163	147
	Management	8	8
	Service	5	8
	Wages (1000Yuan/year)	2,247.6	2,122.1
	Wages (Yuan/unit)	518.5	424.5
Raw Material and Power	Motor (Yuan/unit)	1,300	1,392
	Valves etc (Yuan/unit)	516.4	552
	Casting (Yuan/unit) (3,400 Yuan/ton)	1,305.6	1,027.1
	Power and Others	Same	
Royalties (Yuan/Unit)		0	247
Operating Cost Per Unit (Yuan)		3,640.5	3,642.6

U$ 100 = ¥ 8.7 RMB

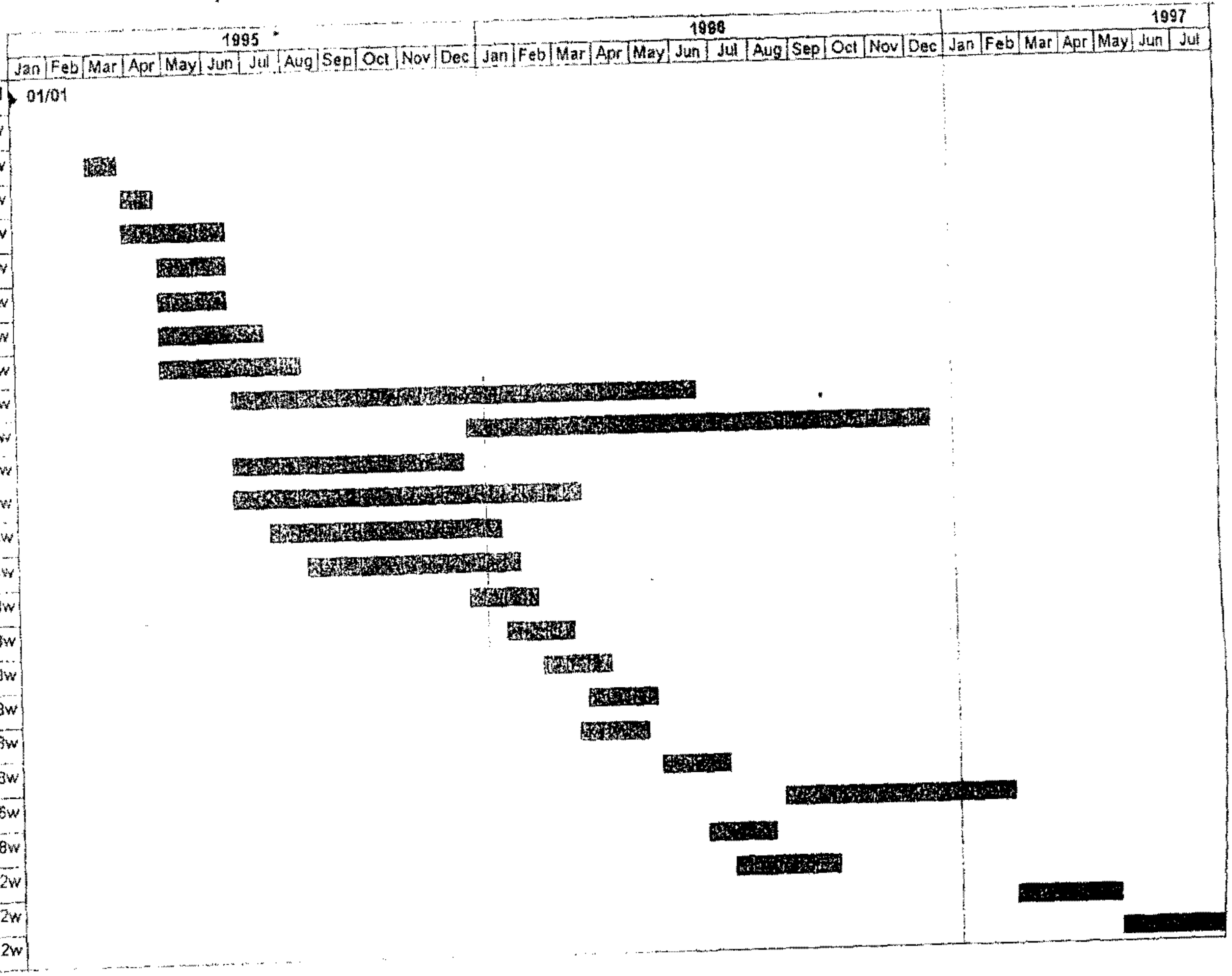
Oct 31, 1994

Annex 3

Project Implementing Schedule

table 7

ID	Task Name	Duration
1	Feasibility Study	0d
2	Study Tour Abroad	8w
3	Contract Signing	4w
4	Formulation of Implementation	4w
5	Arrival of Documentation	12w
6	Equipment Ordering (1)	8w
7	Equipment Ordering (2)	8w
8	Equipment Ordering (3)	12w
9	Fixture Design	16w
10	Translation of Documentation	52w
11	Prototype Manufacture	52w
12	Arrival of Equipment (1)	26w
13	Arrival of Equipment (2)	39w
14	Arrival of Equipment (3)	26w
15	Fixture Manufacture	24w
16	Installation of Equipment (1)	8w
17	Installation of Equipment (3)	8w
18	Trial Run (1)	8w
19	Installation of Equipment (2)	8w
20	Trial Run (3)	8w
21	Trial Run (2)	8w
22	Prototype Testing	26w
23	Training	8w
24	Trial Run of Production Line	12w
25	Prototype Appraisal	12w
26	Project Acceptance	12w



Beijing Factory
ods III p. 2?

ANNEX 4

Environmental Assessment

There is no obvious increase in environmental hazard with this project by comparison with current compressor production.

A formal environmental assessment will be carried out by the local National Environmental Protection Agency office during project implementation.

Beijing Refrigerating Machinery Factory
Deputy Director

Shen Wenyi

ANNEX 5

Safety

The new refrigerant (HCFC-22) used in production has the same exposure limit as CFC-12 currently used (1,000 ppm). No materials used in the new production process are significantly more hazardous than those currently used.

A number of new production tools are being introduced into the Factory. Comprehensive training in their use will reduce the risk to operators to a minimum.

Beijing Refrigerating Machinery Factory
Deputy Director

Shen Wenyi

ANNEX 6

Calculation of Unit Abatement Cost

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

Where:

C = $3,760,500
C(F) = $ 612,000 (10 year economic life)
OC = 0
OS/R = 0
0DP = 233,000 kg

UAC = US$2.63/kg ODP/year.

Country of origin:	CHINA
Project title:	The Conversion of Medium sized Semi-hermetic CFC-12 Air Conditioning Compressor Production to HCFC-22 Production at the Beijing Refrigerating Machinery Factory (BRMF).
Sector/sub-sector	Commercial and Industrial Refrigeration and Air Conditioning

Relationship to country program (World Bank)

Technology

In the refrigeration and air conditioning industry HCFC-22 is a well known, proven and acceptable (but transitional) technology to reduce CFC consumption. In principle the technology is not very different from CFC-12 technology. The main reason for the relatively high project costs is the fact that at present a dated, company designed compressor is produced which is to be replaced by a design of Arctic Circle Ltd. (UK) which is fundamentally different and needs much higher accuracy equipment. This means that not only conversion is taking place but at the same time modernization which is the reason for claiming 80 % of the project costs for funding. Justification of this 80 % is based on financial calculations, demonstrating that the remaining 20 % to be funded by the company themselves (via bank loans) is really a maximum and which is, from economic point of view, already hardly defensible.

A technology transfer agreement has to be signed with Arctic Circle Ltd. (A statement of intent is present). Due to this, future, agreement and the experience of the company a successful implementation of the project can be expected.

The selection of HCFC-22 technology is supported. The motivation for this support is given in the attached note "Justification for the selection of HCFC-22 technology".

Environmental impact

HCFC-22 has an ODP of 0.05 and is an acceptable, though transitional, refrigerant to reduce ODS.

Project costs

- The equipment requested is essential for the conversion process.
- The list of costs is accurate, reasonable and very well motivated.
- The technology transfer fee (USD 450000) is rather high.
- No operational costs are being claimed.
- The UAC value obtained is reasonable compared to other, similar, projects.

Implementation timeframe

The proposed implementation time frame is reasonable.

Relevance and adequacy of information provided

Information provided consisted of project proposals, detailed appendices directly sent from the companies, comments by World Bank officer and consultant and a Strategy Document. Altogether sufficient information for a review has been present.

Recommendations

Approval as proposed

Martien Janssen, OORG MM338
Eindhoven,
The Netherlands
20-October-1994

Note
on the justification for the selection of HCFC-22 technology
in the commercial refrigeration projects of
Shanghai, Beijing, Anhui, Nanjing, and Taizhou, China

The justification for the selection of HCFC-22 technology is briefly described in the five project proposals. A more thorough justification is presented in a "Strategy study on the gradual phaseout of CFC substances in Industrial and Commercial Refrigeration Industry, China" which contains essential information for the projects. Furthermore, additional information is supplied by the World Bank responsible officers and consultants involved. From this information the following is concluded:

1. In this stage HCFC-22 is absolutely essential for the rapid CFC phase out in domestic and industrial refrigeration in China, which is a very important sector regarding its CFC use. Other technologies (e.g. HFC-134a) would lead to a serious delay and increase costs in the market place. This is inline with the China Country Program.

2. The cost effectiveness of a factory conversion to HCFC-22 by transferring developed countries technology, which requests a considerable modernization, can be questioned. However, it has been demonstrated that any alternative procedure (e.g. implementing new HFC-134a technology, adjusting current technology to new refrigerants) would, if possible at all, be less cost effective already from a company point of view. From a country point of view the cost effectiveness would be even worse because these technologies would certainly increase costs in the market place (e.g. service, material costs).

The selection of HCFC-22 technology is supported for these five projects.

Martien Janssen, OORG MM338
Eindhoven,
The Netherlands
20-October-1994

PROJECT COVER SHEET

COUNTRY:	Peoples' Republic of China
PROJECT TITLE:	The Conversion of Small Semi-hermetic CFC-12 Refrigeration Compressor Production to HCFC-22 Production
SECTOR COVERED:	Commercial Refrigeration and Air Conditioning
ODS USE IN SECTOR:	11,900 tonnes CFC-12 in 1993 (11,900 tonnes ODP)
PROJECT IMPACT:	Phase out 300 tonnes CFC-12 annually (285 tonnes ODP)
PROJECT DURATION:	3 Years
PROJECT ECONOMIC LIFE:	10 Years
TOTAL PROJECT COST:	Investment Cost US$3,395,000 Incremental Operating Cost US$ 0 Total Project Cost US$3,395,000
PROPOSED FUND FINANCING: financial agent fee	US$2,716,000 81,500 **US$2,797,500**
IMPLEMENTING ENTERPRISE:	The Jiangsu Taizhou Commercial Machinery Factory (JTCMF)
COORDINATING MINISTRY:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY:	The World Bank
UNIT ABATEMENT COST:	US$1.94/kg ODP/year

Technical Assessment: OORG reviewer Mr. Martien Janssen recommends approval of this project (attached).

PROJECT SUMMARY:

This project will gradually phaseout 300 tonnes of CFC-12 by establishing productin capacity for 30,000 HCFC-22 small semi-hermetic compressors at JTCMF. This will be accomplished by converting JTCMF's 10,000 existing CFC-12 production capacity and by closing five additional CFC-12 compressor manufactures. Closing costs will be borne be China.

This project employs commercially available and mature technology in one of the country's largest CFC use sectors. Previous country study investigations have identified this as a high priority project. The China Country Program (CP) approved by the China State Council and accepted by the MPEC, has listed this as a priority project for implementation in 1993.

PROJECT OBJECTIVES

The objectives of this project are to:

i) introduce HCFC-22 based small semi-hermetic compressor technology; and

ii) convert and expand the enterprise's small semi-hermetic compressor production to HCFC-22 based units;

iii) close down production of CFC-12 compressors at five additional factories.

SECTOR BACKGROUND

JCTMF has been selected by the Ministry of Internal Trade as a demonstration plant for the dissemination of ODS technology in the manufacture of compresors in China. China's commercial, industrial and air conditioning industries consumed about 11,900 tonnes of CFC-12 in 1993. It is estimated that 60-85 percent of this consumption (7,140 to 10,100 tonnes) was used in servicing existing equipment. This amount will continue to grow unless equipment based on CFC alternatives is introduced. In 1996 CFC-12 consumption is expected to reach 17,000 tonnes for commercial, industrial and air conditioning applications.

ENTERPRISE BACKGROUND

100 tonnes of CFC-12 is used directly in charging compressors produced by the enterprise. Forty percent of current production is assembled onto condensing units and commercial refrigeration equipment in the factory, the remainder are sold to other concerns. Production capacity is 10,000 units per year. Actual production is 9,200 sets (1992). JTCMF's market share of this sector is about 46 percent. The CFC-12 semi-hermetic compressors currently produced are of Japanese (Hitachi) design, produced on a high technology production line imported in 1985. None are exported. The enterprise is a 100 percent wholly state-owned Chinese enterprise and the largest producer of semi-hermetic compressors in China.

PROJECT DESCRIPTION

For this project JTCMF will introduced mature small semi-hermetic HCFC-22 compressor technology from abroad and convert its production line. Semi-hermetic compressors of 5-12 kW capacity are widely used in China. Demand in 1992 reached 20,000 sets.

JTCMF has concluded an agreement in principle with Arctic Circle (UK) in Rome, Italy on 8th. June. This company produces a well established design of semi-hermetic compressor which can be used at medium and low temperatures in addition to air conditioning duties and which matches the enterprise's current production well.

With these compressors, evaporating temperatures down to -40 Deg.C can be achieved at condensing temperatures as high as 50 Deg.C. They are therefore suitable for equipment specified for the Chinese design ambient temperature of 35 Deg.C.

JCTMF's annual production of about 10,000 small semi-hermetic compressors will be increased to 30,000. There is currently an over-supply of these category of compressor in the Chinese market. The strategy document describes how production will be concentrated in a small number of factories via production licenses issued by MMI, thereby taking advantage of economies of scale. The production capacity lost through closure of other enterprises is shown below:

	Annual Capacity
Lucyang Ref. Machinery Factory	6,000
Dalian " " "	6,000
Subei " " "	6,000
Jiangpu " " "	6,000
Chongqing " " "	6,000
Total	30,000

Since JCTMF is replacing rather dated technology with the latest Western designs, there is an inevitable improvement in product quality and specification. This is more than offset by the significant counterpart investment being made by JCTMF of US$679,000 (20% of the total project cost).

JUSTIFICATION OF ALTERNATIVE TECHNOLOGY SELECTION

There are three potential alternatives technolgoies for this project - HCFC22, HFC134a, and Ammonia. HCFC-22 was selected as the preferred alternative technology for this project for the following reasons:

i) It is cost effective - HFC134a and its associated polyolester lubricant are not currently available in China in commercial quantities and when and if they become available are likely to cost 2-3 times that for equivalent quantities of HCFC22. Also, 15wt.% less HCFC22 is required to accomplish the same refrigeration task as HFC134a because of its lower molecular weight.

ii) Technology is readily available - Foreign suppliers are reluctant to transfer HFC134a technology while HCFC22 technology is readily and immediately available at a reasonable cost. China does not have indigenous technology for making HCFC22 compressors and therefore must purchase it from abroad.

iii) HFC134a technology requires sofisticated servicing procedures for the large scale facilities envisioned in this project. China does not have trained skilled manpower to service such compressors. It will take some time to implement a service sector training project to ensure adequate service and maintenance standards for HFC134a. Current servicing practices are adequate for HCFC22.

iv) The use of R-717 (Ammonia) would require considerable modification of the systems on which these compressors are used, and R-717 use would simply not be suitable for many of the applications for which HCFC22 is used because of its toxicity and flammability.

A number of zero-ODP HFC based refrigerant blends intended as direct drop-in replacements in HCFC-22 systems are currently being developed in the West. Provided service levels improve sufficiently and the numbering become available at a reasonable price in China, use of these blends could provide a direct transition to zero-ODP refrigerants with no change required to the technology being proposed in this project.

According to the Montreal Protocol agreement, China will phase out CFC use by the end of 2005. The China CP, recently accepted by the Montreal Protocol Executive Committee (MPEC) gave HCFC-22 a key role in phasing out CFC-12 use in this sector.

It is therefore concluded that on balance, given the conditions in the PRC, HCFC-22 is the best choice for CFC-12 replacement in this sector. Successful implementation of this project will lead to the replication of this technology to other enterprises.

PROJECT COSTS

Summary of Project Costs

The total project cost is $3,395,000 of which $2,716,000 million is considered eligible for MP financing. The grant request of $2,797,500 includes eligible project costs as well as financial administration costs. There are no net incremental recurrent costs or benefits associated with this project.

Capital Costs

The capital costs of US$3,395,000 include capital investment in technology transfer fees, NPV of first four years of estimated royalty payments, production equipment, training, and compressor testing device and costs for trial production. A breakdown of investement costs is provided in Annex 1.

Incremental Recurrent Costs/Savings

These are based on planned production increases (all within present plant capacity) and projected price increases for CFC-12. The net increase in unit production costs are zero.

Benefits

No net incremental benefits are expected.

Local Ownership Fraction

JTCMF is 100% Chinese owned.

Contingencies and Other Costs:

A 15% contingency was included in all capital cost estimates. A 3% financial administration fee was included in the grant request.

UNIT ABATEMENT COST:

1.94 US$/kg ODP/year. Detailed calculation is given in Annex 2.

PROJECT IMPLEMENTATION

JCTMF is responsible for the execution of this project, which will be supervised by NEPA and MMI. The Ministry of Internal Trade Design Institute will provide technical support. The project will be completed in three years.

REQUIRED REGULATORY ACTIONS:

The following will be undertaken to ensure the success of this project.

i) Voluntary agreements from the Enterprise with the Chinese government to phaseout CFC-12 production

ii) Control and Coordination of the Enterprise by NEPA

iii) The Chinese government will control the production of small CFC-12 compressors by the issuing of production licenses to prevent oversupply of the market and undercutting by CFC-12 compressor manufacturers. This is described in the sector strategy document produced by MMI.

The following are measures that will be adopted to ensure that new non-CFC products become established in the marketplace at a sufficient rate for the phaseout goals to be achieved. These have been proposed by MMI and GMRI to the responsible ministries.

i) Tax Policy

The selling price of non-ODS products will be slightly higher than current CFC-12 based production. From 1998 differential tax rates will be applied to each to ensure that non-CFC based products become established in the market.

The State Environmental Protection Agency (NEPA), State Economy and Trade Commission, the Ministry of Finance and the Dept. of General Tax Administration will be responsible for drafting these tax measures with input from MMI and MIT.

ii) Import and Export Controls

From 2001 the same bodies listed above in conjunction with the General Customs Administration will institute import and export policies to prevent the import of CFC based equipment.

iii) Production Licenses

From mid-1998 production licenses will be issued by MMI to control the total supply of compressors to the market. This measure will be used in conjunction with (i) above to ensure that HCFC-22 based equipment becomes established in the Chinese market.

The aim of these measures will be to cease production of all CFC based refrigeration equipment by January 1st., 2004.

RESULTS

Direct Project Impacts

This project will remove 200 tonnes of CFC-12 in 1994 or the first year of full operation. This amount of CFC-12 will increase to 300 tonnes annually over subsequent years as the servicing needs of machines equipped with HCFC-22 compressors are re-charged with HCFC-22 instead of CFC-12. This project employs commercially available technology in one of the country's largest CFC use sectors.

Indirect Project Impact

This project concerns the direct replacement of JTCMW's CFC-12 compressor production. Considerable over-capacity for production of this type of compressor exists in China, the Chinese government will control production via the issuing of production licenses. Five additional CFC-12 compressor manufactures will be shut down as this project is implemented.

When this technology has been established at JTCMF, it is intended to replicate it to other similar enterprises as detailed in the China CP. HCFC-22 semi-hermetic medium compressor technology will thus be spread to all companies supplying these compressors in China. Funding will be requested for these enterprises in due course.

ENTERPRISE COMMITMENT

Once MP funding is available, JTCMF will carry out the activities relating to the production of HCFC-22 compressors as described in this document and assume responsibility for project implementation.

ANNEX 1

Investment Costs and Equipment Justification

Investment Costs

Item	Description	Cost (US$)
A.1	Technology Transfer Fee	731,550
A.2	Imported Equipment	1,495,000
A.3	Domestic Equipment	290,000
A.4	Installation and Commissioning	200,000
A.5	Utilities	134,250
A.6	Training and Expert Help	101,650
A.7	15% Contingency	442,550
	Total	**3,395,000 (US$)**

Basic License Agreement:

Up-front payment:	US$ 512,550
NPV at 12% of first four years of royalties:	US$ 219,000

Royaltiy payment based on minimum royalties of $61,200 for the first year of production and $76,500 for following three years.

Equipment Justification

Taken from Section 5 of Project Feasibility Study

5.1 Equipment Required for Project

5.1.1 Existing Equipment

In 1985 as part of the Hitachi semi-hermetic compressor project, JCTMF bought 8 sets of NC machine tools, high precision boring machines, automatic lathes for forming pistons, vacuum drying stoves, testing devices, etc. There are now a total of 26 imported machine tools and 38 home produced sets of equipment associated with the Hitachi line which is capable of producing 10,000 semi-hermetic compressors per year.

In 1993 JCTMF made a further investment of 2.5m Yuan ($416,000 US) in foundry equipment. Production capacity for compressor body casting increased from 10,000 to 20,000 units per year. Foundry equipment includes two sets of cupolas, four sets of fettling machines, mechanical mould handling and sand treatment equipment. There are also 3 standby generating sets supplying 300 kVA of power and 4 sets of compressors providing 30 m3/min of compressed air. Efficient dust removal and waste water treatment equipment ensures environmentally friendly operation of the facility.

5.1.2 Expansion of Foundry Facilities

Beside the installation described above, a compressor foundry sub-factory has been set up in Zhuzhuang County near Taizhou City. A further production capacity of 15,000 compressor castings is anticipated in 1995. Added to the existing 20,000 capacity this gives a total capacity of 35,000 castings, sufficient to meet the requirements of the 30,000 HCFC-22 compressors that will be produced following project implementation.

5.1.3 Further Equipment Required

i) Crankcase machining line

The existing equipment consists of four sets of 50 model horizontal machining centres and two sets of honing machines. The machining centres are being worked for three shifts, and the honing machines for only one.

It is now planned to add two sets of model 63 horizontal machining centres. Rough surface machining, drilling and tapping will be carried out by new double headed horizontal milling machines of domestic manufacture, multi axis drilling machines and tapping machines. Together with the existing equipment, this new equipment will enable the crankcase machining operations on two different compressor bodies to be carried out.

The new equipment required for crankcase machining is listed in Table 5.1 below:

Table 5.1 New Equipment for Crankcase Machining

No.	Equipment	Model	Manufacturer	Quantity	Price US$
B1.1	Horizontal Machining Centre	HN63-C	Nigata (Japan)	2	805,000
B2.7	Multi-spindle Drilling machine	DK316	Dailian Machine Tool Factory	1	25,000
B2.1	Horizontal Double Headed Milling Machine	X2540	Sanmin Machine Tool Factory	4	60,000
B2.2	Multi headed Tapping Machine	Special Machine	Dailian	1	10,000

ii) <u>Crankshaft, piston, connecting rod, valve plate and cylinder head machining.</u>

Equipment to carry out these operations on the existing semi-hermetic compressor production is under utilized. Only single shift working is required to produce 10,000 units per year. The addition of a few imported and domestically produced machines will enable to planned production capacity of 30,000 HCFC-22 compressors to be met with two shift working.

The machining operations associated with production of these components are listed in Table 5.2 below:

Table 5.2 New Equipment for Sundry Component Machining

No	Equipment	Model	Manufacturer	Qty	Price US$
	Crankcase Production Line				
B1.2	NC Grinder		UK	2	300,000
B2.3	Crankshaft Grinder	MA8260	Shanghai Machine Tool Factory	2	30,000
B2.4	Deep Drilling Machine	Z2102/500	Deizhou	2	10,000
	Subtotal			**6**	**440,000**
	Valve Plate Production				
B2.7	Multi-shaft Drilling Machine	**DK316**	Dailian Machine Tool Factory	1	25,000
B2.5	Milling Machine	**NB43100**	Xinxang	2	30,000
	Subtotal			**3**	**55,000**
	Connecting Rod Production				
B1.3	High precision Double Headed Boring Machine	MBF 350D	Japan	2	200,000
	Subtotal			**2**	**200,000**

iii) Assembly Line

A new assembly line will be set up on the site of the present one. A testing device before delivery for HCFC-22 compressors will be added. Details are given in Table 5.3 below:

Table 5.3 Assembly Line

No	Equipment	Model	Manufacturer	Quantity	Price US$
B1.4	Testing Device Delivery		Arctic Circle Ltd.	1	100,000
	Assembly Line	JCTMF		1	100,000
	Subtotal			2	200,000

iv) Items Required for Conversion of Refrigeration Equipment to HCFC-22

These are listed in Table 5.4

Table 5.4Items for Refrigeration Equipment Production

	Equipment	Model	Manufacturer	Price US$
B1.5	Refrigerant Drying Equipment		UK	50,000
B1.6	Leak Detector		UK	10,000
B1.7	Refrigerant Recycling Equipment-t		UK	30,000
	Subtotal			**90,000**

5.2 Test Equipment

JCTMF has a computerized compressor performance testing device from Japan and a complete measuring and testing centre. No further test instruments are required.

5.3 Justification of New Equipment Purchase

5.3.1 Crankcase Machining

A total of eight tools (B1.1, B2.1, B2.2, B2.7) is required for crankcase machining. The total cost of $900,000 accounts for half the project investment costs. The reasons this equipment is required is given below:

Six separate specifications of crankcase are required to replace JCTMF's current production. In order to produce these 6 different designs at a high enough rate for the new production capacity, the flexibility offered by programmable machine tools is an absolute requirement.

A three shift system is employed with an average production time of 12 minutes for the small size crankcase and 24 minutes for the large size. Two production lines will be employed for the small and large crankcase size respectively, the loading frequency being every 12 and 24 minutes respectively. Since components of a similar size are being loaded on each machining centre, the variety and therefore the chance of error is reduced. Hence the following equipment is required:

i) Although JCTMF has four HN50 machining centres, two more HN63 centres must be purchased. This is because the larger size crankcase is 80mm longer than the crankcases produced at the moment. The main bearing holes cannot be made with HN50 machines. The technology supplier state that HN63 machining centres must be used.

Table 5.5 below shows a comparison of the main machine parameters:

Item	**HN50-A**	**HN63-C**
Table Dimensions	500mm x 500mm	630mm x 630mm
x/y/z Axis Travel	650mm x 650mm x 500mm	1,000mm x 850mm x 750mm

ii) The multi-axis drilling machine will be used to form multiple holes . Because this machine drills these holes simultaneously it can achieve the accuracy required in batch production.

iii) The double headed horizontal milling machine (X2540) will be used for rough processing of the two flank faces and top face of the crankcase to reduce the cutting required of the machining centres.

iv) Multi-headed tapping machines will be used for cutting threads on each crankcase face. It processes a group of holes simultaneously and is a more efficient and cost effective method than using a machining centre.

5.3.2 Valve Plate Machining

Three additional machines are required, B1.2 and B2.5 at a cost of $120,000 US.

i) Multi-spindle drilling machine for forming a group of holes on the valve plate with high dimensional and positional accuracy.

ii) Face grinder will be used for grinding the flat surfaces of the valve plate.

5.3.3 Crankshaft Machining

i) An NC grinding machine will be used for machining the crankshaft journals. The dimensional and positional accuracy required is higher than H6 (ISO). The precision of step part of it will be over 4 grade. The accuracy possible on a manually controlled milling machine is only H7 and therefore the required accuracy cannot be guaranteed in volume production.

The technology suppliers have stated clearly that the accuracy of the existing method is not sufficient for them to guarantee the performance of their compressor design. Thus the NC grinding machine is a necessity.

ii) The new crank grinders are required for the big-end journals. These are needed to achieve the required accuracy whilst maintaining the production volume.

iii) The deep drilling machines are required for forming the main oilways in the crankshaft. These are used on existing compressors. The increase in capacity means that new machines are required.

5.3.4 Connecting Road Machining

Two additional machine tools are required at a cost of 200,000 US$. Accurate machining of the connecting rod is very important. The small end and main bearing holes must be formed with a high degree of parallel precision. The technology supplier has stated that both holes must be formed by a high precision machine at one time. The production rate dictates the need for two machines.

5.3.5 Assembly Line

Two additional machines are required, no's B1.4 and B2.6 at a cost of 200,000US$.

i) The performance test device is a piece of equipment for production testing which determines quickly whether the compressor is functioning correctly. This must match the compressor models being produced and must be purchased from the technology supplier.

ii) B2.6 comprises assembly line modifications consisting of washing equipment, transfer facilities and tools for assembly. These will be designed and manufactured in-house by JCTMF.

5.3.6 Equipment for Refrigeration Equipment Conversion

Three pieces of additional equipment are required, no's B1.5, B1.6 and B1.7 at a cost of $90,000 US. These are required to enable HCFC-22 based refrigeration equipment (e.g. cabinets, coldstores and ice cream machines) to be produced.

According the MIT production standard SB142-144-84 the moisture content of refrigerant should be less than 20 ppm. Chinese produced HCFC-22 has a higher moisture content and thus requires drying before use. Previous methods employed were not satisfactory.

System pressures are higher and thus more prone to leaks. Sensitive leak detection equipment is required. The recycling equipment is required in order to reduce to a minimum HCFC-22 emitted to atmosphere.

5.4 Summary

Whilst retaining existing production equipment where possible, new equipment is required for producing both the new HCFC-22 range of compressors and HCFC-22 based refrigeration equipment.

24 sets of new equipment are need at a cost of 1,785,000. This is the minimum required for a practical transition to the new technology.

ANNEX 2

Unit Abatement Cost Calculation

$$UAC = \frac{C(F) - (OC - OS/B)}{ODP} \quad \text{US \$ / kg ODP/year}$$

Where:

C	=	3,395,000 US $
C (F)	=	$552,520 (Econ life: 10 years, Discount 10%)
OC	=	0
OS/B	=	0
ODP	=	285,000 kg

$$A = \frac{552{,}520 + (0-0)}{285{,}000}$$

$$= 1.94 \text{ US \$ / kg ODP/year}$$

ANNEX 4

Environmental Assessment

There is no obvious increase in environmental hazard with this project by comparison with current compressor production.

A formal environmental assessment will be carried out by the local National Environmental Protection Agency office during project implementation.

ANNEX 5

Safety

The new refrigerant (HCFC-22) used in production has the same exposure limit as CFC-12 currently used (1,000 ppm). No materials used in the new production process are significantly more hazardous than those currently used.

A number of new production tools are being introduced into the Factory. Comprehensive training in their use will reduce the risk to operators to a minimum.

Country of origin: CHINA

Project title: The Conversion of Small Semi-hermetic CFC-12 Refrigeration Compressor Production to HCFC-22 Production at the Jiangsu Taizhou Commercial Machinery Factory (JTCMF)

Sector/sub-sector Commercial Refrigeration and Air Conditioning

Relationship to country program (World Bank)

General Remark

JTCMF is increasing its production capacity from 10,000 to 30,000 units per year and the funding requested includes this production capacity increase. Justification for this project is found in the fact that at the same time 5, named, companies (total capacity 30,000 units per year) will close down production by governmental action. This makes the project in principle a conversion project and eligible for funding.

Technology

In the refrigeration and air conditioning industry HCFC-22 is a well known, proven and acceptable (but transitional) technology to reduce CFC consumption. In principle the technology is not very different from CFC-12 technology.

JTCMF produces compressors from a Hitachi (Japan) design from a reasonably high technology level. The company is also equipped with reasonably modern equipment including some machining centres. The present product has to be replaced by a design from Arctic Circle Ltd. (UK) which needs some higher accuracy production methods. Besides this, not all new components can be produced on the present machinery (e.g. because of dimensions a larger machining centre is necessary). This leads to relatively high costs for the conversion process. In fact, not only conversion is taking place but at the same time modernization which is the reason for claiming 80 % of the project costs for funding. Justification of this 80 % is based on financial calculations, demonstrating that the remaining 20 % to be funded by the company themselves (via bank loans) is really a maximum and which is, from economic point of view, already hardly defensible.

A technology transfer agreement has to be signed with Arctic Circle Ltd. (A statement of intent is present). Due to this, future, agreement and the experience of the company a successful implementation of the project can be expected.

The selection of HCFC-22 technology is supported. The motivation for this support is given in the attached note "Justification for the selection of HCFC-22 technology".

Environmental impact

HCFC-22 has an ODP of 0.05 and is an acceptable, though transitional, refrigerant to reduce ODS.

Project costs

- The equipment requested is essential for the conversion and capacity expansion process
- The list of costs for machining equipment is accurate, reasonable and well motivated.
- A relatively large part of the capacity increase is obtained by better utilizing existing equipment (more shifts) so without additional equipment costs.
- The technology transfer fee (USD 519000) is rather high.
- No operational costs are being claimed.
- The UAC value obtained is reasonable or even relatively low compared to other, similar, projects.

Implementation timeframe

The proposed implementation time frame is reasonable.

Relevance and adequacy of information provided

Information provided consisted of project proposals, detailed appendices directly sent from the companies, comments by World Bank officer and consultant and a Strategy Document. Altogether sufficient information for a review has been present.

Recommendations

Approval of the project as proposed.

Martien Janssen, OORG MM338
Eindhoven,
The Netherlands
20-October-1994

Note
on the justification for the selection of HCFC-22 technology
in the commercial refrigeration projects of
Shanghai, Beijing, Anhui, Nanjing, and Taizhou, China

The justification for the selection of HCFC-22 technology is briefly described in the five project proposals. A more thorough justification is presented in a "Strategy study on the gradual phaseout of CFC substances in Industrial and Commercial Refrigeration Industry, China" which contains essential information for the projects. Furthermore, additional information is supplied by the World Bank responsible officers and consultants involved. From this information the following is concluded:

1. In this stage HCFC-22 is absolutely essential for the rapid CFC phase out in domestic and industrial refrigeration in China, which is a very important sector regarding its CFC use. Other technologies (e.g. HFC-134a) would lead to a serious delay and increase costs in the market place. This is inline with the China Country Program.

2. The cost effectiveness of a factory conversion to HCFC-22 by transferring developed countries technology, which requests a considerable modernization, can be questioned. However, it has been demonstrated that any alternative procedure (e.g. implementing new HFC-134a technology, adjusting current technology to new refrigerants) would, if possible at all, be less cost effective already from a company point of view. From a country point of view the cost effectiveness would be even worse because these technologies would certainly increase costs in the market place (e.g. service, material costs).

The selection of HCFC-22 technology is supported for these five projects.

Martien Janssen, OORG MM338
Eindhoven,
The Netherlands
20-October-1994

PROJECT COVER SHEET

COUNTRY:	Peoples' Republic of China	
PROJECT TITLE:	The Conversion of Small Open-type CFC-12 Refrigeration Compressor Production to HCFC-22 Production	
SECTOR COVERED:	Commercial Refrigeration and Air-Conditioning	
ODS USE IN SECTOR:	11,900 tonnes CFC-12 in 1993 (same ODP)	
PROJECT IMPACT:	Phase out 180 tonnes CFC-12 annually (171 tonnes ODP)	
PROJECT DURATION:	3 Years	
PROJECT ECONOMIC LIFE:	10 Years	
TOTAL PROJECT COST:	Investment Cost:	US$2,699,000
	Incremental Operating Cost	US$0
	Total Project Cost:	US$2,699,000
PROPOSED FUND FINANCING:		US $2,159,000
(Financial Agent fee)		65,000
	Total	**US $2,224,000**
IMPLEMENTING ENTERPRISE:	The Anhui Provincial Refrigerating Machinery Factory (APRMF)	
COORDINATING MINISTRY:	National Environmental Protection Agency (NEPA), Ministry of Machine Industry (MMI)	
TECHNICAL SUPPORT:	The General Machinery Research Institute (GMRI).	
IMPLEMENTING AGENCY:	The World Bank	
UNIT ABATEMENT COST:	USD2.57kg/ODP/year	

Technical Assessment: OORG reviewer Mr. Martien Janssen recommends approval of the project (review attached), but notes that three cost items (testing equipment and trail production) should be excluded from the grant request unless better justification is provided. The Bank is working to clarify the eligiblity of these cost items. If eligiblity can not be established, the funding request will be correspondingly reduced.

PROJECT SUMMARY:

This project will phaseout 180 tonnes of CFC-12 consumption associated with the production of small semi-hermetic compressors at the Anhui Provincial Refrigerating Machinery Factory (APRMF) by converting the production to HCFC-22 based compressors.

This project employs commercially available and mature technology in one of the country's largest CFC use sectors. Previous country study investigations have identified this as a high priority project. The China Country Program (CP) approved by the China State Council and accepted by the MPEC, has listed this as a priority project for implementation in 1993.

PROJECT OBJECTIVES

The objectives of this project are to: (i) introduce HCFC-22 based small semi-hermetic compressor technology and (ii) convert the enterprise's small semi-hermetic compressor production to HCFC-22 based units.

SECTOR BACKGROUND

China's commercial, industrial refrigeration and air conditioning industries consumed about 11,900 tonnes of CFC-12 in 1993. It is estimated that 60-85% of this consumption (7140 to 10,100 tonnes) was used in servicing existing equipment. This amount will continue to grow unless equipment based on CFC alternatives is introduced. In 1995 CFC-12 consumption is expected to reach 13,000 tonnes for commercial, industrial refrigeration and air conditioning applications.

ENTERPRISE BACKGROUND

The total annual ODS consumption associated with equipment using APRMF's compressor production is 180 tonnes. 126 tonnes is used directly in charging equipment produced by the enterprise. Production capacity is 10,000 units per year. Actual production is 10,804 sets (1993). APRMF's market share of this sector is about 12%. 70% of current production is assembled onto condensing units in the factory, the remainder are sold to other concerns. Open-type compressors of 1-5 kW capacity are widely used in China. The CFC-12 open-type compressors currently produced are of Chinese design. None are exported. The enterprise is a 100% wholly state-owned Chinese enterprise.

PROJECT DESCRIPTION

For this project APRMF will introduced mature small semi-hermetic HCFC-22 compressor from abroad and convert its production line. APRMF has concluded an agreement in principle with York International (US). This company produces a well established design of open type compressor which can be used at medium and low temperatures and which matches the enterprise's current production well. There is an inevitable degree of modernization to APRMF's product and production facilities by virtue of the fact that dated existing technology is being replaced by modern designs. However this is more than compensated by the significant portion of project costs that are being borne by APRMF (USD 540,000, or 20% of total project costs).

JUSTIFICATION OF ALTERNATIVE TECHNOLOGY SELECTION

There are three potential alternatives technologies for this project - HCFC-22, HFC-134a, and Ammonia. HCFC-22 was selected as the preferred alternative technology for this project for the following reasons:

i) It is cost effective - HFC134a and its associated polyester lubricant are not currently available in China in commercial quantities and when and if they become available are likely to cost 2-3 times that for equivalent quantities of HCFC22. Also, 15wt.% less HCFC22 is required to accomplish the same refrigeration task as HFC134a because of its lower molecular weight.

ii) Technology is readily available - Foreign suppliers are reluctant to transfer HFC134a technology while HCFC22 technology is readily and immediately available at a reasonable cost. China does not have indigenous technology for making HCFC22 compressors and therefore must purchase it from abroad.

iii) HFC134a technology requires sophisticated servicing procedures for the large scale facilities envisioned in this project. China does not have trained skilled manpower to service such compressors. It will take some time to implement a service sector training project to ensure adequate service and maintenance standards for HFC134a. Current servicing practices are adequate for HCFC22.

iv) The use of R-717 (Ammonia) would require considerable modification of the systems on which these compressors are used, and R-717 use would simply not be suitable for many of the applications for which HCFC22 is used because of its toxicity and flammability.

A number of zero-ODP HFC based refrigerant blends intended as direct drop-in replacements in HCFC-22 systems are currently being developed in the West. Provided service levels improve sufficiently and blends become available at a reasonable price in China, use of blends could provide a direct transition to zero-ODP refrigerants with no change required to the technology being proposed in this project.
According to the Montreal Protocol agreement, China will phase out CFC use by the end of 2010. The China CP, recently accepted by the Montreal Protocol Executive Committee (MPEC) gave HCFC-22 a key role in phasing out CFC-12 use in this sector.

It is therefore concluded that on balance, given the conditions in the PRC, HCFC-22 is the best choice for CFC-12 replacement in this sector. Successful implementation of this project will lead to the replication of this technology to other enterprises.

PROJECT COSTS AND GRANT REQUEST

Summary

The total project cost is US$2,699,000 of which $2,159,000 is considered eligible for MP financing. The grant request of $2,224,000 includes eligible project costs as well as financial administration costs. No support is requested for the minor incremental recurrent costs associated with this project.

Capital Costs

The capital costs of USD 2,699,000 include capital investment in technology transfer fees, production equipment, training, and compressor performance test equipment, and production costs for trial production. 20% of capital costs will be locally financed to cover inevitable process modernization which results from replacement of dated equipment. A breakdown of capital costs is given in Annex 1 and Annex 2.

Incremental Recurrent Costs/Savings

The NPV of a running royalty payment to the technology supplier (Annex 2) was included in capital costs. Excluding this royalty payment, there is only a small increase (about $0.501 unit) in operating costs. No request is made for these costs.

Benefits

No net incremental benefits are expected.

Local Ownership Fraction

APRMF is 100% Chinese owned.

Contingencies and Other Costs:

A 15% contingency was included in all capital cost estimates except the technology transfer fees and royalties. A 3% financial administration fee was included in the grant request.

UNIT ABATEMENT COST:

USD2.57 /kg/year. Calculation is provided in Annex 3.

PROJECT IMPLEMENTATION

Management

APRMF is responsible for the execution of this project. NEPA and MMI will supervise the execution of the project. The General Machinery Research Institute will provide technical support.

A special group has been designated for project implementation. The schedule is given in Annex 4.

Required Regulatory Actions

The following will be undertaken to ensure the success of this project:

i) Voluntary agreements from the Enterprise with MMI to phaseout CFC-12 production

ii) Supervision and coordination of project by NEPA

iii) MMI will control the production of small open-type CFC-12 compressors by the issuing of production licenses to prevent over-supply of the market and undercutting by CFC-12 compressor manufacturers.

The following are measures that will be adopted to ensure that new non-CFC products become established in the marketplace at a sufficient rate for the phaseout goals to be achieved. These have been proposed by MMI and GMRI to the responsible ministries.

i) Tax Policy

The selling price of non-ODS products will be slightly higher than current CFC-12 based production. From 1998 differential tax rates will be applied to each to ensure that non-CFC based products become established in the market.

The State Environmental Protection Agency (NEPA), State Economy and Trade Commission, the Ministry of Finance and the Dept. of General Tax Administration will be responsible for drafting these tax measures with input from MMI and MIT.

ii) Import and Export Controls

From 2001 the same bodies listed above in conjunction with the General Customs Administration will institute import and export policies to prevent the import of CFC based equipment.

iii) Production Licenses

From mid-1998 production licenses will be issued by MMI to control the total supply of compressors to the market. This measure will be used in conjunction with (i) above to ensure that HCFC-22 based equipment becomes established in the Chinese market. The aim of these measures will be to cease production of all CFC based refrigeration equipment by January 1st., 2004.

RESULTS

Direct Project Impacts

This project will remove 180 tonnes of CFC-12 annually when in full operation.
The savings generated in the service sector are cumulative, since the amount lost annually through leaks from a given piece of equipment is repeated throughout the life of the equipment.

Indirect Project Impact

This project concerns the direct replacement of APRMF's CFC-12 compressor production. Considerable over-capacity for production of this type of compressor exists in China. MMI will control production via the issuing of production licenses as stated above.

When this technology has been established at APRMF, it is intended to replicate it to other similar enterprises as detailed in the China CP. HCFC-22 open-type small compressor technology will thus be spread to all companies supplying these compressors in China. Funding will be requested for these enterprises in due course.

ENTERPRISE COMMITMENT

Once MP funding is available, APRMF will carry out the activities relating to the production of HCFC-22 compressors as described in this document and assume responsibility for project implementation. For Anhui Provincial Refrigerating Machinery Factory:
Director: Wei Qing Sen
Date: September, 1994

ANNEX 1

Breakdown of Investment Costs and Equipment Justification

A.	Machining and Assembly Equipment	
	1 Set of Machines for Crankcase	1,254,600 USD
	4 Sets of Machines for Crankshaft	108,000 USD
	3 Sets of Machines for Valve Plate	103,000 USD
	Toolings, Moulds and Fixtures	266,000 USD
	Compressor Assembly Line	46,000 USD
B.	Test Equipment	
	Pressure Testing Device	23,500 USD
	Performance Checking Device	29,000 USD
C.	Transportation, Insurance and Installation of Equipment	87,000 USD
D.	Training	20,200 USD
E.	Trial Production	167,000 USD
F.	Scrap Value of Unusable Machines	-15,100 USD
G.	Technology Transfer Fee	200,000 USD
	Running royalty (Annex 3)	92,000 USD
	SUB-TOTAL	**2,381,200 USD**
H.	Contingencies	317,800 USD
	TOTAL	**2,699,000 USD**

Equipment Selection and Justification

Note: This is taken from Section 7 of the Project Feasibility Study

7.1 Philosophy

Having purchased drawings and production details of the new compressor, APRMF will need to modify its production equipment. Some equipment additional will have to be purchased, but the overriding philosophy is to use existing equipment to as greater extent as possible in an effort to keep project costs to a minimum.

The existing CFC-12 compressor production line is configured according to the demands of this product and consists of some general machine tools and some dedicated machining centres. There are structural and dimensional differences in the new compressor design, therefore some equipment, notably the dedicated machining centres, will not be capable of re-use. Some machine tools will be used for rough machining.

7.2 Equipment Selected

7.2.1 Machining Compressor Body

Existing and Additional Requirements:

Operation	Equipment	Existing Equipment	Additional Equipment
Rough milling reference surface	milling machine	1	
Rough and Finishing Boring Spindle Bore	Horizontal MC	1	1
Rough and finish milling, spindle bore face			
Machining, spindle bore			
Rough and Finish machining of cylinder bore	Horizontal MC	1	1
Rough and finish machining of cylinder bore surface			
Machining reference face and bores			
Milling and Boring other faces and bore	milling machine	1	1
drilling and tapping other holes	drilling machine	2	
grinding, cylinder bore	grinder	2	

Equipment to be Purchased

Equipment	No.	Model	Manufacturer	Price quoted (USD)
Horizontal MC	2	HN50C	Niigata (Japan)	1,054,600
Vertical Milling Machine	1	X53K	Beijing Machine Tool Works	26,000
# Coordinate Measuring Device	1	RS-30	Giddings & Lewis (US)	174,000
Total				**1,254,600**

Equipment Description

There are five (5) general machine tools and seven (7) dedicated machines in APRMF for CFC-12 compressor body machining. After the production process has been modified, the 5 general machine tools will still be used for machining the compressor body but the 7 dedicated machines cannot be used owing to the significantly different design of the new HCFC-22 compressor and the fact that tighter machining tolerances are required These machines will be scrapped and the project credited with the amount realized. In their place two machining centres and one vertical milling machine are required for machining of the compressor body.

Specific reasons why this new equipment is required are given below:

i) The structure of the new compressor is more complex and higher machining tolerances are specified in the design than for the existing CFC-12 compressor. For example the accuracy requirement for the right angle between cylinder bore and shaft bore is H7 for the CFC-12 compressor, but H6 is required according to the technology supplier.

   There are two ways in which this accuracy can be achieved, namely dedicated machine tools and NC machining centres. The latter can give both the accuracy required and handle a number of different designs; the former can achieve the accuracy but many more pieces of equipment are required if several different crankcase designs are being made and this makes this option more expensive. More tools have to be bought and more space is required.

For this reason NC machining centres have been selected.

ii) Because of the changes in design and accuracy requirements, existing measuring instruments are no longer suitable. A three coordinate measuring device is required to check the dimensions of the compressor body and other parts.

7.2.2 Machining of Crankshaft and Associated Components

Existing and Additional Requirements:

Operation	**Equipment**	**Existing Equipment**	**New Equipment Required**
End Face Milling and Centering	Centering machine	1	
Rough turning of journals	Lathe	2	
Rough turning of small end	lathe	2	
Grinding, forming centre hole	Grinding machine	1	
Final machining of journals	MC lathe	1	1
Final machining of small end	crankshaft lathe	1	1
Lateral face milling	Milling machine	1	
Rough and final grinding of main journal	External grinding machine	1	1
Rough an d final grinding of mall end	Crankshaft grinder	2	1
Milling key slot	Milling machine	1	

Equipment to be purchased:

Machine	Model	No.	Price Quoted (USD)	Manufacturer
NC Lathe	CK6150A	1	42,000	Shanghai No. 2 Machine Tool Works
Crankshaft lathe	S1-1300	1	35,000	Shanghai No. 1 Machine Tool Works
Precision Universal External Grinding Machine	MM1420A	1	15,000	Shanghai No. 3 Machine Tool Works
Crankshaft Grinding Machine	MQ8260	1	15,000	Hanjiang Machine Tool Factory
			Total	**108,000**

Specific reasons why this new equipment is required are given below:

Crankshaft machining is currently carried on ten machines at APRMF. These include three dedicated machines and seven general machine tools. The design of the new crankshaft is different to that of the current compressor, and the specified tolerances are higher. Thus the three dedicated machines will not be suitable and will be scrapped and the project credited with the amount realized. However the seven general machine tools will be retained and used for rough machining of the new compressor crankshaft after modification. It will be necessary to purchase two grinding machines and four lathes. Two of the lathes will be those currently used for the CFC-12 piston machining. These will be used for rough machining of the HCFC-22 crankshaft. Piston for the new compressor will be bought outside.

7.2.3 Valve Plate and Associated Components

Existing Equipment and Additional Requirements:

Operation	Equipment	Existing Equipment	Additional Equipment
Milling: 2 surfaces	Milling Machine	4	
Rough Grinding:	Surface Grinding Machine	2	
Final Grinding: 2 Surfaces	High Precision Grinding Machine	1	1
Machining Cylinder Bores	Vertical MC	1	1
Grinding: 2 surfaces	Grinder	1	1

Equipment to be Purchased for Valve Plate Machining:

Operation	Model	No	Manufacturer	Offer USD
Vertical MC	DM4400	1	Anqin Hongkang Co.	71,000
High precision surface grinding machine	MM71320	1	Hongzhou Machine Tool Works	16,000
Surface Grinding Machine	MB4363B	1	Xinxiang Machine Tool Works	16,000
			Total	**103,000**

Description:

The working pressures encountered in an HCFC-22 compressor are higher than with a CFC-12 compressor. Thus the degree of precision with which the valve plate has to machined flat is greater. Also the valve structure is more complex so that unless flexible machine tools are required, the production rate would be unacceptably slow. Thus in order to meet the requirements of precision and production rate a high precision surface grinding machine, a bore machining center and a face grinder are required. The existing seven machines can continue to be used, but three dedicated machines will be scrapped.

7.2.4 Piston and Connecting Rods

All pistons and connecting rods are currently made in-house by APRMF on five dedicated and four general machines. After conversion to the new production, these parts will be bought out. Four out of five of the original dedicated machines will be scrapped, two of the four general machines will be used for crankshaft production and the remaining two will be used for the production of the cylinder head, end plate and bottom cover, thereby eliminating the need to purchase separate equipment for machining of these parts.

7.2.5 Fixtures, Tools, Moulds and Related Equipment

a) After modification of production, some existing equipment will be retained and some new equipment purchased. Also it will be necessary to design and manufacture some fixtures, moulds and measuring equipment in order to meet the production requirements of the new compressor.

b) Special tools are required by machining centres. They will be purchased separately.

c) To keep the machining centre tools in good condition and ensure the quality of workpieces a universal tool grinding machine is required.

ANNEX 2

NPV of Royalty Payment

Actual production is estimated at 50% production capacity in the fourth year after the project start. In later years full production is anticipated. The Incremental Running Royalty for the first four years of production are shown below:

Item	Year 1	Year 2	Year 3	Year 4
Production of HCFC-22 Compressors	5,000	10,000	10,000	10,000
Royalty	27,100	54,200	54,200	54,200
NPV (at 12%)	27,100	24,200	21,500	19,200
NPV Total	**92,000**			

ANNEX 3

Calculation of Unit Abatement Cost

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

Where:

C = \$2,699,000
C(F) = \$ 439,250 (10 year economic life)
OC = 0
OS/R = 0
0DP = 171,000 kg

UAC = US\$2.57/kg ODP/year.

ANNEX 4

Implementation Schedule

Action	**Year 1**	**Year 2**	**Year 3**
1. Importing Technology			
Contract signing	X		
Technical Preparation & Training	XXX	XXX	
Production Line Design	X		
2. Equipment Purchase and Modification			
Equipment purchase	X		
Manufacture of equipment	X	XXX	
Modification of Existing Equipment		XX	X
Line Installation and Adjustment		X	XX
3. Trial Production			
Pre-production	X	XXX	
Identification of Model Product		XX	
Training			XX
Line Pre-production			XX

ANNEX 5

Safety

HCFC-22 has the same maximum exposure limit as CFC-12 (1,000 ppm). No more hazardous materials are used in the new production than in the old.

In the case of new equipment, a comprehensive training programme will reduce risk to the operators to a minimum.

ANNEX 6

Environmental Assessment

The new production resembles the old and is not thought to present any greater environmental hazards.

A full environmental assessment will be carried out during project implementation.

Country of origin: CHINA

Project title: The Conversion of Small Open-type CFC-12 Refrigeration Compressor Production to HCFC-22 Production at the Anhui Provincial Refrigerating Machinery Factory (APRMF).

Sector/sub-sector Commercial and Industrial Refrigeration and Air Conditioning

Relationship to country program (World Bank)

Technology

In the refrigeration and air conditioning industry HCFC-22 is a well known, proven and acceptable (but transitional) technology to reduce CFC consumption. In principle the technology is not very different from CFC-12 technology. The main reason for the relatively high project costs is the fact that at present a dated, Chinese design compressor is produced which is to be replaced by a design of York International (UK) which is fundamentally different and needs much higher accuracy equipment. This means that not only conversion is taking place but at the same time modernization which is the reason for claiming 80 % of the project costs for funding. Justification of this 80 % is based on financial calculations, demonstrating that the remaining 20 % to be funded by the company themselves (via bank loans) is really a maximum and which is, from economic point of view, already hardly defensible.

A technology transfer agreement exists with York International (US) in order to produce HCFC-22 compressors in the range from 1 to 5 kW. Due to this technology agreement and the experience of the company a successful implementation of the project can be expected.

The selection of HCFC-22 technology is supported. The motivation for this support is given in the attached note "Justification for the selection of HCFC-22 technology".

Environmental impact

HCFC-22 has an ODP of 0.05 and is an acceptable, though transitional, refrigerant to reduce ODS.

Project costs

- The equipment requested is essential for the conversion process.
- The list of costs for machining equipment is accurate, reasonable and well motivated.
- The two items mentioned under test equipment need a better specification, as well as the trial production item.
- No operational costs are being claimed.
- The UAC value obtained is reasonable compared to other, similar, projects.

Implementation timeframe

The proposed implementation time frame is reasonable.

Relevance and adequacy of information provided

Information provided consisted of project proposals, detailed appendices directly sent from the companies, comments by World Bank officer and consultant and a Strategy Document. Altogether sufficient information for a review has been present.

Recommendations

Approval of the project provided specific items mentioned above are better motivated or eliminated.

Martien Janssen, OORG MM338
Eindhoven,
The Netherlands
20-October-1994

Note
on the justification for the selection of HCFC-22 technology
in the commercial refrigeration projects of
Shanghai, Beijing, Anhui, Nanjing, and Taizhou, China

The justification for the selection of HCFC-22 technology is briefly described in the five project proposals. A more thorough justification is presented in a "Strategy study on the gradual phaseout of CFC substances in Industrial and Commercial Refrigeration Industry, China" which contains essential information for the projects. Furthermore, additional information is supplied by the World Bank responsible officers and consultants involved. From this information the following is concluded:

1. In this stage HCFC-22 is absolutely essential for the rapid CFC phase out in domestic and industrial refrigeration in China, which is a very important sector regarding its CFC use. Other technologies (e.g. HFC-134a) would lead to a serious delay and increase costs in the market place. This is inline with the China Country Program.

2. The cost effectiveness of a factory conversion to HCFC-22 by transferring developed countries technology, which requests a considerable modernization, can be questioned. However, it has been demonstrated that any alternative procedure (e.g. implementing new HFC-134a technology, adjusting current technology to new refrigerants) would, if possible at all, be less cost effective already from a company point of view. From a country point of view the cost effectiveness would be even worse because these technologies would certainly increase costs in the market place (e.g. service, material costs).

The selection of HCFC-22 technology is supported for these five projects.

Martien Janssen, OORG MM338
Eindhoven,
The Netherlands
20-October-1994

PROJECT COVER SHEET

COUNTRY:	Peoples' Republic of China	
PROJECT TITLE:	The Production of Small and Medium Sized Ammonia Refrigeration Compressors	
SECTOR COVERED:	Commercial and Industrial Refrigeration and Air Conditioning	
ODS USE IN SECTOR:	11,900 tonnes CFC-12 in 1993 (11,900 tonnes ODP)	
PROJECT IMPACT:	Phase out 240 tonnes CFC-12	
PROJECT DURATION:	3 Years	
PROJECT ECONOMIC LIFE:	10 Years	
TOTAL PROJECT COST:	Investment Cost	USD3,488,000
	Incremental Operating Cost	USD 0
	Total Project Cost	USD3,488,000
PROPOSED FUND FINANCING:	USD2,790,000 84,000 (financial agent fee) **USD2,874,000**	
IMPLEMENTING ENTERPRISE:	The Yantai Refrigerating Machinery Works (YRMW)	
COORDINATING MINISTRY:	The National Environmental Protection Agency (NEPA), The Ministry of Machine Industry (MMI)	
IMPLEMENTING AGENCY:	The World Bank	
UNIT ABATEMENT COST:	$2.37/kg ODP/year	

Technical Assessment: OORG reviewer Mr. Martien Janssen recommends approval of this project (attached). Civil works have been excluded from the list of project costs in line with his comments.

PROJECT SUMMARY:

This project will eliminate 240 tonnes of annual CFC-12 consumption in medium and low temperature commercial refrigeration equipment (12-72 kW capacity) by the production of small ammonia compressors and ancillary equipment. 3,200 small ammonia compressors and ancillary equipment will be produced annually when the plant has reached full capacity.

In some applications Ammonia is the ideal substitute for CFC-12. Previous country study investigations have identified this as a high priority project. The China Country Program (CP) approved by the China State Council and accepted by the MPEC, has listed this as a priority project for implementation in 1993.

PROJECT OBJECTIVES

The objectives of this project are to phaseout 240 tonnes of CFC-12 consumption associated with the manufacture of compressors at plants to be closed through adoption of mature foreign technology for the manufacture of small ammonia compressors and related ancillary equipment.

SECTOR BACKGROUND

China's commercial, industrial and air conditioning industries consumed about 11,900 tonnes of CFC-12 in 1993. It is estimated that 60-85% of this consumption (7,140 to 10,100 tonnes) was used in servicing existing equipment. This amount will continue to grow unless equipment based on CFC alternatives is introduced. In 1995 CFC-12 consumption is expected to reach 13,000 tonnes for commercial, industrial and air conditioning applications.

ENTERPRISE BACKGROUND

YRMW produces mainly large and medium reciprocating ammonia refrigeration compressors, large and medium rotary compressors and refrigeration systems with cooling capacity over 72 kW. About 20% of compressors and ancillary equipment are assembled on to condensing units. Existing annual production capacities are 4,000, 400 and 600 for reciprocating compressors, rotary compressors and refrigerating units respectively. About 6,000 sets of ancillary equipment can be produced.

1991 production was 1,191 reciprocating compressors, 16 rotary compressors, 111 condensing units and 4,224 sets of ancillary equipment.

The enterprise does not currently produce CFC-12 compressors or ammonia compressors below 72 kW cooling capacity.

Some of YRMW's products were developed entirely in-house; others were developed in conjunction with the General Machinery Research Institute (GMRI). All are of Chinese design.

The enterprise exports a small portion of production to Singapore. Thailand, Malaysia, Indonesia and Russia.

YRMW is a 100% wholly owned state enterprise.

The enterprise occupies an area of 296,000 m2 with a building area of 122,000 m2. The original value of fixed assets is RMB 68.59 million. The staff total 1.865 of whom 244 are technicians and engineers.

PROJECT DESCRIPTION

YRMW will introduce mature small and medium open-type compressor technology from abroad. Using principally existing production machinery with some new pieces, the enterprise will set up a production facility for 3,200 compressors per year with comparable quantities of ancillary equipment. This will not directly displace any of YRMW's current production because it does not manufacture any CFC-12 compressors. However, these compressors will replace CFC-12 compressors manufactured by other concerns. Annual production proposed represents a saving in CFC-12 of about 240 tonnes composed of the initial charge and service requirements of the systems of which they are used. When in full production it is estimated that these compressors will enjoy about 25% of the market share for this category of machine.

The following enterprises currently producing 12-72 kW open drive CFC-12 compressors will close. No compensation for these closures is being requested from the Fund.

	Annual Capacity
Luahuan Ref. Machinery Factory	1,000-
Harbin " " "	1,000-
Wuhan " " "	1,000-
Hangzhou " " "	1,000-
Guangzhou " " "	1,000-
Changcheng " " "	1,000-
Qingpu Branch Shanghai Air Cond	1,000-
Total	7,000-

Ammonia compressors over 72 kW capacity have been produced for over 30 years in China. These large and medium ammonia units are widely used for food freezing, coldstores and process cooling in food, fishery and light industries. Ammonia refrigeration equipment is readily accepted among a large proportion of users. These will be manufactured using principally existing equipment used in the production of ammonia equipment. Some specialized production equipment will be needed in addition to this.

Standards for the design manufacture and testing of ammonia compressors are stipulated in the Chinese state standards GB-10874-10876-89. Ancillary equipment standards are covered in state standards JB454-468-86, JB4348-4354-86, and JB4337-4347-86. Standards for ammonia refrigeration systems are stipulated in state standards GBJ72-84 (Coldstore design) and GBJ66-84 (Installation guidelines and acceptance parameters). These standards ensure the safe and efficient use of ammonia refrigeration plant in China.

These compressors are intended principally for use in the agricultural and fishing sectors, and for medium and small scale cold storage applications. The demand in 1991 in this sector was 13,000 sets of refrigeration equipment of which 4,000 were ammonia compressors.
There are about 30 manufacturers with a total production capacity of 40,000 units per year currently producing CFC-12 compressors in this capacity range for the commercial, industrial and air-conditioning industries. This is clearly excess production capacity. The danger exists that CFC-12 compressor manufacturers will undercut the price of the ammonia compressor in an effort to retain their market share. This situation will be controlled and is dealt with below under "Required Regulatory Actions". This strategy is discussed in detail in the Strategy Document that accompanies this project submission, and in the China Country Program.

YRMW has concluded a preliminary agreement with the GRAM company of Denmark for the transfer of the manufacturing technology of their HC/T 75 series of reciprocating refrigeration compressors. The HC/T 75 is a well establish design of compressor which can be used at medium and low temperatures in addition to air conditioning duties and which matches the companies current production well. It is well suited to the Chinese market.

There is an inevitable degree of modernization to YRMW's product and production facilities by virtue of the fact that dated existing technology is being replaced by modern designs. However this is more than compensated by the significant portion of project costs that are being borne by YRMW (USD 698,000, or 20% of total project costs).

JUSTIFICATION OF ALTERNATIVE TECHNOLOGY SELECTION

According to the Montreal Protocol agreement, China will phase out CFC use. The China CP, recently accepted by the Montreal Protocol Executive Committee (MPEC) gave Ammonia and HCFC-22 key roles in phasing out CFC-12 use in this sector. Particular advantages of Ammonia as a refrigerant are:

i) It has an ODP and GWP of zero and is thus ideal from an macro environmental point of view.

ii) It is thermodynamically the most efficient of all common refrigerants.

iii) Ammonia is widely available in China and cost about 3% of the price of HCFC-22. It's use is small refrigeration systems was widespread until China's Open Door policy of the late seventies.

iv) Ammonia refrigeration technology is arguably the most mature of all since it has been in use as a refrigerant for 120 years. Technology for the size of compressor under consideration is readily available and well developed.

The shortcomings of ammonia as a refrigerant are its toxicity and flammability in critical concentrations with air. This restricts its application to areas without Human exposure. Since Ammonia has a highly pungent and unpleasant smell. Both the lethal exposure level and the flammable concentration with air are well above the level that can be voluntarily tolerated by humans which effectively reduces the likelihood of injury or death. One recent Norwegian study shows fatal accidents caused by ammonia systems to be on a par with other refrigerants.

PROJECT COSTS

Summary of Project Costs

The total project cost is USD3,488,000 of which USD2,790,000 million is considered eligible for MP financing. The grant request of USD2,874,000 includes both eligible project costs as and financial administration costs. There are no net incremental recurrent costs or benefits associated with this project.

Capital Costs

The capital costs of USD3,495,000 include capital investment in technology transfer fees, facility design and manufacture, production equipment (including installation and commissioning), compressor performance test equipment, and production costs for trial production. 20% of capital costs will be locally financed to cover inevitable process modernization which results from replacement of dated equipment. A breakdown of investment costs is given in Annex 1.

Incremental Recurrent Costs/Savings

The agreement reached with GRAM stipulates a royalty of 3.5% be paid on the sales price of the new compressors. The NPV of the running royalty (Annex 2) was included in the capital cost estimate. There are no other incremental operating costs or savings associated with this project.

Benefits

No net incremental benefits are expected.

Local Ownership Fraction

YRMW is a 100% state-owned Chinese enterprise.

Contingencies and Other Costs

A 15% contingency was included in all capital cost estimates except the technology fee. A 3% financial administration fee is included in the grant request.

UNIT ABATEMENT COST

USD2.37 /kg/year. A detailed calculation is provided in Annex 5.

PROJECT IMPLEMENTATION

Management

YRMW is responsible for the execution of this project. NEPA and MMI will supervise the execution of the project. The General Machinery Research Institute will provide technical support. A special team of employees will be delegated to ensure the smooth execution of the project.

YRMW will create a project team of 7-8 technicians and engineers, headed by a chief engineer. The team will be involved with the project on a full-time basis, in charge of technology importing, equipment purchase and installation, special machinery design, training etc. etc. Some work will be executed by YRMW's other departments.

The schedule is given below:

Task	Year 1	Year 2	Year 3	Year 4	Year 5
Import Technology	XXXX				
Procure Equipment	XXXX				
Design & Build Special Equipment	XX	XXXX			
Installation and Trial Production		XXXX	XX		
Trial Production			XXXX	XXXX	
Full Production					XXXX

REQUIRED REGULATORY ACTIONS

The following will be undertaken to ensure the success of this project.

i) Supervision and coordination of the project by NEPA

ii) Considerable excess production capacity for this size of compressor exists in

China and there is a danger that CFC-12 compressor manufacturers will undercut YRMW's production. MMI will control the production at these other enterprises via the issuing of production licenses to prevent this situation from occurring.

The following are measures that will be adopted to ensure that new non-CFC products become established in the marketplace at a sufficient rate for the phaseout goals to be achieved. These have been proposed by MMI and GMRI to the responsible ministries.

i) Tax Policy

The selling price on non-ODS products will be slightly higher than current CFC-12 based production. From 1998 differential tax rates be will applied to each to ensure that non-CFC based products become established in the market.

The State Environmental Protection Agency (NEPA), State Economy and Trade Commission, the Ministry of Finance and the Dept. of General Tax Administration will be responsible for drafting these tax measures with input from MMI and MIT.

ii) Import and Export Controls

From 2001 the same bodies listed above in conjunction with the General Customs Administration will institute import and export policies to prevent the import of CFC based equipment.

iii) Production Licenses

From mid-1998 production licenses will be issued by MMI to control the total supply of compressors to the market. This measure will be used in conjunction with (i) above to ensure that HCFC-22 and ammonia based equipment become established in the Chinese market.

The aim of these measures will be to cease production of all CFC based refrigeration equipment by January 1, 2004.

RESULTS

Direct Project Impacts

This project will remove 240 tonnes of CFC-12 when in full operation.

Indirect Project Impact

As described above, production of CFC-12 compressors at other plants will be controlled to compensate for YRMW's production.

ENTERPRISE COMMITMENT

Once MP funding is available, YRMW will carry out the activities relating to the production of ammonia compressors as described in this document and assume responsibility for project implementation.

For Yantai Refrigerating Machinery Works

The Chief Executive Officer: Gu De Lu
Date: September, 1994

ANNEX 1

Investment Costs and Equipment Justification

Expenditure

Technology Transfer Fee (including USD474,300 NPV of royalty for first 4 yrs of production)	USD 746,300
Equipment Purchase	USD1,902,000
Installation & Commissioning	USD 29,000
Trial Production	USD 453,000
Contingency	USD 357,600
Total	**USD3,488,000**

Equipment that will be purchased for the project is listed below.

Part	No	Type	Description	Manufacturer	Price (in US$1,000)
	1	MAXIM630	Horizontal machining center	Milacron (US)	1330
Case	2	XH755	Horizontal machining center	Qinghai no.1 Machine Tool Factory	118
	3	YLZJ-15-00	Horizontal Multi-shaft Drilling Machine	Self made	52
Ancillary	4	WKQ-5.5	NC Cutting Machine	Chinese Ship Industry Company	66
Equipment	5	TK54100	Vertical NC boring & milling machine	Sino-Czechoslovakia Friendship Factory	66
Testing Device	6		Performance testing device for small size ammonia compressor (12 ~ 72) kW	GRAM Company	270
Total					**1,902**

Equipment Justification

Note: This is taken from Section 5 of the Project Feasibility Study

Philosophy of New Equipment Purchase

A limited amount of equipment will be purchased to enable the current production facilities to be modified for the production of 3,200 small ammonia compressors per year with ancillary. Full use will be made of existing workshop and production facilities.

New Equipment Required

Crankshaft, connecting rod, piston, cylinder liner, shaft seal, bearings, valve plates, piston rings, motors and electrical controls will be purchased from specialized manufacturers. Thus only production equipment for crankcases and ancillary equipment is required.

Machining of Small Ammonia Compressors:

i) The milling machine for machining the crankcase end face and the radial drilling machine for forming oil holes are general purpose machine tool and will be used for this purpose in the production of the new compressor. Thus no new equipment is required.

ii) The existing multi spindle drilling machine cannot be used for cylinder block holes because the existing machine is not suitable for the new design of crankcase. A new purpose made drilling machine is also required.

iii) Because the structure of the new compressor is basically different from the existing compressor, the dedicated equipment used in their manufacture cannot be used for the following operations: coarse and final machining of the bearing housing; coarse and final machining of the cylinder liner housing; coarse and final machining of the cylinder head and side cover. In order to ensure the ISO H6 level of precision required by the technology suppliers and to achieve the required production rate, 3 horizontal machining centres are required, one with a 500mm x 500mm table for the cylinder liner housing and two with 630 x 630 tables for machining of the bearing housing, the cylinder head and side cover.

Domestically produced 630 x 630 machining centres cannot achieve the required level of precision. Imported equipment must therefore be used.

These equipment pieces are listed in Annex 1. Several quotations were obtained (Annex 9). The American Milacron machine was chosen. This equipment has a reputation for quality and reliability in China. The Chinese machine tools from the Qinghai company were selected for the same reason.

Ancillary Equipment Manufacture:

i) The following existing equipment will be used for ancillary equipment production: plate welding machines, automatic drum welding equipment, X-ray flaw detectors, gas cutting machines, automatic welding equipment, tubing reamers.

ii) There is no spare capacity on the NC cutting machine currently used for cutting plate profiles. Thus a new machine is required.

Several quotations were obtained for this equipment which should be equipped with a 5.5m x 12m rail. The equipment from the Chinese Ship Industry was selected for reasons of reliability.

iii) The equipment currently used to manufacture the heat exchanger end plates has no spare capacity and new equipment must therefore be purchased. A vertical NC boring and milling machine was selected from the Sino-Czech friendship Company.

Testing Device

Since China does not currently ammonia compressors of the capacity in question, test equipment is not available. This has to be imported. It is a dedicated piece of equipment manufactured by the technology supplier (GRAM) for testing of their compressors.

ANNEX 2

NPV of Running Royalty

Year	4	5	6	7
Production Quantity	2,240	2,560	2,880	3,200
Royalty	164,000	187,400	211,000	234,000
Net present Value (12%)	116,800	119,100	119,700	118,700
Total	**474,300** USD			

ANNEX 3

Environmental Assessment

The project has been reviewed by the relevant authorities and that unconditional approval has been given.

ANNEX 4

Safety

The Yantai Refrigerating Machinery Works has a great deal of experience in the manufacture of large and medium sized ammonia refrigeration equipment. The factory is equipped with all relevant safety devices.

This project is based on modification of existing production facilities for the production of 12-72 kW small ammonia refrigeration compressors. Thus operators will be familiar with most of the equipment in use.

In the case of new equipment, a comprehensive training programme will reduce risk to the operators to a minimum.

ANNEX 5

Unit Abatement Cost Calculation

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

Where:

C = 3,488,000 USD
C(F) = $567,660 (Annualized over 10 years at 10%)
OC = 0 USD
OS/R = 0
ODP = 240,000 kg

UAC = USD2.37/kg.yr.

Country of origin: CHINA

Project title: The production of small and medium sized ammonia refrigeration compressors at Yantai Refrigeration Machinery Works (YRMW).

Sector/sub-sector Commercial and Industrial Refrigeration and Air Conditioning

Relationship to country program (World Bank)

General Remark

At present YRMW is not producing small and medium sized ammonia compressors (between 12 kW and 72 kW) but plans to produce 3200 compressors per year in this size range as an addition to their production of higher capacity compressors. This means that formally speaking no conversion of CFC-technology to non-ODP substances takes place and consequently no funding via the Multilateral Fund can take place.

However, it is a China country policy to promote the ammonia technology by controlling the production of CFC-12 compressors. (More details are found in the Strategy Document). In fact, it is planned to close down the production of CFC-12 compressors in seven, named, enterprises (to a capacity of 7000 compressors per year) by governmental action. Therefore, this project can be considered as a conversion project and is in principle eligible for funding.

Technology

In the refrigeration and air conditioning industry ammonia is a well known, proven and acceptable (nontransitional) technology to reduce CFCs or HCFCs consumption. However, the application of ammonia has specific technology aspects (for a large part due to safety aspects). The company has already experience with producing ammonia compressors in capacities above 72 kW.

A technology transfer agreement exists with GRAM, Denmark in order to produce ammonia compressors in the range from 12 to 72 kW. Due to this technology agreement and the long term experience of the company with ammonia a successful implementation of the project can be expected.

The ammonia technology was selected due to its favorable ODP, GWP, efficiency, maturity and availability of ammonia.

Environmental impact

Ammonia has an ODP of zero and a negligible GWP. Ammonia can have a local environment impact due to its toxicity. This safety aspect can be handled well using the proper technology but limits the application area of the ammonia technology.

Project costs

- The equipment requested is essential for the conversion and capacity expansion process
- The list of costs for machining equipment is accurate, reasonable and well motivated. The production of several components needs more accurate machining than can be produced with existing equipment.
- A relatively large part of the capacity increase is obtained by better utilizing existing equipment so without additional equipment costs.
- Costs of civil works must be excluded from the list of costs.
- No operational costs are being claimed.
- The UAC value obtained is reasonable compared to other, similar, projects.

Implementation timeframe

The proposed implementation time frame is reasonable.

Relevance and adequacy of information provided

Information provided consisted of project proposals, detailed appendices directly sent from the companies, comments by World Bank officer and consultant and a Strategy Document. Altogether sufficient information for a review has been present.

Recommendations

Approval of the project provided costs mentioned above are excluded

Martien Janssen, OORG MM338
Eindhoven,
The Netherlands
20-October-1994

UNIDO

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

COUNTRY	People's Republic of China		
PROJECT TITLE	Conversion from Halon 1211 to ABC dry powder and foam water spray at Nanjing Fire Fighting Equipment Factory		
SECTORS COVERED	Halon (fire protection)		
ODS USE IN SECTOR	4,400 MT (17,600 MT ODP-weighted) of Halon 1211 and 660 MT (10,600 MT ODP-weighted) of Halon 1301 in 1991		
PROJECT IMPACT	Phase out annual consumption of 370 MT of Halon 1211 (total 1480 ODP-weighted MT)		
PROJECT DURATION	24 months		
PROJECT ECONOMIC LIFE	10 years		
TOTAL PROJECT COST	Investment (capital) costs, US$		521,954
	Incremental operating costs/savings, US$		147,292
	Project preparation costs, US$		30,000
	Total Project Costs, US$		699,246
	Agency overhead (13 per cent)		90,902
OWNERSHIP STRUCTURE	100 per cent Chinese		
PROPOSED MF FINANCING	US$	790,148	including Agency overhead (13 per cent)
UNIT ABATEMENT COST	US$	0.12	per kg of phased-out ODS
COUNTERPART ENTERPRISE	Nanjing Fire Fighting Equipment Factory		
IMPLEMENTING AGENCY	UNIDO		
COORDINATING MINISTRY	The Ministry of Public Security		
NATIONAL COORDINATING AGENCY	National Environmental Protection Agency (NEPA)		

PROJECT SUMMARY

This project will phase out the annual use of 370 MT of Halon 1211 (ODP=4.0, that is, total 1,480 MT ODP-weighted ODS) as fire extinguishing media in portable fire extinguishers and in fixed fire fighting installations produced by the Nanjing Fire Fighting Equipment Factory, one of the largest manufacturers of fire fighting equipment in China.

The phasing out of the halon will be accomplished by a total change of the production facilities where instead of portable Halon extinguishers, ABC dry powder extinguishers will be produced. The Halon in the fixed fire fighting systems will be replaced with production of foam/water system. The selection of alternative extinguishing agents is based on the strategy given in the China Country Program for the Phaseout of Ozone Depleting Substances.

The requested Multilateral Fund grant for the project is US$ 790,148. The project document also indicates the investment commitments made by the Nanjing Fire Fighting Equipment Laboratory.

This project was appraised by the SINTEF NBL (Norwegian Fire Research Laboratory). Their comments are incorporated in this version.

Contents

1. Project overview

This project will phase out the annual use of 370 MT of Halon 1211 (ODP=4.0, that is, total 1,480 MT ODP-weighted ODS) as fire extinguishing media in portable fire extinguishers and in fixed fire fighting installations produced by the Nanjing Fire Fighting Equipment Factory.

The Nanjing Factory is a specialized manufacturer assigned by the Public Security Ministry of PR China to produce fire extinguishing equipment, systems and supplies. The factory is one of the largest manufacturers of fire fighting equipment in China.

At present, production in the factory is concentrated around four main products:

a) Portable Halon 1211 fire extinguishers;

b) Fixed Halon 1211 fire extinguishing systems;

c) Water sprinkler systems; and

d) Fixed CO_2 fire extinguishing systems.

The phasing out of the halon will be accomplished by a total change of the production facilities where instead of portable halon extinguishers, ABC dry powder extinguishers will be produced. The halon in the fixed systems will be replaced with foam water spray fire fighting systems. The production of present fixed CO_2 fire extinguishing systems will be continued.

The alternatives have been selected mainly for two reasons:

- There is no extinguishing media available today which could replace halon 1211 as a drop-in agent. It is therefore necessary to offer the market a wider variety of products in order to cover the same areas of fire hazards as Halon 1211 does today. The selected alternatives have proven and well documented effectiveness against most types of fires and it will, from a technical point of view, be relatively easy to start a production with the new type of extinguishing media. With the exception of foam mixing equipment for the foam/water spray systems most of the necessary equipment for the production is available in China.

- The management and the staff at the Nanjing factory have a long experience in the production of portable fire extinguisher and fixed fire fighting systems. It is therefore of great advantage if a similar production technology can be selected for the replacement products.

In order to accomplish the necessary changes in the products (or introduce new products), new manufacturing processes and new technologies have to be introduced in some areas. This will require new production facilities. The factory will move to a suburban area, more suitable for this type of industrial production. The project has full support both from the Ministry of Public Security and from the local authorities.

The total estimated cost for the project is US$ 1.138.786. The approach adopted here is in accordance with the strategies described in the China Country Programme[1].

[1] China Country Programme, section 3.7 "Halons", January 1993.

2. Project objective

The objective of the present project is to totally phase out the use of Halon 1211 as fire extinguishing media in the production of portable fire extinguishers and fixed fire fighting installations at the Nanjing Fire Fighting Equipment Factory.

The halon will be replaced with the following fire extinguishing media:

a) ABC dry powder:

ABC dry Powder is normally based on a mixture of Ammonium phosphate and Ammonium sulphate. This type of powders is very effective against almost all types of fires and very common as fire extinguishing media in portable fire extinguishers. The effect is well proved both from tests and practical experience. ABC dry powders will soon be produced in China[2].

b) Foam/Water:

The use of AFFF (Aqueous Film Forming Foam)/Water spray is widely spread in the world and has proven to be an effective fire extinguishing media. The selected technology is based on the National Fire Protection Association standard "NFPA 16, Deluge Foam Water Sprinkler and Foam Water Spray Systems." The purpose of the standard is to provide a reasonable degree of protection for life and properties from fires through installation requirements for Foam Water Deluge Sprinkler Systems and Foam Water Spray Systems based upon sound engineering principles, test data and field experience. This type of fire fighting systems is effective against a variety of fire hazards but is mainly installed in areas with a high risk for fires in hydrocarbons or with special foam also in areas with a risk for fires in chemicals.

c) CO_2

The Nanjing Fire Fighting Equipment Factory already produces carbon dioxide fixed systems. The Factory will continue to offer this option. Carbon dioxide is a well proven fire extinguishing media very suitable for certain applications. The disadvantage with carbon dioxide is the increased risk of accidental death caused by discharge of the systems. This means that in areas where CO_2 systems are installed very strict safety precautions have to be taken.

3. Sector background

The "China Country Program for the Phase out of Ozone Depleting Substances under the Montreal Protocol" shows that the total consumption of Halon 1211 was 4,000 MT during 1991 (including 500 MT imported Halon 1211). With an ODP of 4.0 for Halon 1211, this means that the ODP-weighted annual consumption is equivalent to 16,000 MT of ODS.

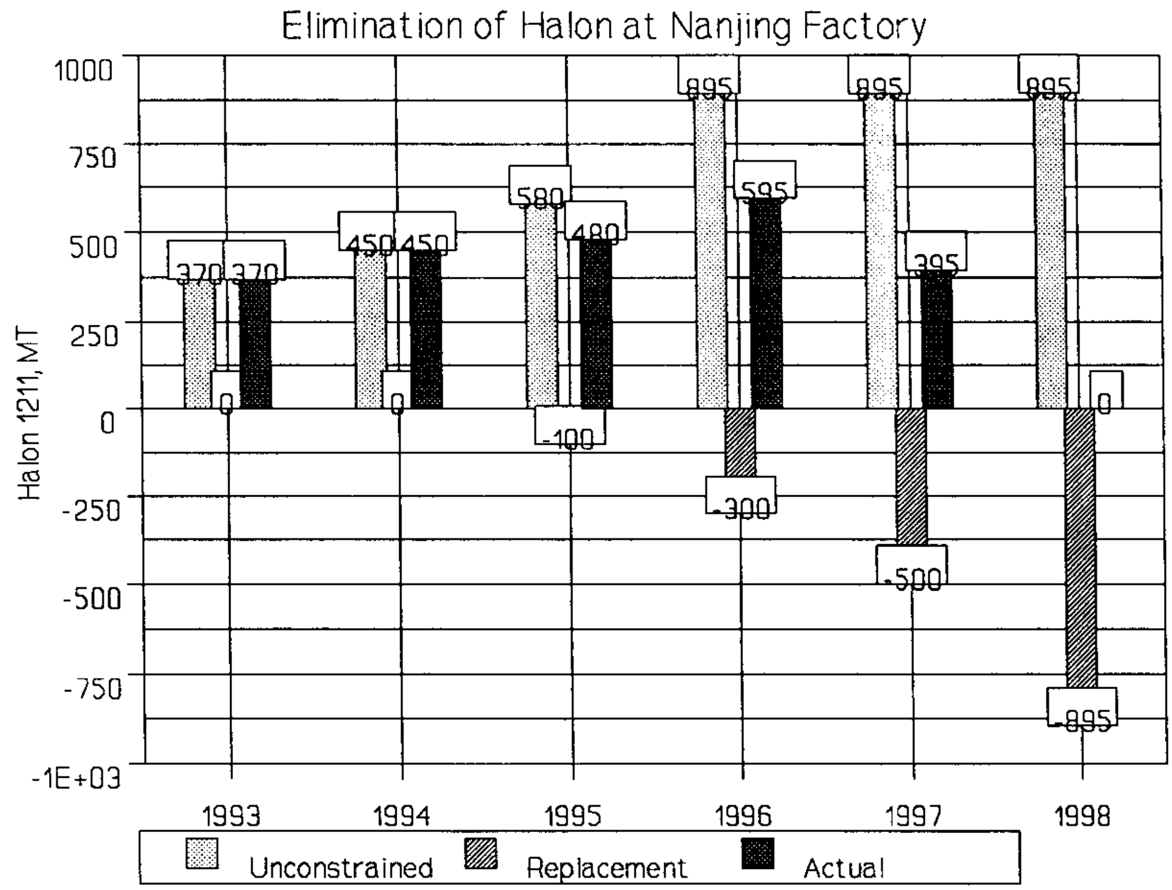
The strategy of the Chinese Government for replacement of halon is also given in the Country Program mentioned above. The proposed project for the Nanjing Factory fully complies with the strategy given in the Country Program.

As shown in the "Report on the Selection of Halon Technology 1990", prepared by the UNDP and UNEP, the world consumption of Halon 1211 is 13,200 MT in 1990 of which 3,500 MT is the annual consumption of China alone.

[2] A project to start the production of 3,000 MT of ammophos (ABC) dry powder at the Beijing Fire protection Equipment Factory has been approved by the Executive Committee of the Multilateral Fund.

China is under rapid economic development and therefore the halon consumption increased by a high rate during 1991-1993. It is estimated that the Chinese consumption almost covered half of the total world consumption of Halon 1211 in 1993.

During 1993 the Nanjing Factory consumed 370 MT of Halon 1211. The production plan for 1994 shows that the consumption will increase to 580 MT for 1995 and 895 MT for 1996. Because of this high rate of increase, it will be very cost effective if the replacement can start as soon as possible.



4. Enterprise background

The Nanjing Fire fighting equipment Factory is one of the largest manufacturers of fire fighting equipment, systems and supplies in China. The factory has 1000 employees and is under the Ministry of Public Security. In 1993 the Nanjing factory earned an annual income of RMB21.0 million (US$2.4 million) which showed an 80 per cent increase over 1992. The factory produced 240,000 portable fire extinguishers in 1993. This is about 10 per cent of the total production of portable fire extinguishers in China. Besides the portable fire extinguishers, the Nanjing factory also produced 2,400 fixed Halon 1211 fire extinguishing systems. The total Halon 1211 consumption during 1993 was 370 MT. The planned production output value of the Nanjing Factory will be RMB 30.0 million (US$ 3.45 million) for 1994 and the Halon consumption for the same year will be approximately 450 MT.

5. Project description

The Nanjing Factory will accomplish the goal to replace all halon-based production by changing over to ABC dry powder for the portable fire extinguishers and foam/water spray for the fixed fire fighting systems. This means that the two new products will be introduced and manufactured in the future. There is no single drop-in agent available today to replace the Halon 1211. Therefore, it is necessary to replace the present production with more than one type of extinguishing media.

The selection of the replacement agents is based on the present production experience at the factory as well as the need to offer the market new fire extinguishing products which together cover the same areas of fire hazards as halon covers today.

The present production capability is utilized to its full capacity. The factory and the equipment for production are in many cases more than 20 years old. Only a limited number of the machines will be suitable to use for the new production. The factory is also situated in an area which is not very suitable for this type of industrial manufacturing activity. Therefore, in order to implement the project efficiently, new production equipment as well as a new factory building of around 5,000 m^2 workshop area will be necessary.

5.1 Production of portable ABC dry powder extinguishers

The portable halon fire extinguishers produced at the Nanjing factory today are made according to Chinese standards. The design and quality of the extinguishers are good and comparable with many similar products available outside China.

The technology for producing ABC dry powder portable fire extinguishers is well known in China and about 65 per cent of the necessary new equipment and machinery for the production are available from domestic suppliers.

All the mechanical components of the new extinguisher will be manufactured at the Nanjing Factory except the pressure gauges and the ABC dry powder which have to be purchased from other suppliers in China. The new manufacturing processes are still based on manual manufacturing and assembling of the extinguishers.

The main production stages for portable ABC dry powder and CO_2 extinguishers is shown in Exhibit 1.

The lists of equipment absolutely needed for the project are prepared by the Nanjing Factory and are given in Annex 6. These lists include equipment to be funded by the Multilateral Fund grant and equipment to be purchased directly by the factory.

Referring to Annexes 1 (total investment costs), 2 (incremental operating costs/savings) and 6.a (list of equipment for portable ABC extinguisher), the cost of the conversion of manufacturing plant for portable ABC dry powder fire extinguishers is given in Exhibit 2. (Please note that this is a part of the whole project and, in reality, may not be implemented in isolation.)

The unit abatement cost of eliminating halon used in portable extinguishers through dry ABC powder technology is given in Annex 4.b.

Exhibit 1. Principal production line for dry powder portable fire extinguishers

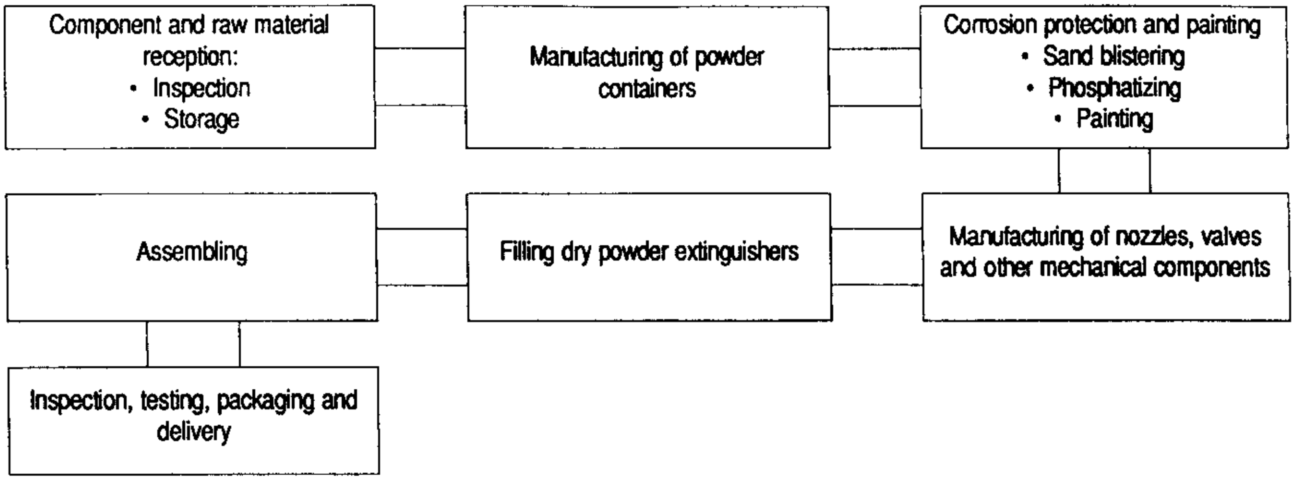


Exhibit 2. Costing of the production of portable ABC dry powder fire extinguisher

	Item	RMB	US$
i	Total investment costs (Annex 1)	4,429,000	509,080
ii	Annual incremental operating costs/savings (Annex 2 and 4.b)	(214,667)	(24,674)
iii	Incremental operating costs/savings for 4 years (4*ii)	(858,667)	(98,697)
iv	NPV of incremental operating costs/savings for 4 years [iii*(317/400)]	(680,493)	(78,218)
v	Net incremental cost (i+iv)	3,748,507	430,863

The net incremental cost for replacement of 140 MT of Halon 1211 with ABC dry powder fire extinguishers is US$ 430,863.

5.2 Production of foam/water spray fire fighting systems

The foam/water spraying system the Nanjing Factory plans to produce should technically be based on the US National Fire Protection Association standard NFPA 16. This standard gives the basic requirements for design and installation of the systems.

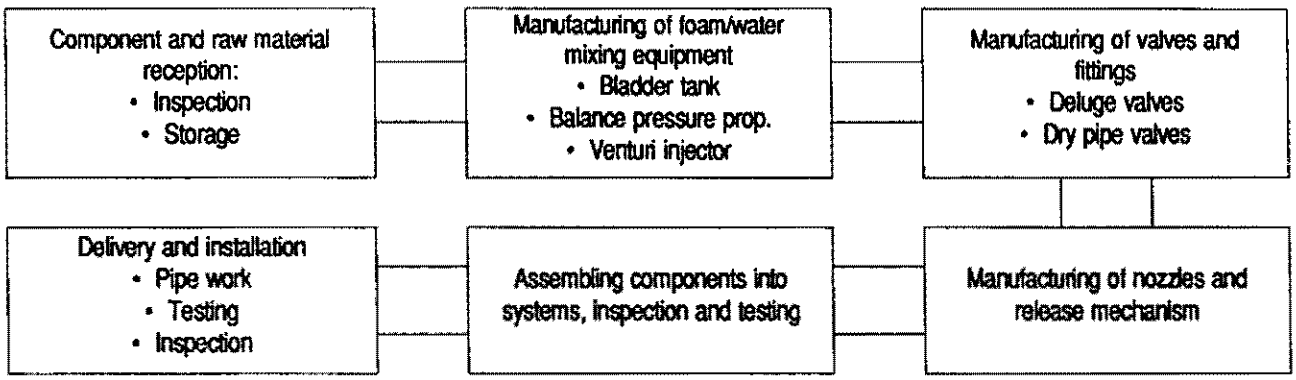
The foam/ water spraying fire extinguishing systems replace halons for fixed fire fighting installations in e.g. chemical industry, power stations and oil refineries.

The Nanjing Factory plans to produce foam /water spraying systems with two different types of extinguishing foams: The AFFF (Aqueous Film Forming Foam) for oil fire hazards and ARC (Alcohol Resistant Compound) for fire hazards in chemical industries.

Many of the components in a foam/water spraying system are of standard types and could easily be purchased in China. The important components for the Nanjing Factory to manufacture themselves are the foam mixing equipment, valves and nozzles. AFFF concentrate is already under production in China, but ARC concentrate either has to be imported or manufactured under license in China. The operational cost calculations here are based upon the price for imported concentrate. In the future, the Factory plans to build up facilities for the production of ARC foam concentrate.

The principal production line for the manufacture of foam/water spraying systems is shown in Exhibit 4.

Exhibit 4. Principal production line for foam/water spray fixed fire extinguishing systems



There are institutes and a number of companies in China that are specializing in the development and production of automatic foam/water fire extinguishing systems. For example, Tianjing Fire Fighting Research Institute possesses a rather strong capacity in research and development of new foam/water systems. The institute has a good knowledge about both the international and the domestic technologies in the fire fighting equipment sector.

Nanjing Fire Fighting Equipment Factory and the Tianjing Fire Fighting Research Institute are both managed under the Public Security Bureau. Therefore, close cooperation between these two institutions is quite easy to achieve. At present, NFFEF has already established contacts with Tianjing Fire Fighting Research Institute through the Public Security Bureau for the technology transfer. The programme of cooperation and the schedule of the development work, including the costs involved, is given Annex 6.b. These costs will be borne by the NFFEF.

The list of equipment needed for the project is given in Annex 6.

Exhibit 5 gives the necessary investment needed for the manufacturing of foam/water spraying systems.

Exhibit 5. Costing of the production of fixed foam/water spray fire fighting systems

	Item	RMB	US$
i	Total investment costs (Annex 1)	3,936,000	452,414
ii	Annual incremental operating costs (Annex 2 and 4.c)	618,907	71,139
iii	Incremental operating costs/savings for 4 years (4*ii)	2,475,627	284,555
iv	NPV of incremental operating costs/savings for 4 years [iii*(317/400)]	1,961,934	225,510
v	Net incremental cost (i+iv)	5,897,934	677,923

The net incremental cost for replacement of 120 MT of Halon 1211 with foam/water spray systems is US$ 677,923. In order to cover industrial fire hazards which today are protected by halon, the foam /water spraying systems have characteristics which make them superior compared to CO_2 based systems. Therefore, it is necessary to offer the market at least two alternative systems which together cover almost all fire hazards today protected by halon.

5.3 Production of fixed CO_2 systems

The Nanjing Factory has a long experience in the production of fixed CO_2 fire fighting systems. The present type of system is, however, not suitable as a halon replacement system. Therefore, it is outside of the discussion here. However, the Nanjing Factory will continue to offer these systems.

6. Justification of selection of alternative technology

In the fire fighting sector mainly three types of ozone depleting agents are used: Halon 1211 CF_2ClBr and Halon 1301 (CF_3Br). For some specific fire hazards also Halon 2402 ($C_2F_4Br_2$) is used. So far there is no drop-in substitute available on the market. The selected replacement agents for the Nanjing Factory, that is ABC dry powder and foam/water spray, are well known fire extinguishing media and they have proved to be effective against a variety of fires. In order to cover the demand of the market, both the portable and fixed type of fire fighting products must be replaced with more than one substitute. The market for halon based fixed fire extinguishing systems is still growing very fast in China. The orders to the Nanjing Factory have increased by more than 100% during 1994. In order to break this development, the market must be offered acceptable alternatives. The selected agents give this possibility. Another aspect justifying the selection of agents is the manufacturing capability at the Nanjing Factory. The new production is well in line with the present manufacturing experience of the staff and management at the factory. This is important also from a quality and training point of view.

7. Project cost

The total incremental cost of the project is US$ 669,246 (see Exhibit 8 below).

Exhibit 8. Total cost of project

	US$
Total investment costs (Annex 1)	521,954
Annual incremental operating costs (Annex 2)	46,464
NPV incremental operating costs for 4 years (3.17*46,464)	147,292
Total incremental cost	669,246
Project preparation costs	30,000
Total project cost	699,246
Agency overhead (13 per cent)	90,902
Total MF grant	790,148

8. Project implementation

The Jiangsu Provincial Environment Bureau and the Nanjing Municipal Environment Bureau will oversee the implementation of the project. The United Nations Industrial Development Organization will provide technical assistance to the Nanjing Factory during the project. The final implementation schedule will include the new factory building and will be made later and attached to project as an annex.

9. Required regulatory actions

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

10. Results

The present project will be completed within 2 years. One year after the completion of the project, the consumption of halons will be completely eliminated at the Nanjing Factory.

11. Overview of annexes

Annex 1:	Breakdown of investment (capital cost)	
Annex 2:	Breakdown of the total incremental operating costs/savings	
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Annex 4:	Calculation of total unit abatement cost	
	Annex 4.a:	Calculation of UAC for the complete project
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Annex 5:	Environmental assessment	
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	Annex 6.a:	List of equipment for portable ABC dry powder extinguishers
	Annex 6.b:	List of equipment for fixed foam/water spray systems

Annex 1. Breakdown of total investment (capital) cost

	Description of cost items	Unit	Unit Cost RMB	Qty	Total Cost RMB	Total Cost US$ (8.70)
1	Portable ABC Dry Powder Extinguisher					
1.A	Equipment produced in China	set	240,000	1	240,000	27,586
1.B	Equipment to be imported	set	465,000	1	465,000	53,448
1.C	Technology acquisition and training	set	400,000	1	400,000	45,977
	Sub-total				*1,105,000*	*127,011*
2	Fixed Foam/Water Spray Fire Fighting System					
2.A	Equipment produced in China	set	1,740,000	1	1,740,000	200,000
2.B	Equipment to be imported	set	1,696,000	1	1,696,000	194,943
2.C	Technology acquisition and training	set	0	0	0	0
	Sub total				*3,436,000*	*394,943*
	TOTAL				**4,541,000**	**521,954**

Annex 2. Breakdown of total incremental operating cost (US$1.00=RMB8.70)

	Description of cost items	Unit	Unit Cost RMB	Quantity	Pre-project total cost		Post Project Total Cost	
					RMB	US$	RMB	US$
A	Portable Halon Extinguisher							
1	Consumption of Halon 1211 per annum	MT	30,000	240	7,200,000	827,586		
2	Annual steel consumption	MT	4,500	384	1,728,000	198,621		
3	Consumption of external structural components per year	set	18.50	240,000	4,440,000	510,345		
4	Annual consumption of packaging materials	pc	3.60	240,000	864,000	99,310		
5	Annual consumption of welding and painting paste	pc	3.60	240,000	864,000	99,310		
	Sub-total				15,096,000	1,735,172		
B	Fixed Halon System							
1	Annual consumption of Halon 1211	MT	30,000	120	3,600,000	413,793		
2	Annual steel cylinder consumption	pc	650	2,400	1,560,000	179,310		
3	Annual consumption of flexible metal tubes used for starting device	set	1,970	2,400	4,728,000	543,448		
4	Annual consumption of other materials used for manufacturing starting device	set	2,157	480	1,035,360	119,007		
5	Annual consumption of painting paste	set	1,530	480	734,400	84,414		
	Sub-total				11,657,760	1,339,972		
C	Additional costs							
1	Electricity				200,000	22,989		
2	Labour	per	6,000	1,000	6,000,000	689,655		
3	Equipment maintenance				96,000	11,034		
	Sub-total				6,296,000	723,678		
D	Portable ABC dry powder extinguisher							
1	Annual ABC dry powder consumption	MT	5,500	480			2,640,000	303,448
2	Annual steel consumption	MT	4,500	840			3,780,000	434,483
3	Annual consumption of external structural components	set	24.50	240,000			5,880,000	675,862
4	Annual consumption of packaging materials	pc	2.80	240,000			672,000	77,241
5	Annual consumption of welding and painting paste	pc	4.50	240,000			1,080,000	124,138
	Sub-total						14,052,000	1,615,172
E	Fixed foam water system							
1	Material consumption per year for 400 m2 foam water system	set	54,750	120			6,570,000	755,172
2	Material consumption per year for 200 m2 foam water system	set	44,100	120			5,292,000	608,276
	Sub total						11,862,000	1,363,448
D	Additional common costs							
1	Electricity						400,000	45,977
2	Labour	per	6000	1,100			6,600,000	758,621
3	Equipment maintenance						540,000	62,069
	Sub total						7,540,000	866,667
	Total Pre-project costs/year				33,049,760	3,798,823		
	Total Post-project costs/year						33,454,000	3,845,287
	Total incremental costs/year						404,240	46,464

Annex 3 Breakdown of incremental benefits

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

Annex 4. Calculation of unit abatement cost (UAC)

Annex 4.a Calculation of total unit abatement cost of overall project (US$1.00=RMB8.70)

		Unit		Unit	
A.0	ODS phase out				
A.1	Average use of Halon 1211 per year	MT/year	370	MT/year	370
A.2	ODP of Halon 1211		3		3
A.3	ODP-weighted Halon 1211 phase out (A.1*A.2)	MT/year	1,110	MT/year	1,110
B.0	Annualized capital cost				
B.1	Total investment costs from Annex 1	RMB	4,541,000	US$	521,954
B.2	Equipment life	year	10	year	10
B.3	Discount rate	%	10	%	10
B.4	Annualized capital cost B.1*0.1627	RMB/year	738,821	US$/year	84,922
C.0	Annual incremental operation cost from Annex 2	RMB	404,240	US$	46,464
D.0	Unit abatement cost				
D.1	Annualized capital cost per kg ODS (B4/A.3/1000)	RMB/kg	0.67	US$/kg	0.08
D.2	Annual incremental operation cost ODS phase out (C.0/A.3/1000)	RMB/kg	0.36	US$/kg	0.04
D.3	Unit abatement cost (D.1+D.2)	RMB/kg	1.03	US$/kg	0.12

Note: The actual ODP-weighted phaseout is actually higher than 360 MT which is used for new equipment. Because 10 to 20 MT of Halon 1211, that is 30 to 60 MT of ODP-weighted ODS used for maintenance in existing installations will also be eliminated.

Annex 4.b Calculation of unit abatement cost for portable dry ABC powder extinguisher (US$1.00=RMB8.70)

		Unit		Unit	
A.0	ODS phase out				
A.1	Average use of Halon 1211 per year	MT/year	240	MT/year	240
A.2	ODP of Halon 1211		3		3
A.3	ODP weighted Halon 1211 phase out (A.1*A.2)	MT/year	720	MT/year	720
B.0	Annualized capital cost				
B.1	Investment cost for portable ABC dry powder extinguishers from Annex 1	RMB	1,105,000	US$	127,011
B.2	Equipment life	year	10	year	10
B.3	Discount rate	%	10	%	10
B.4	Annualized capital cost B.1*0.1627	RMB/year	179,784	US$/year	20,665
C.0	Annual incremental operation savings according to note given below	RMB/year	(214,667)	US$/year	(24,674)
D.0	Unit abatement cost				
D.1	Annualized capital cost per kg ODS (B.4/A.3/1000)	RMB/kg	0.25	US$/kg	0.03
D.2	Annual incremental operation savings ODS phase out (C.0/1000/A.3)	RMB/kg	-0.30	US$/kg	-0.03
D.3	Unit abatement cost (D.1+D.2)	RMB/kg	-0.05	US$/kg	-0.01

Note:

Annual operating cost for portable ABC dry powder extinguishers from Annex 2 (Part D)	14,052,000
2/3 of post-project annual additional common operating costs from Annex 2 (Part F)	5,026,667
(minus) Pre-project annual operating costs for portable Halon extinguishers from Annex 2 (Part A)	(15,096,000)
(minus) 2/3 of pre-project annual additional common operating costs from Annex 2 (Part C)	(4,197,333)
Annual incremental operating savings for portable ABC dry powder extinguishers	(214,667)

Annex 4.c Calculation of unit abatement cost for fixed foam water spray fire fighting system (US$1.00=RMB8.70)

		Unit		Unit	
A.0	ODS phase out				
A.1	Average use of Halon 1211 per year	MT/year	120	MT/year	120
A.2	ODP of Halon 1211		3		3
A.3	ODP weighted Halon 1211 phase out (A.1*A.2)	MT/year	360	MT/year	360
B.0	Annualized capital cost				
B.1	Investment cost for fixed foam water spray fire fighting system from Annex 1	RMB	3,436,000	US$	394,943
B.2	Equipment life	year	10	year	10
B.3	Discount rate	%	10	%	10
B.4	Annualized capital cost B.1*0.1627	RMB/year	559,037	US$/year	64,257
C.0	Annual incremental operation cost according to note given below	RMB/year	618,907	US$/year	71,139
D.0	Unit abatement cost				
D.1	Annualized capital cost per kg ODS (B.4/A.3/1000)	RMB/kg	1.55	US$/kg	0.18
D.2	Annual incremental operation costs ODS phase out (C.0/1000/A.3)	RMB/kg	1.72	US$/kg	0.20
D.3	Unit abatement cost (D.1+D.2)	RMB/kg	3.27	US$/kg	0.38

Note: (All figures are in RMB)

Annual operating cost for fixed foam water spray system from Annex 2 (Part E)	11,862,000
1/3 of post-project annual additional common operating costs from Annex 2 (Part F)	2,513,333
(minus) of pre-project annual operating costs for fixed Halon extinguishers from Annex 2 (Part B)	(11,657,760)
(minus) 1/3 of pre-project annual additional common operating costs from Annex 2 (Part C)	(2,098,667)
Annual incremental operating costs for fixed foam water spray system	618,907

Annex 5. Environmental assessment

In the proposed project, the manufacturing processes are well-established and have easy-to-implement environmental pollution control methods. These are related to metal forming and machining industries, including surface finishing and painting. The new factory building, will have the necessary waste treatment facilities.

Annex 6. List of equipment

Annex 6.a List of equipment for portable ABC dry powder fire extinguisher production line

New equipment to be provided by the Multilateral Fund

	Type and description of equipment	Unit	Qty	Unit price RMB	Total price RMB	Total price US$
A. Domestic equipment (equipment manufactured in China)						
A1	Hardening furnace	pc	1	150,000	150,000	17,241
A2	Duct head tightening machine	pc	2	14,000	28,000	3,218
A3	Cylinder head tightening machine	pc	2	31,000	62,000	7,126
Sub-total (A. Domestic equipment)					240,000	27,586
B. Imported equipment						
B1	Automatic dry powder filling machine	pc	2	130,500	261,000	30,000
B2	High pressure hydraulic testing facility (fixed)	pc	1	204,000	204,000	23,448
Sub-total (B. Imported equipment)					465,000	53,448
C. Technology acquisition and technical training						
C1	Technical training on automatic filling machines (abroad, 2-4 weeks, 6-8 people)	set	1	400,000	400,000	45,977
Sub-total (C. Technology acquisition and technical training)					400,000	45,977
TOTAL					1,105,000	127,011

Annex 6.a (continued)

List of equipment for portable ABC dry powder fire extinguisher production line

New equipment to be provided by the Nanjing Fire Fighting Equipment Factory

	Type and description of equipment	Unit	Qty	Unit price RMB	Total price RMB	Total price US$
A. Equipment manufactured in China						
A1	Sheet metal shearing machine	pc	1	52,000	52,000	5,977
A2	100T single column press: Blank cutting	pc	1	105,000	105,000	12,069
A3	Open type high performance press with fixed table (1,600 kN)	pc	1	245,000	245,000	28,161
A4	Open type high performance press with fixed table (630 kN)	pc	1	95,000	95,000	10,920
A5	Open type high performance press with fixed table (250 kN)	pc	1	68,000	68,000	7,816
A6	Feeding manipulators and conveyor	set	4	98,000	392,000	45,057
A7	Cylinder air tightness tester	pc	1	100,000	100,000	11,494
A8	Phosphatizing and cleaning facility	set	1	200,000	200,000	22,989
A9	Assembly area conveyor	set	2	175,000	350,000	40,230
A10	Automatic packaging machine	pc	1	28,000	28,000	3,218
A11	Spot welding machine	pc	1	12,000	12,000	1,379
Sub-total (A. Domestic equipment)					1,647,000	189,310
B. Jigs, fixtures, dies and tools for all manufacturing processes						
B1	Drawing dies, tightening dies, welding fixtures, etc. (around 60 pieces)	set	1	250,000	250,000	28,736
Sub-total (B. Jigs, fixtures, dies and tools)					250,000	28,736
TOTAL					1,897,000	218,046

Annex 6.b List of equipment for fixed foam/water fire fighting system production line

New equipment to be provided by the Multilateral Fund

	Type and description of equipment	Unit	Qty	Unit price RMB	Total price RMB	Total price US$
A. Domestic equipment (equipment manufactured in China)						
A1	Nozzle assembly line	pc	1	320,000	320,000	36,782
A2	Valve body machining	pc	1	920,000	920,000	105,747
A3	Valve body spinning machine	pc	1	300,000	300,000	34,483
A4	Air-tightness tester	pc	1	200,000	200,000	22,989
Sub-total (A. Domestic equipment)					1,740,000	200,000
B. Imported equipment						
B1	N filling machine	pc	1	217,000	217,000	24,943
B2	DM type frozen storage	pc	1	1,044,000	1,044,000	120,000
B3	N stoppage	pc	1	435,000	435,000	50,000
Sub-total (B. Imported equipment)					1,696,000	194,943
TOTAL					3,436,000	394,943

Annex 6.b (continued)

List of equipment for fixed foam/water fire fighting system production line

New equipment to be provided by the Nanjing Fire Fighting Equipment Factory

	Type and description of equipment	Unit	Qty	Unit price RMB	Total price RMB	Total price US$
A. Domestic equipment (equipment manufactured in China)						
A1	Vertical milling machine	pc	1	124,000	124,000	14,253
A2	Universal knee-type milling machine	pc	1	100,000	100,000	11,494
A3	Single column hydraulic press (fitting)	pc	1	80,000	80,000	9,195
A4	Engine lathe	pc	1	90,000	90,000	10,345
A5	CNC lathe	pc	6	70,000	420,000	48,276
A6	Hydraulic pressure tester for spray nozzles	pc	2	5,000	10,000	1,149
A7	Fatique testing device for water spray nozzles	pc	1	50,000	50,000	5,747
A8	Hydraulic pressure and water tightness tester	pc	1	50,000	50,000	5,747
A9	Fire fighting pump	pc	1	12,000	12,000	1,379
A10	Sluice valve	pc	4	1,000	4,000	460
A11	Back pressure valve Hydraulic water tank	pc	4	1,000	4,000	460
A12	Hydraulic water tank	pc	1	10,000	10,000	1,149
A13	Rotor-type flow meter with read-out	pc	1	5,000	5,000	575
A14	Calibrated water distribution tank	pc	1	5,000	5,000	575
A15	Test tank for water spray nozzle	pc	1	5,000	5,000	575
A16	Air tightness tester	pc	1	5,000	5,000	575
A17	Static operating temperature tester	pc	1	6,000	6,000	690
A18	Universal hydraulic tester	pc	1	20,000	20,000	2,299
A19	Impact testing stand	pc	1	50,000	50,000	5,747
A20	Vibration testing stand	pc	1	48,000	48,000	5,517
A21	Chemical environment corrosion testing tank	pc	1	15,000	15,000	1,724
A22	Valve body hydraulic pressure tester	pc	1	9,000	9,000	1,034
A23	Valve body air-tightness tester	pc	1	250,000	250,000	28,736
A24	Valve body action tester	pc	1	8,000	8,000	920
A25	Hydraulic sand blasting	pc	1	28,000	28,000	3,218
A26	Vertical valve body machining	pc	1	300,000	300,000	34,483
A27	N filling machine	pc	2	243,600	487,200	56,000
A28	Horizontal machining centre	pc	1	2,000,000	2,000,000	229,885
Sub-total (A. Domestic equipment)					4,195,200	482,207

	Type and description of equipment	Unit	Qty	Unit price RMB	Total price RMB	Total price US$
B. Design modification and adoptation equipment						
B1	PC workstation	pc	1	20,000	20,000	2,299
B2	Printer	pc	1	5,000	5,000	575
B3	Plotter	pc	1	80,000	80,000	9,195
B4	Basic CAD software	pc	1	25,000	25,000	2,874
Sub-total (B. Design modification and adoptation equipment)					130,000	14,943
C. Test equipment						
C1	Mechanical tension tester	pc	1	150,000	150,000	17,241
C2	Reed's hardness tester	pc	1	12,000	12,000	1,379
C3	Thickness tester	pc	1	6,000	6,000	690
C4	Digital coating thickness tester	pc	1	5,000	5,000	575
C5	Spectrometer	pc	1	15,000	15,000	1,724
C6	Ultrasonic flaw detector	pc	1	15,000	15,000	1,724
C7	Metallurgical microscope	pc	1	100,000	100,000	11,494
C8	Carbon/sulphur determination equipment	pc	1	3,000	3,000	345
C9	Colorimeter	pc	1	10,000	10,000	1,149
C10	Microscope with readout	pc	1	1,000	1,000	115
C11	Roughness tester	pc	1	40,000	40,000	4,598
Sub-total (C. Test equipment)					357,000	41,034
D. Services						
D1	630 kVA transformer and associated electricity distribution equipment to cope with the increased power demand	set	1	340,000	340,000	39,080
D2	Air compressor	set	2	100,000	200,000	22,989
Sub-total (D. Services)					540,000	62,069
TOTAL					5,222,200	600,252

To be provided by the Nanjing Fire Fighting Equipment Factory:

Technology development and transfer programme of the Nanjing Fire Fighting Equipment Factory on fixed foam/water fire fighting system production line

1. Development and application of automatic foam/water fire extinguishing systems in China

It was as early as in the 1960s that China first developed and/or assimilated the technologies of manufacturing and application of automatic water fire-extinguishing systems. At present, almost all of the Chinese provinces have this kind of technology.

There are a number of companies in China that are specializing in the development and production of automatic water/foam fire-extinguishing systems. Their products can be classified into two groups:

a) The first is a foam fire-extinguishing system that can have high, medium and low intensity. The key end-users are mainly large scale oil tank fields, airports and storage for chemical material. This technology was adopted for use by the Beijing Capital Airport and the "Meidao" corporation at Shanghai airport.

b) The second is a AFFF (aqueous Film Forming Foam) fire-extinguishing system. Important protection objects are: car carriages, carriages, diesel generators, boiler rooms (houses), and places with easy burning liquid.

A fire extinguisher factory in Shanghai (under the supervision of the Public Security Bureau) has adopted a complete water/foam system through a technology transfer arrangement with the Tianjin Fire Fighting Research Institute (also under the Public Security Bureau). This system has already been put into operation for several years.

With regard to the AFFF hydrogenic film stuff production factories, there are, for example, only in Jiangsu province already two factories: Yangzhou Factory and Changzhou Factory. With regard to Nanjing Fire Fighting Equipment Factory (NFFEF), the factory will in short develop and supply a new foam/water system.

2. Development of a foam/water system at the Nanjing Fire Fighting Equipment Factory

Tianjing Fire Fighting Research Institute possesses a rather strong capacity in research and development of new foam/water systems. The institute has a good knowledge about both the international and the domestic technologies in the fire fighting equipment sector.

Nanjing Fire Fighting Equipment Factory and the Tianjing Fire Fighting Research Institute are both managed under the Public Security Bureau. Therefore, close cooperation between these two institutions is quite easy to achieve. At present, NFFEF has already established contacts with Tianjing Fire Fighting Research Institute through the Public Security Bureau for the technology transfer. The programme of cooperation and the schedule of the development work, including the costs involved are given in the exhibit below. These costs will be borne by the NFFEF.

3. Workplan for developing an automatic water/foam fire extinguishing system:

Projects to be developed	Time of implementation	Cost (RMB)	Cost, $
Software	Oct. 1994 - Feb. 1996	380,000	43,678
Wet alarming system	June 1994 - Begin. 1996	500,000	57,471
Rain valve system	Begin. 1995 - end 1996	1,200,000	137,931
Closed nozzle	June 1994 - begin 1996	60,000	6,897
Open nozzle	June 1994 - begin 1996	40,000	4,598
Foam nozzle	Jan. 1995 - end 1996	160,000	18,391
Foam storage tank	Jan. 1995 - end 1996	80,000	9,195
Rubber storage bag	Jan. 1995 - end 1996	120,000	13,793
Foam proportion	Jan. 1995 - end 1996	280,000	32,184
General testing equipment	Jan 1995 - end 1996	450,000	51,724
Special-purpose testing equipment	Jan - Oct. 1995	320,000	36,782
Market survey	Beginning 1995	100,000	11,494
TOTAL		3,690,000	424,138

REPORT

STF05 F94009

Technical Review of Project Proposal from the Nanjing Fire Fighting Equipment Factory

Industrial Development
July 1994

SINTEF
Industrial Development

CONTENTS

1. Introduction

This is a technical review of a project proposal from the Nanjing Fire Fighting Equipment Factory in China. The review is conducted by SINTEF Industrial Development on behalf of United Nations Industrial Development Organization, UNIDO. SINTEF NBL, Norwegian Fire Research Laboratory, has been consulted on questions regarding fire technology.

This report builds entirely on the information given in the project proposal documentation. No other sources of information about the Nanjing project has been seen or used.

The report is structured according to the format for technical reviews given by UNIDO.

2. Relationship to country programme

The project is consistent with the China Country Programme and constitutes part of an articulated sectoral/sub-sectoral strategy.

3. Technology

We fully agree on the basic objectives of this project. Replacing of halon with ABC dry powder, foam/water and CO_2 will give the Chinese home market a possibility to choose between different extinguishing media, depending on the objects to be protected against fire.

Many companies are working with development of new gaseous media as substitute for halon, but the uncertainties related to environmental impacts and even human exposure are still not fully investigated. These facts strengthens the choice that has been made for the new production at Nanjing Fire Fighting Equipment Factory. Another important factor is the similarity of production going from portable halon extinguishers to ABC dry powder. The factory will benefit on the already existing experience amongst the staff, thus decreasing the need for training and education.

Based on this we consider the technology described in the project proposal to be the most cost effective technology available for this conversion. The selected technologies are also optimal from an environmental soundness and safety point of view.

The technologies in question are all considered transitional. Although no formal agreements on licensing or technology transfer seem to have been made, we consider the acquirement of the equipment specified in Annex 6 of the project proposal to be reasonably straight forward. The associated training of personnel should also go well.

We do, however, find reasons to question the proposal to start production of thin-wall type CO_2 containers at the factory. The production technology is quite new and expensive, and almost one third of the total project cost is related to purchasing of this equipment. We do not have doubts about the necessity of high pressure containers, but the costs of the obvious alternative, to by such containers from producers in Germany or the USA, should be thoroughly discussed in the project proposal. Another alternative could be to establish a company in China that focuses on producing such containers for a number of domestic users. This is an important strategic "make or buy issue" that should not be omitted from the project proposal.

Exactly the same line of arguments could be made about the decision to make or buy glass bulbs. It might be cheaper and/or more strategically sound to buy glass bulbs from abroad/domestic producer then to acquire a glass bulb production line as proposed. This is also a major cost in the project proposal.

4. Environmental impact

The selection of alternative agents will continue to fulfil both the international and the national regulations for replacements of halon. The new agents will have no impact on the environment as long as we can consider the production of CO_2 to be negligible.

The project proposal does not say anything about the amount of stored halon in the factory. We assume that the elimination of halon at the factory follows the change of production as described in the report. Destruction of stored halon should therefor not be necessary.

We agree that the proposed manufacturing processes are well established with easy-to-implement environmental pollution control methods. Future environmental legislation might however demand special treatment of ABC powder waste containing phosphate.

5. Project costs

Project costs and cost of equipment

All the specified equipment in the project proposal is to our knowledge necessary for the production of the 4 extinguishing products. The list of equipment given in annex 6 also seems to be complete.

There is little or no information in the report about what will be done with the existing equipment. Much of the equipment specified in annex 6a and 6c is expected to be in the facility prior to the conversion. The technology to produce ABC dry powder containers is not much different than for halon containers (eg. A1 and A4 in annex 6a), and some of the equipment for fixed CO_2 fire fighting systems production (eg. A1, A3 and A5 in annex 6c) must also be present before the conversion.

We do recognize the information that much of the existing equipment is "more than 20 years old" (page 3) and that there is a need for modernization. The total cost of the needed equipment might therefor not be much different from the sums given in annex 6a and 6c, but there is a need for more information. In particular, two questions should be answered:

1. What is the salvage value of scrapped equipment?
2. To what extent can existing equipment be modified to perform functions needed in the conversion, and if so, what is the cost of these modifications?

The new equipment will result in an increase in existing capacity. This is recognized in the project proposal where the factory is prepared to self-finance 50%. The calculated unit abatement cost in annex 4 is also conservative (to high) in this respect because only replacement of halon according to today's production level is considered. Both of these facts strengthens the project proposal.

Start-up/commissioning cost

Training costs are included in the project proposal, but they could be underestimated. We are not referring to technology acquisition in terms of design drawings, manufacturing documentation, testing and so on, but to post "D2 Technical training" in annex 6b (portable CO_2 fire extinguisher production line) and 6d (foam/water fire fighting system production line). Both of these production lines involves technology the factory has no or limited experience with. Estimated training costs is about 3% of total investment costs. We believe 6-10% (at least) would be more realistic, including redundant production costs and contingency costs.

If production of glass bulbs and thin-wall type CO_2 containers is outsourced, training cost as given (3%) is probably realistic.

The experience of the management and the staff at the Nanjing factory is an important asset. Will moving the factory to a new suburban area mean major personnel changes?

Operating costs

We have little basis for judging the appropriateness of costs of different materials, energy, labour etc., but the amounts specified does not seem unreasonably high. Beside from this, the calculation of operating costs has several weaknesses:

1. Annual incremental operating savings/costs (notes in annex 4) are calculated as though the conversion from halon to the new extinguishing media happens instantaneously from day 1 of the project. Rather, it must be a gradual transition with perhaps different introduction speeds for the 4 new products. Such a detailed introduction plan, specifying volumes each year for all the 4 products, must be the basis for calculating annual incremental operating costs/savings. This is also a basis for any marketing plan, see section 6 "Other comments".

2. Costs are generally divided after a "share of halon"-key amongst the 4 new products. From a profit analysis perspective we doubt that this would be correct, but since the issue here is halon replacement, it is acceptable. However, we argue that one should

not consider all of the additional common costs (labour, electricity equipment maintenance) as part of the operating costs related to conversion. A substantial share of the increase in common costs must be associated with the production increase, and not only with the conversion.

3. We would also expect so called learning curve effects, in the respect that operating costs should decline over time. Learning curve effects can be hard to predict, but a reduction of operating costs of 3-10% (proportionate to production volumes) from year 1 to year 4 might be realistic. As an example of learning curve effects, a decrease in quality related costs can be mentioned. We are not familiar with the quality level at the factory, but the change of production gives a good opportunity to raise the level of quality assurance.

We do not know how these changes in the way of calculating annual incremental operating savings/costs will affect the total project costs, other than that a reduction is likely.

Other costs
As mentioned above, contingency costs could be included in the start-up/commissioning cost. The project proposal gives little information about institutional costs. Costs associated with mitigation of adverse environmental impact is to our knowledge not relevant in this project.

Cost effectiveness
We assume that the relevant "cost effectiveness" for this project is not related to the future income of the factory, but to the reduction of ODP for each dollar spent. The calculation of unit abatement costs in annex 4 addresses the question of cost effectiveness in a thorough and conservative manner.

The calculation of unit abatement cost is conservative (to high) for 3 reasons. One reason is given in the project proposal and relates to elimination of halon used for maintenance purposes. The second reason is that a factor of 3 ODP per MT halon 1211 is used, while some institutions use a factor of 4. The third reason why the calculation of abatement cost is conservative, is that only phase out of today's use of halon is considered (360 MT per year), and the project also hinders an expected increase of halon (more than a doubling) in a fast growing market for fire extinguishers.

We have no experience in assessing the size of unit abatement cost (0.59 US$/kg) for a project like this. We would however be highly surprised if many projects could come up with numbers that matches this project. Nanjing Fire Fighting Equipment Factory is a major producer in a fast growing and big market.

In terms of reduction of ODP we conclude that the project is cost effective.

Implementation time
4 years should be sufficient implementation time for the conversion. Conversion to ABC powder extinguishers could probably be done in one year, while conversion to CO_2 portable fire extinguishers and foam/water spray fire fighting systems is more complicated. We would again like to mention the need for a more detailed project plan with estimates of the timetable/volumes for the conversion of the 4 different extinguishing products.

6. Other comments

The project proposal is highly production oriented and gives very little information about the market environment or about the market strategy of the Nanjing Fire Fighting Equipment Factory. This is in our opinion a clear weakness that should be corrected.

As a minimum the following questions should be answered:

1. What is the targeted market share for the Nanjing factory in portable and fixed fire fighting equipment in China?
2. What are the expected production volumes of the 4 replacements products in the coming years?
3. What market position, in terms of price and satisfaction of specified customer demands, does the factory consider necessary in order to reach the targeted market share(s)?
4. What market strategy, in terms of product characteristics, price, distribution and promotion is intended? In particular, does the factory own or have access to relevant distribution channels in line with the planned expansion? Are there any plans for training of sales people in the new products?

The report does not consider if the factory should participate in service activities for portable fire extinguishers. It is quite common that manufacturers of portable fire extinguishers perform service on their equipment. The factory could also establish a training centre for maintenance personnel that could carry out service on the products. The factory will have the necessary knowledge and equipment to establish this activity without cost investments. Therefor, a fifth question should also be answered:

5. What are the plans, if any, related to service and maintenance of the fire extinguishers in general, and portable fire extinguishers in particular?

7. Recommendations

We recommend that the project is approved after modification. The proposals for modifications are as follows:

A. A market strategy for the Nanjing Fire Fighting Equipment Factory should be sketched, covering at least the 5 questions given in section 6.

B. The investments in a glass bulb production line and a thin-wall type CO_2 containers production line should be reconsidered. A discussion of the alternative of buying CO_2 containers and glass bulbs from foreign or domestic producers (could be established) is necessary. These are very important strategic decisions that should be taken on a solid foundation.

C. Depending on the outcome of B, training costs as given i annex 6b and 6d should be reevaluated. In the case of internal production of glass bulbs and CO_2 containers, we recommend that training costs are at least doubled.

D. The questions on salvage value and possible modification of existing equipment should be addressed.

E. Annual incremental operating costs/savings should be recalculated according to point 1-3 in section 5.

PROJECT COVER SHEET

COUNTRY:	CHINA
PROJECT TITLE:	Elimination of CFCs in the Manufacture of Extruded Polystyrene/Polyethylene Foam Sheets at 13 enterprises
SECTORS COVERED:	Foamed Plastics
ODS USE IN SECTOR:	17,773 tons CFCs (=ODP) in 1991
PROJECT IMPACT:	1,309t/y CFCs (=ODP; base 1993)
PROJECT DURATION:	18 months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	Incremental Capital Cost: USD 5,495,000
PROPOSED MLF GRANT:	USD 5,495,000 (representing the national ownership)
COST EFFECTIVENESS:	USD 0.68/kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY:	National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATES:	June-October 1994

PROJECT SUMMARY

In China, about 100 enterprises manufacturing extruded PS/PE foam sheet have been identified. Currently, predominantly CFC-12 is used as blowing agent. Under this project, 13 enterprises will switch to the use of butane as alternative blowing agent. Butane is highly flammable and its usage requires extensive safety measures. The process conversion to butane will include retrofitting of existing extruders, installation of butane storage tanks, building modifications, exhaust and ventilation systems and gas detection systems. Technology transfer and trials are also essential elements of the conversion.

PROJECT OF THE GOVERNMENT OF CHINA

Elimination of CFCs in the Manufacture of Extruded Polystyrene/Polyethylene Foam Sheets at 13 enterprises

1. PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of extruded polystyrene foam sheet at 13 enterprises across China.

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, XPS/XPE). Production is divided between larger state-owned enterprises and smaller township or private enterprises. More detailed information about the sector is provided in the following table:

Categories Sub-categories	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. The National Council of Light Industry (NCLI) is responsible for the phaseout coordination in all foam categories and has, as part of the Country Programme preparation, worked out a detailed phaseout strategy. This strategy has just been updated.

The proposed sub-projects in this proposal have been developed as part of a MLF funded instructional workshop program, implemented through The World Bank. The stated goal of this program is to develop a minimum of five ODS phaseout projects after each workshop. So far, 30 project requests have been logged after just two workshops. The next and last workshop will be held in February 1995.

3. ENTERPRISE BACKGROUND

The following 13 enterprises ARE covered by this project:

ENTERPRISE	CFC TONNES	LOCAL SHARE
FEICHENG	150	100%
FOSHAN # 3	360	100%
GUANGXING	36	100%
GUIZHOU	50	100%
HAILUN	95	100%
HEBEI SIXING	65	100%
JIANHUA	100	100%
JINAN	30	100%
JINFENG	70	61.4%
SHENRONG	48	57%
SHENZHEN SHENTIE	75	100%
SHIJIAZHUANG	160	100%
SUZHOU # 7	70	100%
TOTAL: 13	1,309	-

More information on the individual enterprise is provided under the respective sub-project in the annexes.

4. PROJECT DESCRIPTION

The total CFC consumption of the subject enterprises amounted to 1,309 tonnes in 1993. In line with China's plan to eliminate ODS consumption, the enterprises have selected, after technical and economic evaluation of the various available options, butane as the replacement of choice. Under the project, existing extruders will be retrofitted and the production areas will be adapted to meet the butane usage requirements. Butane storage tanks and the required safety systems to mitigate fire and exposure hazards from the use of butane will be installed, as well as improved exhaust and ventilation systems. Extensive safety and production training will also be provided by an external process expert.

5. TECHNOLOGY

5.1 OVERVIEW

There are several options to replace CFCs in the production of XPS/XPE foam sheet, such as:

- o Atmospheric gases (Nitrogen; Carbon Dioxide);
- o Hydrocarbons (LPG; butanes; pentanes);
- o HCFCs (-22; -142b);
- o HFCs (-134a; -152a).

5.1.1 ATMOSPHERIC GASES

NITROGEN GAS is inert, nontoxic and noncombustible, but asphyxiant. The use is burdened by a low solubility in the resin and a relatively high density of the end product. New resin developments may make the use of nitrogen a more viable in the future.
BERSTORFF TECHNOLOGY is based on a mixture of nitrogen and alcohol. This technology exhibits undefined risks in toxicity and fire. The resulting product has also a higher density.
CARBON DIOXIDE GAS is an asphyxiant, high energy consuming and moderately toxic gas. Carbon dioxide as a co-agent is proven technology. The use of only CO_2 in EPS sheet is patented and requires licensing.

5.1.2 HYDROCARBONS

N-PENTANE, BUTANE, ISOPENTANE AND ISOBUTANE are proven replacements. The technology is cost effective and results in product of acceptable quality. However, the flammability of hydrocarbons requires stringent safety precautions in the manufacturing process, resulting in the need for retrofitting. In addition, hydrocarbons are petrochemically reactive and contribute to the formation of atmospheric zone.

LIQUIFIED PETROLEUM GASES (LPG) has also been proposed as replacement for CFC-12 in PE/PP and PS foam industry. LPG is however toxic, flammable and not generally accepted for food packaging. If used, molecular sieves as purifier/deodorizer and a buffer agent for boiling point stabilization will be required.

5.1.3 HYDROCHLOROFLUOROCARBONS

HCFC-22 is non-flammable, low in toxicity, thermal and chemical active, has been proven effective. The compound has however an ODP, and only qualifies as an interim replacement. **HCFC-142b** can be used alone or in combination with HCFC-22 to reduce the flammability. The price penalty is however considerable and equipment has to be modified to cope with the moderate flammability and the modified diffusivity of the compound.

5.1.4 HYDROFLUOROCARBONS

HFC-134a is non-flammable, low in toxicity and with no ODP, is just recently introduced in the market. The current pricing will prevent utilization in the very cost sensitive food serving and packaging applications. The utilization of HFC-134a in foam competes with the utilization as a refrigerant in appliances and automotive air conditioners. **HFC-152a** is low in toxicity, moderate flammable and possesses no ODP. It appears to be a long term alternative. The compound's flammability will required modification of production equipment.

5.2 SELECTION

The use of butane has been selected to replace CFCs in the conversion because it is

- o a proven technology in processing and product performance,
- o environmentally acceptable,
- o low in toxicity,
- o adaptable to the existing equipment,
- o cost effective

A draw back is its high flammability, requiring stringent safety precautions. Also, butane is currently only available with a maximum purity of ranging from 60 to 80% which will affect the quality slightly. The enterprises are all aware of this and will address both issues during project implementation.

5.3. REQUIRED MODIFICATIONS

The use of LPG/butane will require substantial changes in the production and storage facilities. The possible changes or modification may include :

- o Plant Exhaust System
  - * The plant/warehouse air must be moving at all times.

* Exhaust ducts or fans mounted at floor level and parallel to the foam extruder line.
* Exhaust ducts or fans to draw fresh air across the plant floor area in the foam storage area.
* The plant and warehouse air should be changed hourly.
* The exhaust fans do not need explosion proof motors.

o Ceiling Fans/Blow-down Fans
* Production area and the warehouse should have ceiling fans spaced 10-13 meter apart.
* Fans should run continuously and will keep the air circulating to prevent pockets of butane build up in the building.

o Foam Storage Area
* Air must be moving at all times by using fans and wall mounted exhaust fans at floor area.
* Fans spaced 10 -13 meter apart with louvered openings located on the wall opposite the exhaust fans.
* Exhaust ducts to draw fresh air across the plant floor in the foam storage area.
* Polyethylene bags used to wrap rolls should be perforated to allow butane to flow out of and fresh air to flow in. Diameter of holes is about 10 to 15 mm and spaced about 150 to 200 mm apart. Furthermore, polyethylene bags should be anti-static.
* Stack rolls on pallets to circulate air around the roll more easily.

o Butane Sensing Equipment
* Permanent monitoring device to be installed at the following locations to detect possible presence of butane:
  - bulk storage tank
  - high pressure pump
  - die-head of extruder
  - reclaim grinder/recycling machine
  - foam storage area.
* Portable gas detecting system to monitor the butane throughout the plant.

o Bulk Storage Tank
* Installation and location of bulk storage tank are subject to compliance with the local rules and regulations. The recommended design pressure for a hydrocarbon tank is 250 psi, this will allow storage of propane which exerts the maximum vapor pressure.
* Low pressure pump, high pressure pump and deodorizer to be included in this area.
* Standard safety features pertaining to the use of hydrocarbons, such as piping system, pressure relief and return system, pressure gauge and switch, water sprinkler system, fire fighting equipment etc to be considered while design for the bulk storage tank area.

o The whole plant must have sufficient fire extinguishers, of which some are trolley mounted and most are handheld. Both CO2 or powder type of fire extinguishers are acceptable. Static eliminators should be installed at winding section to arrest static current from the roll.

o In line with the above-mentioned modifications on equipment and safety requirement, the following process adjustment are required:

* addition of anti-shrinkage and buffer agent to improve cell size and to control diffusion,
* Readjustment of heaters and extrusion pressure to achieve the correct density and to reduce fire hazard,
* addition of anti-static agent to further reduce fire hazards from spark generation.

Users of hydrocarbons are subject to stringent fire regulations. The appointment and training of a company safety expert is strongly recommended. The emission of hydrocarbons is currently not regulated in China, nor are restrictions expected in the foreseeable future.

ALL SAFETY PRECAUTIONS MUST CONFORM TO THE REQUIREMENTS OF RELEVANT LOCAL, PROVINCIAL AND STATE AUTHORITIES

6. PROJECT COSTS

For the conversion of the manufacturing process to use of butane, the following cost elements may be involved:

Equipment retrofitting:

- motors & accessories
- mechanical adjustments
- Engineering/labor fees

Building modification:

- Fire deflecting walls
- Separation walls
- Separation of the Control Room

Relocation costs:

- Dismantling and re-assembling of extruder(s) or thermoforming equipment from current location to another within the same plant or to a new location (cost of the new location are not included)
- loading and unloading (requiring the use of crane-lift) of extruders
- Transportation cost

Trials and production training;

Technology transfer.

The consolidated project cost of these 13 sub-projects is summarized below:

6.1 TOTAL PROJECT COST

Extruder retrofitting (20 units)	1,400,000
Deflection walls	249,000
Relocation costs	565,000
Butane tank and booster pump	725,000
Metering pump	30,000
Explosion proof motors (10 units)	80,000

Fire safety & alarm system	1,813,600
Technology transfer, In service training	130,000
Contingency	502,400
TOTAL	5,495,000

Please refer to the individual enterprise' sub-project in the annexes for a more detailed cost breakdown.

6.2 OPERATING COSTS

The costs and availability of CFCs in China varies from place to place and can be very high in remote areas. On the other side, facilities in such areas have no problems to include such costs in their prices as the very location provides also an areal sales protection. The calculation of incremental costs/benefits (IRC/IRB) with standardized chemical prices would change competitive positions dramatically. On the other side, the net effect of the IRC/IRB for all 13 sub-projects is just USD 21,000 (IRC; see annex-14), which amounts to less than USD 2,000 per recipient. Large CFC-users show generally IRB and smaller users IRC. Although CFC prices increase, it is also expected that subsequent batches of projects will show lower individual CFC-use. Overall, it is expected that IRC will continue to about cancel out IRB.

Based on the previous described situation NEPA/NCLI proposes:

- o Not to include individual IRC/IRB in the projects under this proposal;
- o To forgo IRC/IRB in future ODS phaseout projects concerning extruded polystyrene/polyethylene foam sheet.

6.3 UNIT ABATEMENT COST

a)	ODS Reduction Project Costs	USD 5,495,000
b)	Annual Incremental Costs/Benefits	USD -
c)	Capital Recovery Factor (10%)	0.16275
d)	ODS Reduction/y	kg 1,309,000
	Unit Abatement Costs [(a*c + b)/d]	**SD 0.68/kg/y**

7. FINANCING PLAN

The total incremental capital cost for the project totals $6,377,000. Based on the percentage of the individual enterprise' local ownership, total amount being requested amounts to:

USD 5,495,000
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8. SCHEDULE

The following implementation schedule is applicable to all the 13 enterprises.

TASK	Q1	Q2	Q3	Q4	Q5	Q6
Project Preparation						
Specifications	x					
Tenders, Selection		xx				
Purchase Orders			x			
Site preparation						
Building Adaptations			xx			
Civil Works				xx		
Tanks Installation					xx	
Equipment Changes					xx	
Start-up, Trials, Training					xx	x
Commissioning						x

9. REQUIRED REGULATORY ACTION

The enterprise will check with local authorities on fire regulations and will comply fully with national and local safety regulations and standards.

10. PROJECT IMPACT

These projects will eliminate the use of a total of 1,309 tons of CFCs upon project completion. The project employs commercially viable and environmentally acceptable technology.

11. ANNEXES

Annex 1: Sub-project No. 1: FEICHENG
Annex 2: Sub-project No. 2: FOSHAN No. 3

Annex 3: Sub-project No. 3: GUANGXING
Annex 4: Sub-project No. 4: GUIZHOU
Annex 5: Sub-project No. 5: HAILUN
Annex 6: Sub-project No. 6: HEBEI SIXING
Annex 7: Sub-project No. 7: JIANHUA
Annex 8: Sub-project No. 8: JINAN
Annex 9: Sub-project No. 9: JINFENG
Annex 10: Sub-project No. 10: SHENRONG
Annex 11: Sub-project No. 11: SHENZHEN SHENTIE
Annex 12: Sub-project No. 12: GUANGXING
Annex 13: Sub-project No. 13: SUZHOU NO. 7
Annex 14: Incremental Recurring Costs/Benefits

Annex 1

PROJECT COVER SHEET

COUNTRY	: CHINA
PROJECT TITLE	: FEICHENG PLASTIC PACKAGING MATERIAL FACTORY - Elimination of CFC-12 in the Manufacture of XPS?XPE Foam Sheet
SECTOR COVERED	: Foamed Plastics
ODS USED IN SECTOR	: 17,773 MT CFCs (=ODP) in 1991
PROJECT IMPACT	: 150 MT of CFC-12 per year based on 1993 consumption
PROJECT DURATION	: 18 months
PROJECT ECONOMIC LIFE	: 10 years
TOTAL PROJECT COST	: Capital cost incurred USD 410,000
PROPOSED MLF GRANT	: USD 410,000
COST EFFECTIVENESS	: USD 0.44/kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY	: China National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	: National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY	: UNDP
APPRAISAL DATE	: October, 1994

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PROJECT SUMMARY

Feicheng Plastics Products Factory (FENCHENG) is the state-owned enterprise directly under the supervision of Shandong Second Light Industry Bureau. In 1990 and 1992, FEICHENG bought two extruders separately, one for XPE foam sheet and another for PE foam netting. Both machines (single screw 40mm diameter) were from Poly Machinery Works Co. Ltd. (Taiwan) . The FEICHENG products are mainly used for packing of furniture, electronic goods, electrical appliances, instruments, arts and crafts and fresh fruits. Under this project, FEICHENG will phase out 150t of ODS annually by switching from the use of CFC-12 to butane. The project contains capital cost for conversion, safety and training.

PREPARED BY: Ko Swee Hee
REVIEWED BY: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF CHINA

FEICHENG - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF XPE FOAM SHEET AND NETTING

1. ENTERPRISE BACKGROUND

FEICHENG was established in 1990 as a state-owned enterprise under the direct supervision of Shandong Second Light Industry Bureau. It is situated in the Feicheng City in Shandong Province. Its production area is a single story building housing two extruders. The use of butane as a blowing agent to replace CFC-12 is possible at this location to produce XPE foam sheet and netting and to address fire hazards. FEICHENG currently employs about 65 workers. It has grown rapidly over the years and continued growth is expected but for the high price of CFC-12. Its raw material and CFCs usage is as follows:

1991: 300 mt of resin, 60 mt CFC-12
1992: 600 mt of resin, 120 mt CFC-12
1993: 800 mt of resin, 150 mt CFC-12
1994: 850 mt of resin, 170 mt CFC-12 (estimated)

2. PROJECT DESCRIPTION

Under this project, FEICHENG will phase out the use of CFC-12 in its XPE foam sheet and netting production through substitution by butane as replacement. Butane is available in China with purity ranging from 60-80% which is still acceptable as blowing agent in this industry. "MERCAPTAN" is added into butane to ease detection of butane presence, thus requiring deodorizing as well as strict control on variation in volatiles by adding buffering agent. The project includes modification of existing extruder, fire safety and alarm system in the production area and warehouse to mitigate fire and explosion hazard from the use of butane. Extensive production and safety training and technology transfer to the plant operators will also be provided through an external process specialist.

3. PROJECT COSTS

3.1. CAPITAL COSTS

	Description		Cost(USD)
o	1 butane bulk tank		65,000
o	Extruder retrofitting (2 sets)		140,000
o	Fire deflection wall (18m)		6,000
o	Building modification		25,000
o	Fire safety & Alarm systems		125,000
	Exhaust fans (14 pcs)	25,200	
	Ventilation ducting (30m)	25,000	

Industrial blow down fans(14)	14,000	
Gas sensing/detection system(6)	42,000	
Portable gas detector	4,000	
Fire extinguishers		
* Trolley mounted(5)	5,000	
* Handheld(10)	1,000	
Static eliminator (2)	6,000	
Emergency spot light (4)	2,800	
o Technology transfer/training		10,000
o Contingency/rounding		39,000
TOTAL INCREMENTAL CAPITAL COST		**410,000**

3.2. OPERATING COSTS/BENEFITS

No incremental costs/or benefits are included since, as a matter of policy for XPE/PS projects, these are assumed on a national Chinese level to be neutral.

3.3. UNIT ABATEMENT COSTS

a.	ODS Reduction Capital Costs	US$410,000
b.	Annual incremental costs	US$ -
c.	Capital Recovery Factor(10y/10%)	0.16275
d.	ODS Reduction/year	kg 150,000
Unit	**Abatement Costs [{(a(c) + b})/d]**	**US$/kg/y 0.44**

4. FINANCIAL PLAN

The enterprise requests a grant covering the total incremental cost as calculated under 3.1: **US$410,000**

5. PROJECT IMPACT

This project will eliminate the use of 150 tons of CFC-12 in the first year after implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex-1A: Technical Review

TECHNICAL REVIEW

1. **COUNTRY:** China

2. **PROJECT TITLE:** **FEICHENG PLASTICS PRODUCTS FACTORY - Elimination of CFC-12 in the Manufacture of XPE Foam Sheet and netting**

3. **(SUB) SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.

5. **TECHNOLOGY:** The company will replace CFC-11 by butane. Other technologies are also available but the company chooses butane because it is a proven, environmentally sound technique which is cost-effective. On the other hand, however, two main drawbacks are taken: the flammability and the low purity. The precautions to be taken to reduce the flammability hazards are well described in the text. However, serious safety audit and an increased fire prevention and safety awareness among all concerned employees will be most important. Risk analysis is necessary, and risk response must be a procedure which is written, known, implemented and tested out. Specialized firms have to be called in. Training by local fire brigade is a necessity, as well as maintaining a good relation with the brigade.

   The low degree of purity of the butane is a problem which necessitates monitoring and constant care for the workers around.

6. **ENVIRONMENTAL** CFC-12 has an ODP of about 1 and a GWP of about 3. Butane has none of these properties but may contribute more to smog formation at low level.

7. **PROJECT COST:** Project costs can be accepted as proposed. The cost to remove one ton of ODS is USD 2,947. This is a low price.

8. **IMPLEMENTATION** 1.5 years is a reasonable time span to perform the change-over.

9. **RECOMMENDATION:**To be accepted as proposed.

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

PROJECT COVER SHEET

COUNTRY	:	CHINA
PROJECT TITLE	:	FOSHAN NO. 3 PLASTIC FACTORY - Elimination of CFC-12 in the Manufacture of XPS/XPE Foam Sheet
SECTOR COVERED	:	Foamed Plastics
ODS USED IN SECTOR	:	17,773 MT CFCs (=ODP) in 1991
PROJECT IMPACT	:	360MT of CFC-12 per year based on 1993 consumption
PROJECT DURATION	:	18 months
PROJECT ECONOMIC LIFE	:	10 years
TOTAL PROJECT COST	:	Capital cost incurred USD 1,065,000
PROPOSED MLF GRANT	:	USD 1,065,000
COST EFFECTIVENESS	:	USD 0.48kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY	:	China National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY	:	UNDP
APPRAISAL DATE	:	July/August, October 1994

PROJECT SUMMARY

Foshan No. 3 Plastic Factory is a state-owned enterprise which produces XPE/XPS, using CFC-12 as a blowing agent. The purpose of this project is to phase out the CFC-12 usage through butane. The project provides capital cost for conversion, safety and training.

PREPARED BY: Ko Swee Hee/Bert Veenendaal
REVIEWED BY: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF CHINA

FOSHEN NO. 3 - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF EXTRUDED POLYSTYRENE/POLYETHYLENE FOAM SHEET

1. ENTERPRISE BACKGROUND

FOSHAN NO. 3 was established in 1984 as a collectively owned state enterprise under the direct supervision of Foshan Plastics & Leather Industry Trade-/Group Company and NCLI. The enterprise is situated in the Foshan Industrial Zone at the ground floor of a seven story building which is not suitable for use of butane to replace CFC-12. Thus, Foshan decided to develop another piece of land which is about 1 km away for the construction of a new building to house its five extruders and other machineries. The new location is ideal and suitable for butane use; the building will be ready by the end of November 1994. FOSHAN produces XPS/XPE foam sheet and vacuum-formed products. It currently employs about 240 workers. The enterprise has grown rapidly over the years and is expected to show continued growth but for the higher price and shortage of CFC-12. Its raw materials and CFCs usage is as follows:

1991: 1,400 MT of resin, 160 MT CFC-12
1992: 2,000 MT of resin, 280 MT CFC-12
1993: 2,800 MT of resin, 360 MT CFC-12
1994: 2,800 MT of resin, 360 MT CFC-12 (estimated)
1995: 3,600 MT of resin, 400 MT CFC-12 (estimated)

Due to the sudden shortage and high price of CFC-12, the enterprise has slowed down its production in 1994.

2. PROJECT DESCRIPTION

Under this project, FOSHAN will phase out the use of CFC-12 in its XPE/XPS foam sheet production through substitution by butane as replacement. Butane is available in China with purity ranging from 60-80% which is still acceptable as blowing agent in this industry. "MERCAPTAN" is added into butane to ease detection of butane presence, thus requiring deodorizing as well as strict control on variation in volatiles by adding buffering agent. The project includes modification of existing extruder, fire safety and alarm system in the production area and warehouse to mitigate fire and explosion hazard from the use of butane. Extensive production and safety training and technology transfer to the plant operators will also be provided through an external process specialist.

3. PROJECT COSTS

3.1. CAPITAL COSTS

Description	Cost(USD)	
o 2 butane bulk tanks		65,000
o Extruder retrofitting (5)		350,000
o Fire deflection wall (60 m)		21,000
o Bldg modification/Equipment relocation		275,000
o Fire safety & Alarm systems		
Exhaust fans (30 pcs)	54,000	
Industrial blow down fans(40)	40,000	
Gas sensing/detection system(12)	90,000	
Portable gas detector (2)	8,000	
Fire extinguishers		
* Trolley mounted(10)	10,000	
* Handheld(50)	5,000	
Static eliminator (12)	36,000	
Emergency spot light (6)	4,000	
o Technology transfer/training		10,000
o Contingency/rounding		97,000
TOTAL INCREMENTAL CAPITAL COST		**1,065,000**

3.2. OPERATING COSTS/BENEFITS

No incremental costs/or benefits are included since, as a matter of policy for XPE/PS projects, these are assumed on a national Chinese level to be neutral.

3.3. UNIT ABATEMENT COSTS

a.	ODS Reduction Capital Costs	US$1,065,000
b.	Annual incremental costs	US$ -
c.	Capital Recovery Factor(10y/10%)	0.16275
d.	ODS Reduction/year	kg 360,000
Unit Abatement Costs [{(a(c) + b})/d]		**US$/kg/y 0.48**

4. FINANCIAL PLAN

The enterprise requests a grant covering the total incremental cost as calculated under 3.1: **US$1,065,000**

5. PROJECT IMPACT

This project will eliminate the use of 360 tons of CFC-12 in the first year after implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex-2A: Technical Review

TECHNICAL REVIEW

1. **COUNTRY:** China

2. **PROJECT TITLE:** **FOSHAN No. 3 PLASTIC FACTORY - Elimination of CFC-12 in the Manufacture of XPE/XPS Foam Sheet**

3. **(SUB) SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.

5. **TECHNOLOGY:** The company will replace CFC-11 by butane. Other technologies are also available but the company chooses butane because it is a proven, environmentally sound technique which is cost-effective. On the other hand, however, two main drawbacks are taken: the flammability and the low purity. The precautions to be taken to reduce the flammability hazards are well described in the text. However, serious safety audit and an increased fire prevention and safety awareness among all concerned employees will be most important. Risk analysis is necessary, and risk response must be a procedure which is written, known, implemented and tested out. Specialized firms have to be called in. Training by local fire brigade is a necessity, as well as maintaining a good relation with the brigade.

   The low degree of purity of the butane is a problem whic necessitates monitoring and constant care for the worker around.

   The fact that the factory will be relocated in an adapted area to use butane is a positive point.

6. **ENVIRONMENTAL** CFC-12 has an ODP of about 1 and a GWP of about 3. Butane has none of these properties but may contribute more to smog formation at low level.

7. **PROJECT COST:** After discussion with the project leader, the capital costs for technology transfer were lowered substantially to the amount actually presented. The other costs are in relation to the five extruders

The cost to eliminate 1 ton of ODS is USD 3,403 which is a low figure.

8. **IMPLEMENTATION** 1.5 years is a reasonable time span to perform the change-over.

9. **RECOMMENDATION:** To be accepted as proposed.

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

PROJECT COVER SHEET

COUNTRY	:	CHINA
PROJECT TITLE	:	GUANGXING PLASTICS PRODUCTS CO., HUBEI - Elimination of CFC-12 in the Manufacture of XPS Foam Sheet
SECTOR COVERED	:	Foamed Plastics
ODS USED IN SECTOR	:	17,773 MT CFCs (=ODP) in 1991
PROJECT IMPACT	:	36 MT of CFC-12 per year based on 1993 consumption
PROJECT DURATION	:	18 months
PROJECT ECONOMIC LIFE	:	10 years
TOTAL PROJECT COST	:	Capital cost: USD 375,000
PROPOSED MLF GRANT	:	USD 375,000
COST EFFECTIVENESS	:	USD1.70/kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY	:	China National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY	:	UNDP
APPRAISAL DATE	:	October 6th, 1994

PROJECT SUMMARY

Wuhan Guangxing Plastics Products Co. Ltd. (GUANGXING) is a state owned enterprise which belongs to Wuhan Plastics Industrial (Group) Co. Ltd. In 1991, GUANGXING bought an extruder from Poly Machinery Works Co. Ltd. (Taiwan) to produce extruded polystyrene foam sheet. Under this project GUANGXING will phase out 50t of CFC-12 by using butane. The project contains capital cost for conversion, relocation of equipment, safety and training.

Prepared by: Ko Swee Hee/Bert Veenendaal
Reviewed by: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF PEOPLE REPUBLIC OF CHINA

GUANGXING - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF EXTRUDED POLYSTYRENE FOAM SHEET

1. ENTERPRISE BACKGROUND

GUANGXING was established in 1991 as a state-owned enterprise under Wuhan Plastics Industrial (Group) Co. Ltd. The enterprise is located in an industrial area of Wuhan where butane is allowed to be used. The enterprise employs 67 workers. Raw materials and CFCs usage were as follows: 1992: 100 mt of resin, 10 mt CFC-12; in 1993: 400 mt of resin, 36 mt CFC-12; and in 1994: 650 mt of resin, 55 mt CFC-12.

2. PROJECT DESCRIPTION

Under this project, GUANGXING will phase out the use of CFC-12 in its XPS foam sheet production through substitution by butane as replacement. Butane is available in China with purity degree ranging from 60-80% which is still acceptable as blowing agent in this industry. "MERCAPTAN" is added into butane to ease detection of butane presence. This requires deodorizing as well as strict control on variation in volatiles by adding buffering agent. The project includes modification of existing extruder, fire safety and alarm system in the production area and warehouse to mitigate fire and exposure hazard from the use of butane. Extensive production and safety training and technology transfer to the plant operators will be provided through an external process specialist.

3. PROJECT COSTS

3.1. CAPITAL COSTS

	Description		Cost(USD)
o	2 butane bulk tanks		65,000
o	Extruder retrofitting (1 sets)		70,000
o	Equipment relocation		30,000
o	Fire safety & Alarm systems................		167,000
	Exhaust Fans (18pcs)	32,000	
	Ventilation Ducting (140m)	49,000	
	Industrial blow down fans(24)	24,000	
	Gas sensing/detection system(6)	42,000	
	Portable gas detector (1)	4,000	
	Fire extinguishers		
	Trolley mounted(5)	5,000	
	Handheld(10)	1,000	
	Static eliminator (2)	6,000	
	Emergency spot light (6)	4,000	

o	Technology transfer/training	10,000
o	Contingency/rounding	33,000
	TOTAL INCREMENTAL CAPITAL COST	375,000

3.2. OPERATING COSTS/BENEFITS

No incremental costs/or benefits are included since, as a matter of policy, for XPE/PS projects, these are assumed on a national Chinese level to be neutral.

3.3. UNIT ABATEMENT COSTS

a.	ODS Reduction Capital Costs	US$375,000
b.	Annual incremental costs	US$ -
c.	Capital Recovery Factor(10y/10%)	0.16275
d.	ODS Reduction/year	kg 36,000
Unit Abatement Costs [{(a(c) + b})/d]		US$/kg/y 1.70

4. FINANCIAL PLAN

The enterprise requests a grant covering the total incremental cost as calculated under 3.1: **US$375,000**

5. PROJECT IMPACT

This project will eliminate the use of at least 36 tons of CFC-12 in the first year of implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex 3A: Technical Review

TECHNICAL REVIEW

1. **COUNTRY:** China

2. **PROJECT TITLE:** **GUANGXING PLASTIC PRODUCTS CO. LTD. - Elimination of CFC-12 in the Manufacture of XPS Foam Sheet**

3. **(SUB) SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.

5. **TECHNOLOGY:** The company will replace CFC-11 by butane. Other technologies are also available but the company chooses butane because it is a proven, environmentally sound technique which is cost-effective. On the other hand, however, two main drawbacks are taken: the flammability and the low purity. The precautions to be taken to reduce the flammability hazards are well described in the text. However, serious safety audit and an increased fire prevention and safety awareness among all concerned employees will be most important. Risk analysis is necessary, and risk response must be a procedure which is written, known, implemented and tested out. Specialized firms have to be called in. Training by local fire brigade is a necessity, as well as maintaining a good relation with the brigade.

   The low degree of purity of the butane is a problem which necessitates monitoring and constant care for the workers around.

6. **ENVIRONMENTAL** CFC-12 has an ODP of about 1 and a GWP of about 3. Butane has none of these properties but may contribute more to smog formation at low level.

7. **PROJECT COST:** In view of the relatively small amount of butane needed, it can be asked whether two bulk tanks are needed, since it doubles the investments for safety.

The cost to eliminate 1 ton of ODS is USD 11,389.

The total costs for five safety and alarm systems (USD 173,600) seem high in relation to the small amount of butane to be used (36 tons). This may be limited to the unfavourable plant lay-out.

8. **IMPLEMENTATION** 1.5 years is a reasonable time span to perform the change-over.

9. **RECOMMENDATION:** The question of the number of butane bulk tanks needs to be addressed, and if necessary, the capital costs need to be adjusted.

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

Annex 4

PROJECT COVER SHEET

COUNTRY	:	CHINA
PROJECT TITLE	:	GUIZHOU JINCHANG PLASTICS PRODUCTS CO. LTD - Elimination of CFC-12 in the Manufacture of XPS Foam Sheet
SECTOR COVERED	:	Foamed Plastics
ODS USED IN SECTOR	:	17,773 MT CFCs (=ODP) in 1991
PROJECT IMPACT	:	50 MT of CFC-12 per year based on 1993 consumption
PROJECT DURATION	:	18 months
PROJECT ECONOMIC LIFE	:	10 years
TOTAL PROJECT COST	:	Capital cost incurred USD 390,000
PROPOSED MLF GRANT	:	USD 390,000
COST EFFECTIVENESS	:	USD 1.27/kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY	:	China National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY	:	UNDP
APPRAISAL DATE	:	September 30, 1994

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PROJECT SUMMARY

Guizhou Jinchang Plastics Products Co. Ltd. (JINCHANG) is a state owned enterprise belonging to the Guiyang Freight Car Works of the Ministry of Railways. In 1991, JINCHANG bought an extruder from Chi Chang Machinery Enterprise Co. Ltd. to produce extruded polystyrene foam sheet. Under this project, JINCHANG will phase out 50 t of CFC-12 by using butane. The project covers the capital cost for conversion, relocation of equipment, safety and training.

PREPARED BY: Ko Swee Hee/Bert Veenendaal
REVIEWED BY: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF CHINA

JINCHANG - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF XPS FOAM SHEET

1. ENTERPRISE BACKGROUND

JINCHANG was established in 1991 as a state-owned enterprise under Guiyang Freight Car Works of the Ministry of Railroad. It is situated in a residential are which is not suitable for application of butane technology. In order to meet the safety requirement of using butane, JINCHANG decided to move to another location 1km away from the existing factory where butane can be safely used. JINCHANG employs about 52 workers. Its raw material and CFCs usage is as follows:

1992: 100 mt of resin, 10t CFC-12
1993: 500 mt of resin, 50t CFC-12
1994: 950 mt of resin, 80 mt CFC-12 (estimated)

2. PROJECT DESCRIPTION

Under this project, JINCHANG will phase out the use of CFC-12 in its PE Foam Tubing through substitution by butane as replacement. Butane is available in China with purity ranging from 60-80% which is still acceptable as blowing agent in this industry. "MERCAPTAN" is added into butane to ease detection of butane presence, thus requiring deodorizing as well as strict control on variation in volatiles by adding buffering agent. The project includes modification of existing extruder, fire safety and alarm system in the production area and warehouse to mitigate fire and explosion hazard from the use of butane. Extensive production and safety training and technology transfer to the plant operators will also be provided through an external process specialist.

3. PROJECT COSTS

3.1. CAPITAL COSTS

	Description		Cost(USD)
o	2 butane bulk tanks		65,000
o	Extruder retrofitting		70,000
o	Fire deflection wall (40 m)		14,000
o	Equipment relocation		55,000
	Fire deflection wall(30m)		10,000
o	Fire safety & Alarm systems		140,000
o	Exhaust fans (22 pcs)	40,000	
	Industrial blow down fans(32)	32,000	
	Gas sensing/detection system(7)	49,000	

Portable gas detector (1)		4,000	
Fire extinguishers		7,500	
* Trolley mounted(5)	5,000		
* Handheld(10)	1,000		
Static eliminator (2)		6,000	
Emergency spot light (4)		3,000	
o Technology transfer/training			10,000
o Contingency/rounding			36,000
TOTAL INCREMENTAL CAPITAL COST			**390,000**

3.2. OPERATING COSTS/BENEFITS

No incremental costs/or benefits are included since, as a matter of policy for XPE/PS projects, these are assumed on a national Chinese level to be neutral.

3.3. UNIT ABATEMENT COSTS

a.	ODS Reduction Capital Costs	US$390,000
b.	Annual incremental costs	US$ -
c.	Capital Recovery Factor(10y/10%)	0.16275
d.	ODS Reduction/year	kg 70,000
Unit	**Abatement Costs [{(a(c) + b})/d]**	**US$/kg/y 1.27**

4. FINANCIAL PLAN

The enterprise requests a grant covering the total incremental cost as calculated under 3.1: **US$390,000**

5. PROJECT IMPACT

This project will eliminate the use of 70 tons of CFC-12 in the first year after implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex-4A: Technical Review

TECHNICAL REVIEW

1. **COUNTRY:** China

2. **PROJECT TITLE:** **GUIZHOU JINCHANG PLASTICS PRODUCTS CO. LTD. - Elimination of CFC-12 in the Manufacture of XPS Foam Sheet**

3. **(SUB) SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.

5. **TECHNOLOGY:** The company will replace CFC-11 by butane. Other technologies are also available but the company chooses butane because it is a proven, environmentally sound technique which is cost-effective. On the other hand, however, two main drawbacks are taken: the flammability and the low purity. The precautions to be taken to reduce the flammability hazards are well described in the text. However, serious safety audit and an increased fire prevention and safety awareness among all concerned employees will be most important. Risk analysis is necessary, and risk response must be a procedure which is written, known, implemented and tested out. Specialized firms have to be called in. Training by local fire brigade is a necessity, as well as maintaining a good relation with the brigade.

   The low degree of purity of the butane is a problem which necessitates monitoring and constant care for the workers around.

   It is beneficial that the factory moved away from the residential area.

6. **ENVIRONMENTAL** CFC-12 has an ODP of about 1 and a GWP of about 3. Butane has none of these properties but may contribute more to smog formation at low level.

7. **PROJECT COST:** The costs for a small pentane user (50 t) are relatively high. It can, for instance, be questionned why two butane bulk tanks are proposed. This can only be accepted if the plant layout urges such a solution.

   The cost to eliminate 1 ton of ODS is USD 8,900, which is relatively high.

8. **IMPLEMENTATION** 1.5 years is a reasonable time span to perform the change-over.

9. **RECOMMENDATION:** To be accepted, if the question on the number of bulk tanks answered satisfactorily.

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

Annex 5

PROJECT COVER SHEET

COUNTRY	: CHINA
PROJECT TITLE	: HAILUN PLASTIC PACKAGING MATERIAL FACTORY - Elimination of CFC-12 in the Manufacture of XPS?XPE Foam Sheet
SECTOR COVERED	: Foamed Plastics
ODS USED IN SECTOR	: 17,773 MT CFCs (=ODP) in 1991
PROJECT IMPACT	: 95 MT of CFC-12 per year based on 1993 consumption
PROJECT DURATION	: 18 months
PROJECT ECONOMIC LIFE	: 10 years
TOTAL PROJECT COST	: Capital cost incurred USD 335,000
PROPOSED MLF GRANT	: USD 335,000
COST EFFECTIVENESS	: USD 0.57/kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY	: China National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	: National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY	: UNDP
APPRAISAL DATE	: October, 1994

PROJECT SUMMARY

Hailun Plastics Packaging Material Factory (HAILUN), in Heilongjiang Province, is a state-owned enterprise directly under the supervision of Hailun City Packaging Company. In 1987, HAILUN ordered from Battenfield a single screw extruder using CFC-12 as blowing agent to manufacture XPS/XPE foam sheet. Under this project, HAILUN will phase out 95 t of ODS annually by switching from the use of CFC-12 to butane. The project contains capital cost for conversion, safety and training.

PREPARED BY: Ko Swee Hee REVIEWED BY: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF CHINA

HAILUN - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF XPS/XPE FOAM SHEET

1. ENTERPRISE BACKGROUND

HAILUN was established in 1986 as a state-owned enterprise under the direct supervision of Hailun City Packaging Company. The enterprise is situated in Hailun City north to Harbin. It is isolated from residential area so that butane can be used. It employs 26 workers. Its raw material and CFCs usage is as follows:

1992: 480 mt of resin, 90 mt CFC-12
1993: 500 mt of resin, 95 mt CFC-12
1994: 500 mt of resin, 95 mt CFC-12 (estimated)

2. PROJECT DESCRIPTION

Under this project, HAILUN will phase out the use of CFC-12 in its XPS/XPE foam sheet and netting production through substitution by butane as replacement. Butane is available in China with purity ranging from 60-80% which is still acceptable as blowing agent in this industry. "MERCAPTAN" is added into butane to ease detection of butane presence, thus requiring deodorizing as well as strict control on variation in volatiles by adding buffering agent. The project includes modification of existing extruder, fire safety and alarm system in the production area and warehouse to mitigate fire and explosion hazard from the use of butane. Extensive production and safety training and technology transfer to the plant operators will also be provided through an external process specialist.

3. PROJECT COSTS

3.1. CAPITAL COSTS

	Description		Cost(USD)
o	1 butane bulk tank		45,000
o	Extruder retrofitting		70,000
o	Fire deflection wall (30m)		11,000
o	Fire safety & Alarm systems		169,500
	Exhaust fans (46 pcs)	80,900	
	Industrial blow down fans(14)	29,000	
	Gas sensing/detection system(6)	40,000	
	Portable gas detector	4,000	
	Fire extinguishers		
	* Trolley mounted(6)	6,000	
	* Handheld(16)	1,600	

	Static eliminator	6,000	
	Emergency spot light (3)	2,000	
o	Technology transfer/training		10,000
o	Contingency/rounding		29,500
TOTAL INCREMENTAL CAPITAL COST			335,000
			=======

3.2. OPERATING COSTS/BENEFITS

No incremental costs/or benefits are included since, as a matter of policy for XPE/PS projects, these are assumed on a national Chinese level to be neutral.

3.3. UNIT ABATEMENT COSTS

a.	ODS Reduction Capital Costs	US$335,000
b.	Annual incremental costs	US$ -
c.	Capital Recovery Factor(10y/10%)	0.16275
d.	ODS Reduction/year	kg 95,000
Unit	**Abatement Costs [{(a(c) + b})/d]**	**US$/kg/y 0.57**
		============

4. FINANCIAL PLAN

The enterprise requests a grant covering the total incremental cost as calculated under 3.1: **US$335,000**

5. PROJECT IMPACT

This project will eliminate the use of 95 tons of CFC-12 in the first year after implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex-5A: Technical Review

TECHNICAL REVIEW

1. **COUNTRY:** China

2. **PROJECT TITLE:** **HAILUN PLASTICS PACKAGING MATERIAL FACTORY** - Elimination of CFC-12 in the Manufacture of XPE/PS Foam Sheet

3. **(SUB) SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.

5. **TECHNOLOGY:** The company will replace CFC-11 by butane. Other technologies are also available but the company chooses butane because it is a proven, environmentally sound technique which is cost-effective. On the other hand, however, two main drawbacks are taken: the flammability and the low purity. The precautions to be taken to reduce the flammability hazards are well described in the text. However, serious safety audit and an increased fire prevention and safety awareness among all concerned employees will be most important. Risk analysis is necessary, and risk response must be a procedure which is written, known, implemented and tested out. Specialized firms have to be called in. Training by local fire brigade is a necessity, as well as maintaining a good relation with the brigade.

   The low degree of purity of the butane is a problem which necessitates monitoring and constant care for the workers around.

6. **ENVIRONMENTAL** CFC-12 has an ODP of about 1 and a GWP of about 3. Butane has none of these properties but may contribute more to smog formation at low level.

7. **PROJECT COST:** Costs as presented are realistic and can be accepted. The cost for removal of 1 ton of ODS is USD 4,158, which is acceptable.

8. **IMPLEMENTATION** 1.5 years is a reasonable time span to perform the change-over.

9. **RECOMMENDATION:** To be accepted as proposed.

H Creyf

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

PROJECT COVER SHEET

COUNTRY	:	CHINA
PROJECT TITLE	:	HEBEI SIXING POLYPACK PRODUCTS CO. LTD. - Elimination of CFC-12 in the Manufacture of XPE Netting
ODS USED IN SECTOR	:	17,773 MT CFCs (=ODP) in 1991
PROJECT IMPACT	:	65 MT of CFC-12 per year based on 1993 consumption
PROJECT DURATION	:	18 months
PROJECT ECONOMIC LIFE	:	10 years
TOTAL PROJECT COST	:	Capital cost - USD 410,000
PROPOSED MLF GRANT	:	USD 410,000
COST EFFECTIVENESS	:	USD 1.03/kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY	:	China National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	:	National Environmental Protection Agency(NEPA)
IMPLEMENTING AGENCY	:	UNDP
APPRAISAL DATE	:	October 6th, 1994

PROJECT SUMMARY

Hebei Sixing Polypack Products Co. Ltd (SIXING) is the state-owned enterprise directly under the supervision of Hebei External Trade Department Foodstuff Import & Export (Group) Company. During 1990 to 1993, SIXING imported three extruders from Nakamura Machinery Works Co. Ltd.. Two of them use CFC-12 as blowing agent. Under this project, SIXING will phase out 65t CFC-12 by using butane. The project contains capital cost for conversion, safety and training.

Prepared by: Ko Swee Hee/Bert Veenendaal
Reviewed by: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF CHINA

HEBEI SIXING - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF EXTRUDED POLYETHYLENE FOAM SHEET AND NETTING

1. ENTERPRISE BACKGROUND

SIXING was established in 1990 as a state-owned enterprise under the direct supervision of Hebei External Trade Department Import & Export (Group) Co. It is located in the north-western part of Shijiazhuang city. Its layout and nearby environment allow the use of butane. SIXING employs 40 workers. Its raw materials and CFCs usage in 1992 was 200 mt of resin and 50 mt CFC-12, and in 1993 was 250 mt of resin, 65 mt CFC-12.

2. PROJECT DESCRIPTION

Under this project, SIXING will phase out the use of CFC-12 in its XPE foam sheet and netting production through substitution by butane technology as replacement. Butane is available in China with purity degree ranging from 60-80% which is still acceptable as blowing agent in this industry. "MERCAPTAN" is added into butane to ease detection of butane presence. This requires deodorizing as well as strict control on variation in volatiles by adding buffering agent. The project includes modification of existing extruder, fire safety and alarm system in the production area and warehouse to mitigate fire and exposure hazard from the use of butane. Extensive production and safety training and technology transfer to the plant operators will be provided through an external process specialist.

3. PROJECT COSTS

3.1. CAPITAL COSTS

	Description		Cost(USD)
o	1 butane bulk tank		45,000
o	Extruder retrofitting (2 sets)		140,000
o	Fire deflection wall(21m)		7,000
o	Building Modification		20,000
o	Fire safety & Alarm systems............		151,500
	Exhaust Fans (27pcs)	48,600	
	Ventilation ducting (8m)	10,000	
	Blowdown Fans (18)	18,000	
	Exhaust Hood (2)	10,000	
	Gas sensing/detection system(6)	42,000	
	Portable gas detector (1)	4,000	
	Fire extinguishers		
	Trolley mounted(6)	6,000	
	Handheld(18)	1,800	

	Static eliminator (3)	9,000
	Emergency spot light (3)	2,100
o	Technology transfer/training	10,000
o	Contingency/rounding	36,500
TOTAL INCREMENTAL CAPITAL COST:		**USD 410,000**

3.2. OPERATING COSTS/BENEFITS

No incremental costs/or benefits are included since, as a matter of policy, for XPE/PS projects these are assumed, on a national Chinese level, to be neutral.

3.3. UNIT ABATEMENT COSTS

a.	ODS Reduction Capital Costs	US$410,000
b.	Annual incremental savings	US$ -
c.	Capital Recovery Factor(10y/10%)	0.16275
d.	ODS Reduction/year	kg 65,000
Unit Abatement Costs [{(a(c) + b})/d]		US$/kg/y 1.03

4. FINANCIAL PLAN

The enterprise requests a grant covering the total incremental cost as calculated under 3.1: **US$ 410,000**

5. PROJECT IMPACT

This project will eliminate the use of 65 tons of CFC-12 in the first year after implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex-6A: Technical Review

TECHNICAL REVIEW

1. COUNTRY: China

2. **PROJECT TITLE:** **HEBEI SIXING POLYPACK PRODUCTS CO. LTD. - Elimination of CFC-12 in the Manufacture of XPE netting**

3. **(SUB) SECTOR:** **Foamed Plastics**

4. **CP RELATIONSHIP:** **The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.**

5. **TECHNOLOGY:** **The company will replace CFC-11 by butane. Other technologies are also available but the company chooses butane because it is a proven, environmentally sound technique which is cost-effective. On the other hand, however, two main drawbacks are taken: the flammability and the low purity. The precautions to be taken to reduce the flammability hazards are well described in the text. However, serious safety audit and an increased fire prevention and safety awareness among all concerned employees will be most important. Risk analysis is necessary, and risk response must be a procedure which is written, known, implemented and tested out. Specialized firms have to be called in. Training by local fire brigade is a necessity, as well as maintaining a good relation with the brigade.**

The low degree of purity of the butane is a problem which necessitates monitoring and constant care for the workers around.

6. **ENVIRONMENTAL** CFC-12 has an ODP of about 1 and a GWP of about 3. Butane has none of these properties but may contribute more to smog formation at low level.

7. **PROJECT COST:** It is questioned whether it would not be cheaper for the company to include the third production line at the same time.

Costs are presented realistically.
The cost to remove 1 ton of ODS is USD 7,708.

8. **IMPLEMENTATION** 1.5 years is a reasonable time span to perform the change-over.

9. **RECOMMENDATION:** The company must be recommended to change the third line as well. Otherwise, the project can be approved as presented.

H Creyf

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

PROJECT COVER SHEET

COUNTRY	:	CHINA
PROJECT TITLE	:	SHANGHAI JIANHUA ELECTRO-MECHANICAL & CHEMICAL COMPANY - Elimination of CFC-12 in the Manufacture of PE/PS
SECTOR COVERED	:	Foamed Plastics
ODS USED IN SECTOR	:	17,773 MT CFCs (=ODP) in 1991
PROJECT IMPACT	:	100 MT of CFC-12 per year based on 1993 consumption
PROJECT DURATION	:	One year
PROJECT ECONOMIC LIFE	:	10 years
TOTAL PROJECT COST	:	Capital cost incurred USD 370,000
PROPOSED MLF GRANT	:	USD 370,000
COST EFFECTIVENESS	:	USD 0.60/kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY	:	China National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY	:	UNDP
APPRAISAL DATE	:	August 31, 1994

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PROJECT SUMMARY

Shanghai Jianhua Electro-Mechanical & Chemical Company (JIANHUA) is a state-owned enterprise which produces XPE/XPS, using CFC-12 as a blowing agent. The purpose of this project is to phaseout the CFC-12 usage through butane. The project contains capital cost for conversion, safety and training.

Prepared BY: Ko Swee Hee/Bert Veenendaal
Reviewed BY: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF CHINA

JIANHUA - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF EXTRUDED POLYETHYLENE/POLYSTYRENE FOAM SHEET

1. ENTERPRISE BACKGROUND

JIANHUA was established in 1986 as a state enterprise under the supervision of Shanghai's Bureau of Machinery Facilities and Beijing's Ministry of Internal Trade. The enterprise is located in an old residential and industrial area, sharing with the plastic printing factory on the third story of a building. The enterprise sees the necessity to relocate if butane is to be used to replace CFC-12. The company has therefore decided to construct a new building (now under construction and to be completed by end November, 1994) at No. 1247, Danlu Road, Pudong New Industrial Town, Shanghai. This is an open area with a river passing by.

JIANHUA produces PS foam sheet for its own vacuum machines to convert it into vacuum-formed finished products, and PE foam sheet for packaging purposes. It currently employs about 60 workers for its production. The enterprise has grown rapidly over the years and is expected to show continued growth. CFC consumption since 1991 is as follows:

1991: 700 mt of resin, 100 mt CFC-12
1992: 700 mt of resin, 100 mt CFC-12
1993: 700 mt of resin, 100 mt CFC-12
1994: 800 mt of resin, 120 mt CFC-12(estimated)

2. PROJECT DESCRIPTION

Under this project, JIANHUA will phase out the use of CFC-12 in its XPE/XPS Foam Sheet through substitution by butane technology as replacement. Butane is available in China with purity degree ranging from 60-80% which is still acceptable as blowing agent in this industry. "MERCAPTAN" is added into butane to ease detection of butane presence. This requires deodorizing as well as strict control on variation in volatiles by adding buffering agent. The project includes modification of existing extruder, fire safety and alarm system in the production area and warehouse to mitigate fire and explosion hazard from the use of butane. Extensive production and safety training and technology transfer to the plant operators will be provided through an external process specialist.

3. PROJECT COSTS

3.1. CAPITAL COSTS

Description		Cost(USD)
o 2 butane bulk tanks		65,000
o Extruder retrofitting		70,000
o 2 explosion proof motor(for primary and secondary motors)		16,000
o Building modification		65,000
Fire deflection wall (30m)	10,000	
Relocation of equipment	55,000	
o Fire safety & Alarm systems		112,500
Ventilation and exhaust ducting	40,000	
Industrial blow down fans (14)	10,000	
Gas sensing/detection system(6)	45,000	
Portable gas detector	4,000	
Fire extinguishers		
* Trolley mounted(6)	6,000	
* Handheld(15)	1,500	
Static eliminator	6,000	
o Technology transfer/training		10,000
o Contingency/rounding		31,500
TOTAL INCREMENTAL CAPITAL COSTS		**370,000**

3.2. OPERATING COSTS/BENEFITS

No incremental costs/or benefits are included since, as a matter of policy for XPE/PS projects, these are assumed on a national Chinese level to be neutral.

3.3. UNIT ABATEMENT COSTS

a.	ODS Reduction Capital Costs	US$370,000
b.	Annual incremental benefits	US$ -
c.	Capital Recovery Factor(10y/10%)	0.16275
d.	ODS Reduction/year	kg 100,000
	Unit Abatement Costs [{(a(c) + b})/d]	**US$/kg/y 0.60**

4. FINANCIAL PLAN

The enterprise requests a grant covering the total incremental cost as calculated under 3.1: **US$370,000**

5. PROJECT IMPACT

This project will eliminate the use of 100 tons of CFC-12 in the first year after implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex-7A: Technical Review

TECHNICAL REVIEW

1. COUNTRY: China

2. **PROJECT TITLE:** **SHANGHAI JIANHUA ELECTRO-MECHANICAL AND CHEMICAL COMPANY - Elimination of CFC-12 in the Manufacture of PE/PS Foam Sheet**

3. **(SUB) SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.

5. **TECHNOLOGY:** The company will replace CFC-11 by butane. Other technologies are also available but the company chooses butane because it is a proven, environmentally sound technique which is cost-effective. On the other hand, however, two main drawbacks are taken: the flammability and the low purity. The precautions to be taken to reduce the flammability hazards are well described in the text. However, serious safety audit and an increased fire prevention and safety awareness among all concerned employees will be most important. Risk analysis is necessary, and risk response must be a procedure which is written, known, implemented and tested out. Specialized firms have to be called in. Training by local fire brigade is a necessity, as well as maintaining a good relation with the brigade.

   The low degree of purity of the butane is a problem which necessitates monitoring and constant care for the workers around.

   The fact that JIANHUA will relocate its plant from a residential zone to a more open area is an excellent idea.

6. **ENVIRONMENTAL** CFC-12 has an ODP of about 1 and a GWP of about 3. Butane has none of these properties but may contribute more to smog formation at low level.

7. **PROJECT COST:** The capital costs as requested are realistic. The cost for a static eliminator is rather USD 3,000. The fact that the existing extruder can be retrofitted is an important saving.

8. **IMPLEMENTATION** 1.5 years is a reasonable time span to perform the change-over.

9. **RECOMMENDATION:** To be accepted as proposed.

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

PROJECT COVER SHEET

COUNTRY:	China
PROJECT TITLE:	JINAN - Conversion to CFC-free Technology in the Manufacture of Extruded Polystyrene Foam Sheet
SECTORS COVERED:	Foamed Plastics
ODS USE IN SECTOR:	17,773 tons CFCs (=ODP) in 1991
PROJECT IMPACT:	30t CFC-12/y (base 1993)
PROJECT DURATION:	18 months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	USD 290,000 Incr. Capital Cost
PROPOSED MLF GRANT:	USD 290,000
COST EFFECTIVENESS:	USD 1.57/kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY:	National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	July/August, October 1994

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PROJECT SUMMARY

Jinan Plastic No.4 Factory is a state owned enterprise which produces XPS, using CFC-12 as a blowing agent. Under this project it will phaseout the use of CFC-12 through substitution by butane. The project contains capital cost for conversion, safety and training.

Prepared By: Ko Swee Hee/Bert Veenendaal
Reviewed By: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF CHINA

JINAN CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF EXTRUDED POLYSTYRENE FOAM SHEET

1. ENTERPRISE BACKGROUND

Jinan No.4 was established in 1954 as a subsidiary of the Second Light Industry Bureau in Jinan/Shangdong. It has annual sales of 15 million RMB and 320 employees from which 50 work in the XPS extrusion department. The company produces Molded PE foam, XPS for fast food packaging; EPS bead foam and PE soft pipe. The plant imported an extruder from Polymachinery Works Corporation (Taiwan) in 1986 and has begun its XPS mass production since then. The production of polystyrene foam in 1993 was about 350 t/y, the amount of CFC-use annually is about 30t/y.

2. PROJECT DESCRIPTION

Under this project Jinan No.4 will phaseout the use of CFCs in its XPS operation through substitution by butane. Butane is available in the Chinese market at a 75-80% purity and requires deodorizing as well as strict control on variation in volatiles (buffering may be needed).

The project includes installation of a storage system, retrofit of the extruder, safety modifications in the working area as well as infrastructural measures to mitigate fire and exposure hazards from the use of butane and will provide extensive production and safety training. Technology transfer will be provided through an external process expert.

3. PROJECT COSTS

3.1 CAPITAL COST

DESCRIPTION	AMOUNT (USD)
Butane tank	45,000
Extruder retrofitting	70,000
1 Explosion proof motor for HP extruder	16,000
Control room	5,000
Fire safety & alarm system	117,500
ventilation & exhaust system	40,000
supply & installation of 30 industrial blow-down fans	20,000
sensing system/gas detection	40,000

portable gas detector	4,000
fire extinguishers	7,500
static eliminators	6,000
Technology transfer/training	10,000
Contingency/rounding	26,500
TOTAL	290,000

3.2 OPERATING COSTS

No incremental operating costs/benefits have been calculated since it is assumed at these will be neutral when taken at the Chinese national level.

3.3 UNIT ABATEMENT COST

a)	ODS Reduction Project Costs	**USD 290,000**
b)	Annual Incremental Benefits	USD 0
c)	Capital Recovery Factor (10y/10%)	0.16275
d)	ODS Reduction/y	kg 30,000
	Unit Abatement Costs [{a(c) + b}/d]	**USD/kg/y 1.57**

4. FINANCING PLAN

Requested is a grant covering the total incremental cost of **USD 290,000.**

5. PROJECT IMPACT

This project will eliminate the use of at least 30 tons of CFC-12 in the first year of implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex 8A: Technical Review

TECHNICAL REVIEW

1.	**COUNTRY:**	China
2.	**PROJECT TITLE:**	**JINAN** - Conversion to CFC-free Technology in the Manufacture of Extruded Polystyrene Foam Sheet
3.	**(SUB) SECTOR:**	Foamed Plastics
4.	**CP RELATIONSHIP:**	The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.
5.	**TECHNOLOGY:**	The company will replace CFC-11 by butane. Other technologies are also available but the company chooses butane because it is a proven, environmentally sound technique which is cost-effective. On the other hand, however, two main drawbacks are taken: the flammability and the low purity. The precautions to be taken to reduce the flammability hazards are well described in the text. However, serious safety audit and an increased fire prevention and safety awareness among all concerned employees will be most important. Risk analysis is necessary, and risk response must be a procedure which is written, known, implemented and tested out. Specialized firms have to be called in. Training by local fire brigade is a necessity, as well as maintaining a good relation with the brigade. The low degree of purity of the butane is a problem whicl necessitates monitoring and constant care for the workers around.

6. **ENVIRONMENTAL** CFC-12 has an ODP of about 1 and a GWP of about 3. Butane has none of these properties but may contribute more to smog formation at low level.

7. **PROJECT COST:** After discussion with project leader, several capital costs could be brought down and the actually noted ones are realistic.

   The cost to reduce 1 ton of ODS is USD 10,667. This relative high amount is due to the fact that JINAN will use a small amount of butane, with the required safety measures.

8. **IMPLEMENTATION** 1.5 years is a reasonable time span to perform the change-over.

9. **RECOMMENDATION:** To be accepted as proposed.

H Creyf

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

PROJECT COVER SHEET

COUNTRY:	China
PROJECT TITLE:	JINFENG - Conversion to CFC-free Technology in the Manufacture of Extruded Polystyrene Foam Sheet
SECTORS COVERED:	Foamed Plastics
ODS USE IN SECTOR:	17,773 tons CFCs (=ODP) in 1991
PROJECT IMPACT:	70t CFC-12 per year (base 1993)
PROJECT DURATION:	18 Months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	Incremental Capital Cost: USD 310,000
PROPOSED MLF GRANT:	USD 190,340 reflecting 61.4 national ownership
COST EFFECTIVENESS:	USD 0.72/kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY:	National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATES:	March, July, October, 1994

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PROJECT SUMMARY

Jinfeng Plastic Packaging Co. (Jinfeng) is a joint venture which produces XPS, using CFC-12 as a blowing agent. The purpose of this project is to phaseout the CFC-12 usage through butane. The project contains capital and incremental operation cost for conversion, safety and training.

Prepared By: Maoqi Zhang/Bert Veenendaal
Reviewed By: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF CHINA

JINFENG - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF EXTRUDED POLYSTYRENE FOAM SHEET

1. ENTERPRISE BACKGROUND

Jinfeng Plastic Packaging Corporation was established in 1958 and is located in a Shanghai suburb. It turned into a joint venture in 1993. The Chinese shareholders own 61.4% of the corporation. It has 46 employees. The enterprise has one extruder which was supplied by Xin-Heng (Taiwan). In 1993, it produced about 900 tons of XPS using about 70 tons of CFC-12.

2. PROJECT DESCRIPTION

Under this project, the enterprise will retrofit its extruder, introduce building modifications and safety measures to mitigate fire and exposure hazards from the use of butane. Extensive production and safety training will also be provided through an external expert.

3. PROJECT COSTS

3.1 TOTAL PROJECT COST

DESCRIPTION		AMOUNT (USD)
Extruder retrofitting (1 unit)		70,000
Deflection wall		15,000
Butane tank and booster pump		65,000
Metering pump		30,000
1 Explosion proof motor		16,000
Fire safety & alarm system		
Ventilation & exhaust system	20,000	
Supply & installation of industrial blow-down fans (30 units)	20,000	
Sensing system/gas detection	20,000	
Portable gas detector	4,000	
Fire extinguishers	7,500	
Static eliminators	4,000	
Technology transfer/training		10,000
Contingency		28,500
TOTAL		310,000

3.2 OPERATING COSTS

No incremental operating cost has been calculated since it has been assumed that, within this sub-sectoral in China, overall incremental cost and benefits will be neutralized.

3.3 UNIT ABATEMENT COST

a)	ODS Reduction Project Costs	USD 310,000
b)	Annual Incremental Costs/Benefits	USD -
c)	Capital Recovery Factor (10%)	0.16275
d)	ODS Reduction/y	kg 70,000
	Unit Abatement Costs [(a*c + b)/d]	**USD 0.72/kg/y**

4. FINANCING PLAN

The total project cost amounts to USD 368,000. The requested grant, representing the 61.4% local ownership, is **USD 190,340.**

5. PROJECT IMPACT

This project will eliminate the use of 70 tons of CFC-12 in the first year after implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex 9A: Technical Review

ANNEX 9A
2/3

TECHNICAL REVIEW

1. **COUNTRY:** China

2. **PROJECT TITLE:** JINFENG - Conversion to non-CFC technology in the Manufacture of Extruded Polystyrene Foam Sheet

3. **(SUB) SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** The foam sectoral strategy has been finalized by MCLI and NEPA and is under review. This project was formulated after a workshop on alternative technologies in the foam sector.

5. **TECHNOLOGY:** Apparently, other technical solutions were considered but were not found acceptable either because of high price and/or non-availability (HFCs), technically not feasible (e.g. an early diffusion of HCFC-22 leads to shrinkage), or for practical reasons (e.g. CO2 equipment cannot be imported).

The choice of butane as a blowing agent can be accepted since it offers several technical, toxicological and cost advantages. It is, however, extremely important that passive and active safety measures are taken during and after manufacturing in order to avoid fires. Such additional safety measures could include:

- implementation of a strict no-smoking rule;
- earthing of equipment in the zones where butane is transferred (including discharge from trucks);
- installation of indirect heating in critical zones;
- establishment, training and implementation of safety management systems;
- performance of first production trials under increased safety conditions.

Moreover, it is important that the purity of the butane be checked, especially if the finished products will be used in the food chain. Workers must not be exposed to dangerous concentrations of by-products and necessary precautions must be taken.

		Sufficient time must elapse between production and sales so that the blowing agent has enough time to evaporate.
6.	**ENVIRONMENTAL IMPACT:**	Butane has no ODP, but may contribute to ozone formation at lower level. The Chinese legislation for emissions of Volatile Organic Compounds (VOCs) needs to be consulted.
7.	**PROJECT COST:**	The proposed project costs seem realistic and acceptable. Operating costs/benefits are not considered but assumed to be neutral.
8.	**IMPLEMENTATION:**	As proposed.
9.	**RECOMMENDATION:**	The project can be accepted, taking into account remarks under (5) above.

PREPARED BY: Dr. Hubert Creyf
UNDP Foam Sector Project Reviewer

DATE: 21 October 1994

Annex 10

PROJECT COVER SHEET

COUNTRY	: CHINA
PROJECT TITLE	: SHENRONG (Sino-Foreign Joint Stock Shenyang Shenrong Co.)- Elimination of CFC-12 in the Manufacture of EPS Foam Sheet
SECTOR COVERED	: Foamed Plastics
ODS USED IN SECTOR	: 17,773 MT CFCs (=ODP) in 1991
PROJECT IMPACT	: 48t of CFC-12/y (1993 consumption)
PROJECT DURATION	: 18 months
ECONOMIC LIFE	: 10 years
TOTAL PROJECT COST	: Capital cost: USD 310,000
PROPOSED MLF GRANT	: USD 176,700 (reflecting 57% of Chinese share of ownership)
COST EFFECTIVENESS	: USD 1.05/kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY	: China National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	: National Environmental Protection Agency(NEPA)
IMPLEMENTING AGENCY	: UNDP
APPRAISAL DATE	: August, October 1994

PROJECT SUMMARY

Sino-Foreign Joint Stock Shenyang Shenrong Co(SHENGRONG) is a joint venture company between Shengyang No. 4 Plastic Factory (50%), Shengyang International Trust Investment Co.(7%) and Hongkong Ronghua Trading Co Ltd.(43%). The company manufactures extruded polystyrene foam sheet using CFC-12 as blowing agent. Under this project, SHENGRONG will phase out 48t of ODS annually by converting from CFC-12 to butane. The project contains capital cost for conversion, safety and training.

Prepared by: Ko Swee Hee **Reviewed by:** Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF CHINA

SHENGRONG - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF EXTRUDED POLYSTYRENE FOAM SHEET

1. ENTERPRISE BACKGROUND

Shenyang Shenrong was established in 1987 as a joint venture partnership between the following share-holders:

- o Shenyang No. 4 Plastic Factory............... 50%
- o Shenyang International Trust Investment Co.... 7%
- o Hongkong Ronghua Trading Co Ltd............... 43%

The enterprise is located in the Huanggu District of Shengyang province, China. It is surrounded by residential areas and a hospital which is about 30m away. The plant is producing XPS vacuum forming products, injection molding products and blow-molding products within the same premises. The plant currently employs about 70 workers. The company has grown rapidly during the recent years, but is currently experiencing a slow down. CFC consumption since 1991 is as follows:

1991: 150 mt of resin, 25 mt CFC-12
1992: 200 mt of resin, 35 mt CFC-12
1993: 270 mt of resin, 48 mt CFC-12
1994: 270 mt of resin, 48 mt CFC-12

The slowdown of the production is due to a current sudden shortage of CFC-12 and partly due to the mechanical problems in the production.

2. PROJECT DESCRIPTION

Under this project, SHENRONG will phase out the use of CFC-12 in its EPS operation through substitution by butane technology as replacement. Butane is available in China with purity degree ranging from 60-80% which is still acceptable as blowing agent in this industry. "MERCAPTAN" is added into butane to ease detection of butane presence. Thus requires deodorizing as well as strict control on variation in volatiles by adding buffering agent. The project includes modification of existing extruder, fire safety and alarm system in the production area and warehouse to mitigate fire and exposure hazard from the use of butane. Extensive production and safety training and technology transfer to the plant operators will be provided through an external process specialist.

3. PROJECT COSTS

3.1. CAPITAL COSTS

	Description		Cost(USD)
o	1 unit of butane bulk tank (5 mt)		45,000
o	Extruder retrofitting		70,000
o	2 explosion proof motor(for primary and secondary motors)		16,000
o	Building modification		22,000
o	Fire safety & Alarm systems...........		119,500
	Ventilation and exhaust system	40,000	
	Industrial blow down fans	20,000	
	Gas sensing & detection system	42,000	
	Portable gas detector	4,000	
	Fire extinguishers	7,500	
	Static eliminator	6,000	
o	Technology transfer/training		10,000
o	Contingency/rounding		27,500
TOTAL INCREMENTAL CAPITAL COST			**310,000**

3.2. OPERATING COSTS/BENEFITS

No incremental costs/or benefits are included since, as a matter of policy, for XPE/PS projects these are assumed, on a national Chinese level, to be neutral.

3.3. UNIT ABATEMENT COSTS

a.	ODS Reduction Capital Costs	US$310,000
b.	Annual incremental costs	US$ -
c.	Capital Recovery Factor(10y/10%)	0.16275
d.	ODS Reduction/year	kg48,000
Unit Abatement Costs [{(a(c) + b})/d]		**US$/kg/y: 1.05**

4. FINANCIAL PLAN

The enterprise requests 57% of the total costs (US$ 310,000), representing the Chinese share of ownership. The amount is

USS$176,700

5. PROJECT IMPACT

This project will eliminate the use of at least 48t of CFC-12 in the first year after implementation. This project also employ commercially viable and environmentally acceptable technology.

TECHNICAL REVIEW

1. **COUNTRY:** China

2. **PROJECT TITLE:** **SINO-FOREIGN JOINT STOCK SHENYANG SHENRONG CO. - Elimination of CFC-12 in the Manufacture of EPS Foam Sheet**

3. **(SUB) SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.

5. **TECHNOLOGY:** The company will replace CFC-11 by butane. Other technologies are also available but the company chooses butane because it is a proven, environmentally sound technique which is cost-effective. On the other hand, however, two main drawbacks are taken: the flammability and the low purity. The precautions to be taken to reduce the flammability hazards are well described in the text. However, serious safety audit and an increased fire prevention and safety awareness among all concerned employees will be most important. Risk analysis is necessary, and risk response must be a procedure which is written, known, implemented and tested out. Specialized firms have to be called in. Training by local fire brigade is a necessity, as well as maintaining a good relation with the brigade.

   The low degree of purity of the butane is a problem whicl necessitates monitoring and constant care for the workers around.

6. **ENVIRONMENTAL** CFC-12 has an ODP of about 1 and a GWP of about 3. Butane has none of these properties but may contribute more to smog formation at low level.

7. **PROJECT COST:** The proposed costs are realistic and show a total amount of USD 370,000. This means that the elimination of 1 ton of ODS costs USD 3,854. It is important to know whether the other partners (Hong Kong Trading Co. Ltd. and Shengyang International Trust Investment) are willing to join in this undertaking.

8. **IMPLEMENTATION** 1.5 years is a reasonable time span to perform the change-over.

9. **RECOMMENDATION:** It is recommended to approve the project as presented.

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

PROJECT COVER SHEET

COUNTRY	:	CHINA
PROJECT TITLE	:	Elimination of CFC-12 in the Manufacture of XPS Foam Sheet at Shenzhen Shentie Plastics Tableware Products Company, Shenzhen.
SECTOR COVERED	:	Foamed Plastics
ODS USED IN SECTOR	:	17,773 MT CFCs (=ODP) in 1991
PROJECT IMPACT	:	75 MT of CFC-12 per year based on 1993 consumption
PROJECT DURATION	:	18 months
PROJECT ECONOMIC LIFE	:	10 years
TOTAL PROJECT COST	:	Incr. Capital cost: USD 345,000
PROPOSED MLF GRANT	:	USD 345,000
COST EFFECTIVENESS	:	USD 0.75KG/Y (unit abatement cost)
NATIONAL EXECUTING AGENCY	:	China National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY	:	UNDP
APPRAISAL DATE	:	October, 1994

PROJECT SUMMARY

Shenzhen Shentie Plastics Tableware Products Company (SHENTIE) is a state owned enterprise which belongs to Guangshen Railroad General Company which provide railroad services for Guangdong Province. In 1985, SHENTIE bought an extruder from Sheng Jia Machinery Works Co. Ltd. to produce extruded polystyrene foam sheet. Under this project SHENTIE will phase out 75t of CFC-12 by using butane. The project contains capital cost for conversion, relocation of equipment, safety and training.

Prepared by: K. S. Hee/B. Veenendaal **Reviewed by:** Dr. H. Creyf

PROJECT OF THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF CHINA

SHENTIE - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF EXTRUDED POLYSTYRENE FOAM SHEET

1. ENTERPRISE BACKGROUND

SHENTIE was established in 1985 as a state-owned enterprise under Guangshen Railroad General Company. It is located in an industrial area of Shenzhen city where butane is allowed to be used. The enterprise employs 85 workers. Raw materials and CFCs usage are as follows: in 1992: 1000 mt of resin, 60 mt CFC-12; and in 1993: 1000 mt of resin, 75 mt CFC-12.

2. PROJECT DESCRIPTION

Under this project, SHENTIE will phase out the use of CFC-12 in its XPS foam sheet production through substitution by butane as replacement. Butane is available in China with purity degree ranging from 60-80% which is still acceptable as blowing agent in this industry. "MERCAPTAN" is added into butane to ease detection of butane presence. This requires deodorizing as well as strict control on variation in volatiles by adding buffering agent. The project includes modification of existing extruder, fire safety and alarm system in the production area and warehouse to mitigate fire and exposure hazard from the use of butane. Extensive production and safety training and technology transfer to the plant operators will also be provided through an external process specialist.

3. PROJECT COSTS

3.1. CAPITAL COSTS

	Description		Cost(USD)
o	1 butane bulk tank		45,000
o	Extruder retrofitting (1 sets)		70,000
o	Fire Deflection Wall		12,000
o	Equipment relocation		50,000
o	Fire safety & Alarm systems...............		127,100
	Exhaust Fans (30pcs)	54,000	
	Industrial blow down fans(24)	24,000	
	Gas sensing/detection system(4)	30,000	
	Portable gas detector (1)	4,000	
	Fire extinguishers		
	Trolley mounted(5)	5,000	
	Handheld(20)	2,000	
	Static eliminator (2)	6,000	

Emergency spot light (3)	2,100
o Technology transfer/training	10,000
o Contingency/rounding	30,900
TOTAL INCREMENTAL CAPITAL COST	345,000
	=======

3.2. OPERATING COSTS/BENEFITS

No incremental costs/or benefits are included since, as a matter of policy, for XPE/PS projects these are assumed, on a national Chinese level, to be neutral.

3.3. UNIT ABATEMENT COSTS

a.	ODS Reduction Capital Costs	US$345,000
b.	Annual incremental costs	US$-
c.	Capital Recovery Factor(10y/10%)	0.16275
d.	ODS Reduction/year	kg 75,000
Unit Abatement Costs [{(a(c) + b})/d]		US$/kg/y 0.75
		============

4. FINANCIAL PLAN

The enterprise requests a grant covering the complete incremental cost as calculated under 3.1: **US$345,000**

5. PROJECT IMPACT

This project will eliminate the use of at least 75 tons of CFC-12 in the first year after implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex 11A: Technical Review

TECHNICAL REVIEW

1. COUNTRY: China

2. **PROJECT TITLE:** **SHENZHEN SHENTIE PLASTIC TABLE WARE PRODUCTS COMPANY** - Elimination of CFC-12 in the Manufacture of XPS/XPE Foam Sheet

3. **(SUB) SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.

5. **TECHNOLOGY:** The proposed technology, in which CFC-12 will be replaced by butane, is accepted. It is an environmentally sound one, but the main danger is fire safety. It is not clear from the report as to whether the location of the firm (near railway station) is acceptable. Therefore, it is of great importance that the safety spirit be communicated to and responded by all concerned employees. Risk analysis must be performed, and realistic emergency exercises must be organized.

   The purity of butane may be a concern since only 60-80% purity can be guaranteed. Extra ventilation must therefore be applied, and explosion meters foreseen at critical spots where gases can accumulate.

   It will be important to approach the change in production technique in several steps, including dry runs.

6. **ENVIRONMENTAL** CFC-12 has no ODP but has a smog potential. The Chinese emission legislation must be consulted.

7. **PROJECT COST:** The capital costs as presented seem realistic, although the price for 3 emergency spot lights seems high.

The price to remove 1 ton of ODS = USD 5,333. This is acceptable.

8. **IMPLEMENTATION** 1.5 years is reasonable.

9. **RECOMMENDATION:** It is recommended to accept the project, but stressing the safety aspect.

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

PROJECT COVER SHEET

COUNTRY	:	CHINA
PROJECT TITLE	:	SHIJIAZHUANG PLASTIC CEMENT GENERAL FACTORY (PL-GENERAL) - Elimination of CFC-12 in the Manufacture of XPS Foam Sheet
SECTOR COVERED	:	Foamed Plastics
ODS USED IN SECTOR	:	17,773 MT CFCs (=ODP) in 1991
PROJECT IMPACT	:	160MT of CFC-12 per year based on 1993 consumption
PROJECT DURATION	:	18 months
PROJECT ECONOMIC LIFE	:	10 years
TOTAL PROJECT COST	:	Capital cost incurred USD 595,000
PROPOSED MLF GRANT	:	USD 595,000
COST EFFECTIVENESS	:	USD 0.60kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY	:	China National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY	:	UNDP
APPRAISAL DATE	:	October 1994

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PROJECT SUMMARY

Shijiazhuang Plastic Cement General Factory (PL-GENERAL) is a state-owned enterprise which produces XPS, using CFC-12 as a blowing agent. The purpose of this project is to phase out the CFC-12 usage through butane. The project provides capital cost for conversion, safety and training.

PREPARED BY: Ko Swee Hee/Bert Veenendaal
REVIEWED BY: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF CHINA

PL-GENERAL - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF EXTRUDED POLYSTYRENE FOAM SHEET

1. ENTERPRISE BACKGROUND

PL-GENERAL was established in 1991 as a state-owned enterprise under the direct supervision of Ministry of Chemical Industry. It is situated in the residential area which is not suitable for application of butane technology. In order to meet the safety requirement of using butane, PL-GENERAL decided to move to another location 10km away from downtown Shijiazhuang. The new building will be ready by the end of December 1994. PL-GENERAL produces XPS foam sheet. It currently employs about 85 workers. The enterprise has grown rapidly over the years. Continued growth is expected in view of present market demand. Its raw materials and CFCs usage is as follows:

1991: 1,250 MT of resin, 120 MT CFC-12
1992: 1,600 MT of resin, 145 MT CFC-12
1993: 1,800 MT of resin, 160 MT CFC-12
1994: 1,800 MT of resin, 160 MT CFC-12 (estimated)

2. PROJECT DESCRIPTION

Under this project, PL-GENERAL will phase out the use of CFC-12 in its XPE/XPS foam sheet production through substitution by butane as replacement. Butane is available in China with purity ranging from 60-80% which is still acceptable as blowing agent in this industry. "MERCAPTAN" is added into butane to ease detection of butane presence, thus requiring deodorizing as well as strict control on variation in volatiles by adding buffering agent. The project includes modification of existing extruder, fire safety and alarm system in the production area and warehouse to mitigate fire and explosion hazard from the use of butane. Extensive production and safety training and technology transfer to the plant operators will also be provided through an external process specialist.

3. PROJECT COSTS

3.1. CAPITAL COSTS

	Description	Cost(USD)
o	2 butane bulk tanks	65,000
o	Extruder retrofitting (2)	140,000
o	Fire deflection wall (32 m)	11,000
o	Equipment relocation	100,000
o	Fire safety & Alarm systems	

Exhaust fans (48 pcs)	86,400	
Industrial blow down fans(36)	36,000	
Gas sensing/detection system(9)	63,000	
Portable gas detector (1)	4,000	
Fire extinguishers		
* Trolley mounted(5)	5,000	
* Handheld(20)	2,000	
Static eliminator (4)	12,000	
Emergency spot light (5)	3,500	
Humidifiers (3)	2,100	
o Technology transfer/training		10,000
o Contingency/rounding		55,000
TOTAL INCREMENTAL CAPITAL COST		**595,000**

3.2. OPERATING COSTS/BENEFITS

No incremental costs/or benefits are included since, as a matter of policy for XPE/PS projects, these are assumed on a national Chinese level to be neutral.

3.3. UNIT ABATEMENT COSTS

a.	ODS Reduction Capital Costs	US$595,000
b.	Annual incremental costs	US$ -
c.	Capital Recovery Factor(10y/10%)	0.16275
d.	ODS Reduction/year	kg 160,000
Unit	**Abatement Costs [{(a(c) + b})/d]**	**US$/kg/y 0.60**

4. FINANCIAL PLAN

The enterprise requests a grant covering the total incremental cost as calculated under 3.1: **US$595,000**

5. PROJECT IMPACT

This project will eliminate the use of 160 tons of CFC-12 in the first year after implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex-12A: Technical Review

TECHNICAL REVIEW

1. **COUNTRY:** China

2. **PROJECT TITLE:** **SHIJIANZHUANG PLASTIC CEMENT GENERAL FACTORY** - **Elimination of CFC-12 in the Manufacture of XPS Foam Sheet**

3. **(SUB) SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.

5. **TECHNOLOGY:** The company will replace CFC-11 by butane. Other technologies are also available but the company chooses butane because it is a proven, environmentally sound technique which is cost-effective. On the other hand, however, two main drawbacks are taken: the flammability and the low purity. The precautions to be taken to reduce the flammability hazards are well described in the text. However, serious safety audit and an increased fire prevention and safety awareness among all concerned employees will be most important. Risk analysis is necessary, and risk response must be a procedure which is written, known, implemented and tested out. Specialized firms have to be called in. Training by local fire brigade is a necessity, as well as maintaining a good relation with the brigade.

   The low degree of purity of the butane is a problem whic necessitates monitoring and constant care for the workers around.

   The fact that the factory has moved out of a residential area is positive.

6. **ENVIRONMENTAL** CFC-12 has an ODP of about 1 and a GWP of about 3. Butane has none of these properties but may contribute more to smog formation at low level.

7. **PROJECT COST:** The capital costs are relatively low for a 160 ton butane user. This results in a USD 4,275 cost to remove 1 ton of ODS.

8. **IMPLEMENTATION** 1.5 years is a reasonable time span to perform the change-over.

9. **RECOMMENDATION:** To be accepted as proposed.

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

PROJECT COVER SHEET

COUNTRY	:	CHINA
PROJECT TITLE	:	SUZHOU PLASTIC WORKS NO. 7 - Elimination of CFC-12 in the Manufacture of PE Foam Tubing
SECTOR COVERED	:	Foamed Plastics
ODS USED IN SECTOR	:	17,773 MT CFCs (=ODP) in 1991
PROJECT IMPACT	:	70 MT of CFC-12 per year based on 1993 consumption
PROJECT DURATION	:	18 months
PROJECT ECONOMIC LIFE	:	10 years
TOTAL PROJECT COST	:	Capital cost incurred USD 345,000
PROPOSED MLF GRANT	:	USD 345,000
COST EFFECTIVENESS	:	USD 0.80/kg/y (unit abatement cost)
NATIONAL EXECUTING AGENCY	:	China National Council of Light Industry (NCLI)
NATIONAL COORDINATING BODY	:	National Environmental Protection Agency (NEPA)
IMPLEMENTING AGENCY	:	UNDP
APPRAISAL DATE	:	August, October 1994

PROJECT SUMMARY

Suzhou Plastic Works No. 7 is a state-owned enterprise which produces XPE/XPS using CFC-12 as a blowing agent. The purpose of this project is to phaseout the CFC-12 usage through butane. The project contains capital cost for conversion, safety and training.

PREPARED BY: Ko Swee Hee
REVIEWED BY: Dr. Hubert Creyf

PROJECT OF THE GOVERNMENT OF CHINA

SUZHOU No. 7 - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF EXTRUDED POLYETHYLENE FOAM TUBING

1. ENTERPRISE BACKGROUND

SUZHOU No. 7 was established in 1986 as a collectively owned state enterprise. The present location of factory is in the middle of the congested, Suzhou old city which is surrounded by residential areas. The city has been identified by the government for preservation because of its historical background. The enterprise will relocate the factory if butane is to be used to replace CFC-12. The company is therefore identified, together with local Council of Light Industry, the new site for the factory which is about 3 km west of Suzhou old city at Heangkan county bounded by canals at two sides and open fields at the other two sides. It is a good location and conversion shall take place there. In addition to producing PE foam tubing, the company is also producing EPS blocks, PE press molding within the same premises. The enterprise currently employs about 10 workers for PE foam tubing production. It has grown rapidly over the years and is expected to show continued growth. Its raw material and CFCs usage is as follows:

1991: 80 mt of resin, 20 mt CFC-12
1992: 100 mt of resin, 35 mt CFC-12
1993: 120 mt of resin, 45 mt CFC-12
1994: 200 mt of resin, 70 mt CFC-12 (estimated)

2. PROJECT DESCRIPTION

Under this project, SUZHOU No. 7 will phase out the use of CFC-12 in its PE Foam Tubing through substitution by butane as replacement. Butane is available in China with purity ranging from 60-80% which is still acceptable as blowing agent in this industry. "MERCAPTAN" is added into butane to ease detection of butane presence, thus requiring deodorizing as well as strict control on variation in volatiles by adding buffering agent. The project includes modification of existing extruder, fire safety and alarm system in the production area and warehouse to mitigate fire and explosion hazard from the use of butane. Extensive production and safety training and technology transfer to the plant operators will also be provided through an external process specialist.

3. PROJECT COSTS

3.1. CAPITAL COSTS

	Description	Sub-item cost	Cost(USD)
o	1 unit of butane bulk tank (5 mt)		45,000
o	Extruder retrofitting		70,000
o	2 explosion proof motor(for primary and secondary motors)		16,000
o	Building modification		60,000
	Up-grading new factory to meet butane requirement	50,000	
	Fire deflection wall(30m)	10,000	
o	Fire safety & Alarm systems		111,500
	Ventilation and exhaust ducting	40,000	
	Industrial blow down fans(20)	14,000	
	Gas sensing/detection system(5)	40,000	
	Portable gas detector	4,000	
	Fire extinguishers		
	* Trolley mounted(6)	6,000	
	* Handheld(15)	1,500	
	Static eliminator	6,000	
o	Technology transfer/training		10,000
o	Contingency/rounding		32,500
	TOTAL INCREMENTAL CAPITAL COST		**345,000**

3.2. OPERATING COSTS/BENEFITS

No incremental costs/or benefits are included since, as a matter of policy for XPE/PS projects, these are assumed on a national Chinese level to be neutral.

3.3. UNIT ABATEMENT COSTS

a.	ODS Reduction Capital Costs	US$345,000
b.	Annual incremental costs	US$ -
c.	Capital Recovery Factor(10y/10%)	0.16275
d.	ODS Reduction/year	kg 70,000
	Unit Abatement Costs [{(a(c) + b})/d]	**US$/kg/y 0.80**

4. FINANCIAL PLAN

The enterprise requests a grant covering the total incremental cost as calculated under 3.1: **US$345,000**

5. PROJECT IMPACT

This project will eliminate the use of 70 tons of CFC-12 in the first year after implementation. The project employs commercially viable and environmentally acceptable technology.

6. ANNEXES

Annex-13A: Technical Review

TECHNICAL REVIEW

1. **COUNTRY:** China

2. **PROJECT TITLE:** SUZHOU PLASTIC WORKS No. 7 - Elimination of CFC-12 in the Manufacture of PE Foam Tubing

3. **(SUB) SECTOR:** Foamed Plastics

4. **CP RELATIONSHIP:** The Government and the industry are committed to sharply reduce and eventually eliminate CFC use. NCLI is responsible for coordinating ODS phaseout activities.

5. **TECHNOLOGY:** The company will replace CFC-11 by butane. Other technologies are also available but the company chooses butane because it is a proven, environmentally sound technique which is cost-effective. On the other hand, however, two main drawbacks are taken: the flammability and the low purity. The precautions to be taken to reduce the flammability hazards are well described in the text. However, serious safety audit and an increased fire prevention and safety awareness among all concerned employees will be most important. Risk analysis is necessary, and risk response must be a procedure which is written, known, implemented and tested out. Specialized firms have to be called in. Training by local fire brigade is a necessity, as well as maintaining a good relation with the brigade.

   The low degree of purity of the butane is a problem which necessitates monitoring and constant care for the workers around.

6. **ENVIRONMENTAL** CFC-12 has an ODP of about 1 and a GWP of about 3. Butane has none of these properties but may contribute more to smog formation at low level.

7. **PROJECT COST:** The project costs can be accepted as presented. The cost to remove 1 ODS ton is USD 5,571.

8. **IMPLEMENTATION** 1.5 years is a reasonable time span to perform the change-over.

9. **RECOMMENDATION:** To be accepted as proposed.

PREPARED BY: Dr.Hubert Creyf, UNDP Foam Sector Project Reviewer
DATE: 26 October 1994

CHINA - XPE/PS, IRC/IRB

PLANT	IRC	IRB	CFC
FEICHENG	---	22,000	150
FOSHAN NO. 3	---	---	360
HUBEI	26,000	---	160
GUIZHOU	---	---	50
HAILUN	---	14,000	95
HEBEI SIXING	26,000	---	65
JIANHUYA	---	90,000	100
JINAN	47,000	---	30
JINFENG	45,000	---	70
SHENRONG	---	10,000	48
SHENZHEN SHENTIE	---	---	75
GUANGXING	---	---	55
SUZHOU NO. 7	13,000	---	70
TOTAL	157,000	136,000	1,328
AVERAGE	2000/PIECE		

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 the manufacture extruded polyethylene and polystyrene foam sheet
SECTORS COVERED:	Foamed Plastics
ODS USE IN SECTOR:	17,773t CFCs (=ODP) in 1991
PROJECT IMPACT:	Phase-out 140t CFC-12 per Year (base 1993)
PROJECT DURATION:	One year
PROJECT DURATION:	10 years
TOTAL PROJECT COST:	Incr. Capital Cost US$429,000 Incr. Recurrent Savings US$ 51,000 Contingency US$ 43,000 Financial Agent Fee US$ 13,000
PROPOSED OTF FINANCING:1/	US$434,000
COST EFFECTIVENESS (UAC):	US$0.42/kg/CFC/year.
IMPLEMENTING ENTERPRISE:	CANGZHOU NO.2 Plastic Plant
NATIONAL COORDINATING AGENCY:	National Environmental Protection Agency: (NEPA)
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY

This project will phaseout 140MT CFC-12 used to produce extruded polyethylene and polystyrene foams through the use of butane blowing agent at Cangzhou No. 2 Plastic Plant(a 100% state owned enterprise). Direct savings in operational costs resulting from the lower price of butane have been deducted from the estimated incremental capital costs for this project. Incremental capital costs include extruder and other retrofitting plus training of workers for safe use and handling of butane. The project will be completed within one year of authorization.

TECHNICAL ASSESSMENT: This project has been reviewed and supported by the OORG technical reviewer, Dr. Mike Jeffs. His comments are attached.

[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 10% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of extruded polyethylene/polystyrene foam sheet at Cangzhou No.2 Plastics Products Plant ("Cangzhou No.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, XPS/XPE). 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:

- o Refrigerating foams.
- o Non-refrigerating foams

Other ministries are involved in the refrigeration foams, i.e.:

- o Ministry of Chemical Industry (MCI),
- o Ministry of Domestic Trade (MIT),
- o China Aerospace Industry Cooperation (CAIC),
- o Ministry of Machinery Industry (MI),

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.

ENTERPRISE BACKGROUND

Cangzhou Plastic Plant No.2 was established in 1985. It has 576 employees, from which 34 are technical staff. The plant imported an extruder from SUMMIT (Japan) in 1985 and has begun its XPS/XPE mass production since then. Now the plant is reportedly the biggest producer of fast food shells in China.

In 1993, CFC-12 consumption was 140t. The plant is already active in the phaseout of CFCs. It recently imported an additional extruder which will use butane. This extruder will be operated under joint venture.

PROJECT DESCRIPTION

Cangzhou No.2 currently uses 140 tons of CFC-12 in its XPE/XPS production. As it gets more and more information on the Montreal Protocol from NEPA, line ministries and implementing agencies as well as under the pressure of CFC price increases, it has designed a ODS phase out program. The first step was to specify a new extruder to be operated with butane. This is financed by and operated through a joint venture and not included in this project.

Under this project, the plant will make the butane conversion on its existing line The project will include the extruder retrofit, tank installation, safety modifications as well as infrastructural measures to mitigate fire and exposure hazards from the use of butane and will provide extensive production and safety training.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION

There are several options to replace CFCs in the production of XPS/XPE foam sheet, such as:

- o Atmospheric gases (Nitrogen; Carbon Dioxide),
- o Hydrocarbons(LPG; butanes; pentanes),
- o HCFCs (-22; -142b),
- o HFCs (-134a; -152a),

A summary of these technologies, their potentials and their limitations is provided UNEP's Technical Options Manual for Foamed Plastics. Butane is selected by the company as an alternative that is:

- o Proven technology in processing and product performance,
- o Environmentally acceptable,
- o Low in toxicity,
- o Adaptable to the existing equipment,
- o Cost effective.

Cangzhou No.2 is not located in a residential area, which facilitates the introduction of butane.

Users of hydrocarbons are subject to stringent fire regulations. The appointment and training of a company safety expert is strongly recommended. The emission of hydrocarbons is currently not regulated in China, nor are restrictions expected in the foreseeable future.

PROJECT COST

The total project cost is estimated at US$472,000 to be used for equipment retrofitting, safety modification, trial, production and safety training, and a 10% contingency. Incremental operating benefit will be $51,000, based on the assumptions given in Annex 2. The 3% financial agency fee brings the OTF financing request to $434,000.

Investment costs of US$429,000 include capital investment in installation of two butane tanks, safety and alarm systems and in service training. See breakdown in Annex 1.

Other costs. A 10% contingency (US$43,000) was included to ensure adequate funding of project costs following appraisal. An additional US$13,000(3%) was added to the grant request to cover the fee for the financial agent that will appraise the project and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Cangzhou No.2 is US$434,000 and was calculated as follows: investment costs, operating cost, 10% contingency and 3% financial 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 Cangzhou No.2.

SCHEDULE

TASK	Q1	Q2	Q3	Q4
Project Preparation				
Specifications	x			
Tenders, Selection	x			
Purchase Orders	x			
Site preparation				
Building Adaptations		xx		
Civil Works		xx		
Tanks Installation		xx		
Equipment Modifications			xx	
Start-up, Trials, Training			xx	x
Commissioning				x

REQUIRED REGULATORY ACTION

The company will work with local fire authorities on fire safety and the adherence to pertinent regulations.

RESULTS:

Direct Project Impacts: This project will eliminate the use of at least 140 tons of CFC-12 in the first year of implementation. Market and company growth indicates that this may increase by 8-10% annually in subsequent years. The project employs commercially viable and environmentally acceptable technology.

Indirect Project Impact: The project will not influence quality and price of the products.

ANNEX 1

BREAKDOWN OF CAPITAL COSTS

	Project Capital Cost (US Dollars)
Extruder retrofitting	80,000
2 Butane tanks incl. auxiliaries	80,000
Aeration room	80,000
2 Explosion proof motors for HP extruder	16,000
Control room	10,000
Fire safety & alarm system	
Ventilation & exhaust system	40,000
Supply & installation of Industrial blow-down fans (30 units)	20,000
Sensing system/gas detection	40,000
Portable gas detector	4,000
Fire extinguishers	15,000
Static eliminator	4,000
Additional heating capacity	10,000
Technology transfer	20,000
In-service training	10,000
Subtotal	429,000
Contingency (10%)	43,000
TOTAL CAPITAL COST:	**472,000**

ANNEX 2

CANGZHOU NO.2
INCREMENTAL OPERATING COSTS

ASSUMPTIONS

- Price of CFC-12 in China was RMB 14,000/t in May; Butane: RMB 7,000/t
- Butane use identical to CFC-12
- Required extra additives: USD 30/t of resin
- Preventive maintenance: 5% of equipment related project costs: $ 18,850.
- Extra heating 100kw used 120 days per year at an average of 50% capacity: 144,000KWh @ 0.60 = RMB 86,400
- 1 USD = 8.5 RMB

1. MATERIAL COST

o	Before: 140t CFC-12 @ 1,618	USD 226,500
o	Future: 140t Butane @ 824	USD 115,300
	additives	USD 36,000
		USD 75,200

2. OTHER RECURRING INCREMENTAL COSTS

o	Training/monitoring	USD 10,000
o	Extra maintenance & utilities	USD 18,500
o	Extra insurance	USD 20,000
o	Extra heating	USD 10,000
		USD 58,500

3. TOTAL ANNUAL RECURRING INCREMENTAL COST

o	Annual recurring incremental benefit	USD 16,700

4. **NET PRESENT VALUE OF THE RECURRENT**
INCREMENTAL SAVINGS USD 50,700 USD 51,000
(4Y/12% Discount)

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) = \$80,200

OC = \$0

OS/R = \$20,750

ODP = 140,000kg

A = \$0.42 per kg CFC

CANGZHOU NO 2 PLASTIC PLANT

TECHNOLOGY

The enterprise produces extruded polyethylene and polystyrene sheet for packaging applications. The use of butane is proven for this application. It is generally cost effective but there are considerable safety issues related to the products flammability.

ENVIRONMENTAL IMPACT

Butane has a zero ODP and therefore is a long term solution. It also has a zero GWP. Butane is a VOC and its use without containment measures will contribute to low level ozone.

The major issue relates to the flammability of butane. The appointment of company safety experts is noted and strongly supported. The training should concentrate on safety issues and adherence to the advice and requirements of local fire authorities is essential.

PROJECT COSTS

The capital costs are for necessary items. The incremental cost calculation is transparent and results in a saving.

The UAC of $ 0.42/kg ODS implies a cost effective project.

IMPLEMENTATION TIMEFRAME

The timeframe is acceptable.

RECOMMENDATION

Approved as proposed.

GMFJ/kd/17/10/94

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER

PROJECT COVER SHEET

COUNTRY:	People's Repablic of China	
PROJECT TITLE:	Conversion to CFC-free technology in the manufacture of extrud polyethylene and polystyrene foam sheet	
SECTORS COVERED:	Foamed Plastics	
ODS USE IN SECTOR:	17,773 tons CFCs (=ODP) in 1991	
PROJECT IMPACT:	Phase-out 200t CFC-12 per year (base 1993)	
PROJECT DURATION:	One year	
PROJECT ECONOMIC LIFE:	10 years	
TOTAL PROJECT COST:	Incr. Capital Cost	US$ 401,000
	Incr. Recurrent Savings	US$ 198,000
	Contingency	US$ 40,000
	Financial Agent Fee	US$ 7,000
PROPOSED OTF FINANCING:1/	US$ 250,000	
COST EFFECTIVENESS (UAC):	US$0.03/kg/CFC/year.	
IMPLEMENTING ENTERPRISE:	Lanzhou Plastic Packing Material Factory.	
NATIONAL COORDINATING AGENCY:	National Environmental Protection Agency (NEPA)	
IMPLEMENTING AGENCY:	The World Bank	

PROJECT SUMMARY

This project will phaseout 200MT CFC-12 used to produce extruded polythylene and polystyrene foams through the use of butane blowing agent at Lanzhou Plastic Packing Material Factory(a 100% state owned enterprise). Direct savings in operational costs resulting from the lower price of butane have been deducted from the estimated incremental capital costs for this project. Incremental capital costs include extruder and other retrofitting plus training of workers for safe use and handling of butane. The project will be completed within one year of authorization.

TECHNICAL ASSESSMENT: This project has been reviewed and supported by the OORG technical reviewer, Dr. Mike Jeffs. His comments are attached.

[1] The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 10% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVES

The objective of this project is to phaseout the use of CFCs in the manufacture of extruded polyethylene/polystyrene foam sheet at Lan Zhou Plastic Packing Material Factory ("LAN ZHOU").

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, XPS/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 Which reflects data from 1991:

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**

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:

- o Refrigerating foams.
- o Non-refrigerating foams

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

- o Ministry of Chemical Industry (MCI),
- o Ministry of Domestic Trade (MIT),
- o China Aerospace Industry Corporation (CAIC),
- o 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.

ENTERPRISE BACKGROUND

LAN ZHOU was established in 1980 as a subsidiary of the local Office of Light Industry in Lanzhou/Gansu. It has fixed assets of 40 million RBM, annual sales of 20 RMB and 450 employees from which 80 work in the XPS/PE extrusion department. The company produces:

- o Mold injected plastic boxes for vegetables packaging;
- o XPS/PE for fast food packaging and interior decoration;
- o HIPS/XPS laminates for food packaging;
- o Textile/XPS laminates for interior decoration.

The plant imported an extruder from Nakamura (Japan) in 1983 and has begun its XPS/PE mass production since then. Now the production (1993) is about 1050 t/y from which 300t polyethylene foam and 750t polystyrene foam. The annual CFC-use is about 200t/y.

PROJECT DESCRIPTION

Under this project LANZHOU will phaseout the use of CFCs in its XPS/PE operation through substitution by butane. Butane is available in the Chinese market at a 80% purity degree and requires deodorizing as well as strict control on variation in volatiles (buffering may be needed).

The project includes installation of a storage system, retrofit of the extruder, safety modifications in the working area as well as infrastructural measures to mitigate fire and exposure hazards from the use of butane and will provide extensive production and safety training. Technology transfer will be provided through an external process expert.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION

There are several options to replace CFCs in the production of XPS foam sheet, such as:

- o Atmospheric Gases,
- o Hydrocarbons,
- o HCFCs,
- o HFCs.

ATMOSPHERIC GASES

<u>Nitrogen Gas</u> is inert, nontoxic and noncombustible, but asphyxiant. The use is burdened by a low solubility in the resin and a relatively high density of the end product. New resin developments may make the use of nitrogen a more viable option in the future.

<u>Berstorff Technology</u> is based on a mixture of nitrogen and alcohol. This technology exhibits undefined risks in toxicity and fire. The resulting product has also a higher density.

Carbon dioxide gas is an asphyxiant, high energy consuming and moderately toxic gas. Carbon dioxide as a co-agent is proven technology. The uses of only CO2 in XPS sheet is patented, and requires licensing.

HYDROCARBONS

N-pentane, butane, isopentane and isobutane are proven replacements. The technology is cost effective and results in product of acceptable quality. However, the flammability of hydrocarbons requires stringent safety precautions in the manufacturing process, resulting in the need for retrofitting. In addition, hydrocarbons are photochemically reactive and contribute to the formation of atmospheric ozone (smog).

Liquified petroleum gases (LPG) have also been proposed as replacement for CFCs in PE/PP and PS foams. LPG is, however toxic, flammable and not generally accepted for food packaging. If used, molecular sieves as purifier/deodorizer and a buffer for boiling point stabilization will be required.

HYDROCHLOROFLUOROCARBONS

HCFC-22, non-flammable, low in toxicity, thermal and chemical stable, has been proven effective. The compound has however an ODP, and only qualifies as an interim replacement.

HCFC-142b can be used alone or in combination with HCFC-22 to reduce the flammability. The price penalty is, however, considerable and equipment has to be modified to cope with the moderate flammability and the modified diffusivity of the compound.

HYDROFLUOROCARBONS

HFC-134a, non-flammable, low in toxicity and with no ODP, is just recently introduced in the market. The current pricing will prevent utilization in the very cost sensitive food serving and packaging applications. The utilization of HFC-134a in foams competes with the utilization as a refrigerant in appliances and automotive air conditioners.

HFC 152a is low in toxicity, moderately flammable and possesses no ODP. It appears to be a likely long term alternative. The compound's flammability will require modification of production equipment.

SELECTION

LAN ZHOU has selected the use of butane. Butane is:

- Proven technology in processing and product performance,
- Environmentally acceptable,
- Low in toxicity,
- Adaptable to the existing equipment,
- Cost effective,

A draw back is its high flammability, requiring stringent safety precautions. Also, butane is currently only available with a maximum purity of 80%. The company will address both issues in its project design.

Users of hydrocarbons are subject to stringent fire regulations. The appointment and training of a company safety expert is strongly recommended. The emission of hydrocarbons is currently not regulated in China, nor are restrictions expected in the foreseeable future.

PROJECT COST

The total project cost is estimated at US$441,000 to be used for equipment retrofitting, safety modification, trial, production and safety training, and a 10% contingency. Incremental operating benefit will be $198,000, based on the assumptions given in Annex 2. The 3% financial agency fee brings the OTF financing request to $250,000.

Investment costs of US$401,000 include capital investment in installation of two butane tanks, safety and alarm systems and in service training. See breakdown in Annex 1.

Other costs. A 10% contingency (US$40,000) was included to ensure adequate funding of project costs following appraisal. An additional US$7,000(3%) was added to the grant request to cover the fee for the financial agent that will appraise the project and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Lanzhou is US$250,000 and was calculated as follows: investment costs, operating cost, 10% contingency and 3% financial 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 Lanzhou.

SCHEDULE

TASK	Q1	Q2	Q3	Q4
Project Preparation				
Specifications	x			
Tenders, Selection	x			
Purchase Orders	x			
Site preparation				
Building Adaptations		xx		
Civil Works		xx		
Tanks Installation		xx		
Equipment Modifications			xx	
Start-up, Trials,Training			xxx	
Commissioning			x	

REQUIRED REGULATORY ACTION

(The company to check with local authorities on fire regulations)

RESULTS:

Direct Project Impacts: This project will eliminate the use of at least 200 tons of CFC-12 in the first year of implementation. Market and company growth indicates that this may increase by 8-10% annually in subsequent years. The project employs commercially viable and environmentally acceptable technology.

Indirect Project Impact: The project will not influence quality and price of the products.

ANNEX 1

BREAKDOWN OF CAPITAL COSTS

	Project Capital Cost US Dollars)
2 Butane tanks	80,000
Extruder retrofitting	80,000
2 Explosion proof motors for HP extruder	16,000
Control room	10,000
Building modifications	
Aeration room	50,000
heating	10,000
Fire safety & alarm system	
ventilation & exhaust system	40,000
supply & installation of 30 industrial blow-down fans	20,000
sensing system/gas detection	40,000
portable gas detector	4,000
fire extinguishers	15,000
static eliminators	6,000
Technology transfer	20,000
In-service training	10,000
Sub total:	401,000
Contingency/rounding	40,000
TOTAL CAPITAL COST:	**441,000**

ANNEX 2

LANZHOU
INCREMENTAL OPERATING COSTS/SAVINGS

ASSUMPTIONS

- Price of CFC-12: RMB 14,000/T (1993)
  Butane: RMB 7,000/t (1993)
- Butane use identical to CFC-12
- Required extra additives: USD 30/t of resin
- Preventive maintenance: 5% of equipment related project costs: $ 18,600
- Extra heating required:
  100KW capacity for 120 days/y at an average of 50%
  capacity: 144,000KWh @ 0.60 = RMB 86,400 = $10,000
- 1 USD = 8.5 RMB

1. MATERIAL

o Before: 200t CFC-12 @ 1,618	USD 323,600
o Future: 200t Butane @ 824	USD 164,800
additives	USD 35,000
	USD 123,800

2. OTHER RECURRENT INCREMENTAL COSTS

o Recurrent training/monitoring costs	USD 10,000
o Extra maintenance & utility	USD 18,600
o Extra insurance	USD 20,000
Extra heating	USD 10,000
	USD 58,600

3. TOTAL ANNUAL RECURRENT INCREMENTAL COSTS

- Annual Savings of USD 65,200

4. Net Present Value of the Recurrent Incremental Savings (4y; 12%) **USD 198,000**

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) = \$71,000

OC = \$0

OS/R = \$65,000

ODP = 200,000kg

A = \$0.03 per kg CFC

LANZHOU PLASTICS PACKAGING MATERIAL FACTORY

TECHNOLOGY

The enterprise produces extruded polyethylene and polystyrene sheet for packaging applications. The use of butane is proven for this application. It is generally cost effective but there are considerable safety issues related to the products flammability.

ENVIRONMENTAL IMPACT

Butane has a zero ODP and therefore is a long term solution. It also has a zero GWP. Butane is a VOC and its use without containment measures will contribute to low level ozone.

The major issue relates to the flammability of butane and especially because the factory is situated in a residential area. The appointment of company safety experts is noted and strongly supported. The training should concentrate on safety issues and adherence to the advice and requirements of local fire authorities is essential.

PROJECT COSTS

The capital costs are for necessary items. The incremental cost calculation is transparent and results in a saving.

The UAC of $ 0.24/kg ODS implies a very cost effective project.

IMPLEMENTATION TIMEFRAME

The timeframe is acceptable.

RECOMMENDATION

Approved as proposed.

GMFJ/kd/17/10/94

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 extruded polyethylene and polystyrene foam sheet**
SECTORS COVERED:	**Foamed Plastics**
ODS USE IN SECTOR:	**17,773 tons CFCs (=ODP) in 1991**
PROJECT IMPACT:	**Phase-out 260t CFC-11/CFC-12 per year (base 1993)**
PROJECT DURATION:	**One year**
PROJECT DURATION:	**10 years**
TOTAL PROJECT COST:	**Incremental Investment Cost: US$434,000** **Incremental Recurrent Saving: US$173,000** **Contingency: US$ 43,000** **Financial Agent Fee: US$ 9,000**
PROPOSED OTF Financing 1/:	**US$ 313,000**
COST EFFECTIVENESS (UAC):	**US$0.08/KG/CFC/YEAR**
IMPLEMENTING ENTERPRISE:	**Zhengzhou Plastic Plant**
NATIONAL COORDINATING AGENCY:	**National Environmental Protection Agency (NEPA)**
IMPLEMENTING AGENCY:	**The World Bank**

PROJECT SUMMARY

This project will phaseout 260MT CFC-11/12 used to produce extruded polyethylene and polystyrene foams through the use of butane blowing agent at Zhengzhou Plastic Plant(a 100% state owned enterprise). Direct savings in operational costs resulting from the lower price of butane have been deducted from the estimated incremental capital costs for this project. Incremental capital costs include extruder and other retrofitting plus training of workers for safe use and handling of butane. The project will be completed within one year of authorization.

TECHNICAL ASSESSMENT: This project has been reviewed and supported by the OORG technical reviewer, Dr. Mike Jeffs. His comments are attached.

1/ The OTF grant is based on 100% Chinese ownership and includes a 3% financial agent fee. A 10% contingency is included in the estimates of incremental capital costs.

PROJECT OBJECTIVES

The objective of this project is to phaseout the use of CFCs in the manufacture of extruded polyethylene/polystyrene foam sheet at Zhengzhou Plastics Products Plant ("Zhengzhou").

SECTOR BACKGROUND

The Chinese foam industry consumed in 1991 17,773 tons CFCs (China Country Program). CFC-11 was the dominant substance (15,600 t, PUF), followed by CFC-12 (2,173 t, XPS/EPE). 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)

NCLI is responsible for the phaseout coordination in all foam categories. Ministerial responsibility is divided into two areas:

- o Refrigerating foams.
- o Non-refrigerating foams

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

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

ENTERPRISE BACKGROUND

Zhengzhou Plastic Plant was established in 1958. It has 300 employees. The plant has two extruders. One was imported from SUMMIT(Japan), the other was made by the company itself. The plant is located in a residential area of the city. In the past three years, it has produced 3,600 tons of XPS and 1,500 tons of XPE.

PROJECT DESCRIPTION

Zhengzhou currently uses 260 tons of CFC-11/CFC-12 in its XPE/XPS production. As it has received more and more information of Montreal Protocol from NEPA, line ministries and implementing agencies as well as it is under the pressure of CFC price increase, the enterprise has begun to consider a CFC-11/CFC-12 phase out program.

After technically and economically evaluating different options, the plant selected butane. Under this project, the plant will make the necessary conversion including safety modifications as well as infrastructural measures to mitigate fire and exposure hazards from the use of Butane and will provide extensive production and safety training.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION

There are several options to replace CFCs in the production of XPS/XPE foam sheet, such as:

- o Atmospheric gases (Nitrogen; Carbon Dioxide),
- o Hydrocarbons(LPG; butanes; pentanes),
- o HCFCs (-22; -142b),
- o HFCs (-134a; -152a),

A summary of these technologies, their potentials and their limitations is provided in UNEP's Technical Options Report.

Butane is selected by the company as an alternative that is:

- o Proven technology in processing and product performance,
- o Environmentally acceptable,
- o Low in toxicity,
- o Adaptable to the existing equipment,
- o Cost effective.

Users of hydrocarbons are subject to stringent fire regulations. The appointment and training of company safety experts is strongly recommended. The emission of hydrocarbons is currently not regulated in China, nor are restrictions expected in the foreseeable future.

PROJECT COST

The total project cost is estimated at US$477,000 to be used for equipment retrofitting, safety modification, trial, production and safety training, and a 10% contingency. Incremental operating benefit will be 173,000, based on the assumptions given in Annex 2. The 3% financial agency fee brings the OTF financing request to $313,000.

Investment costs of US$434,000 include capital investment in installation of two butane tanks, safety and alarm systems and in service training. See breakdown in Annex 1.

Other costs. A 10% contingency (US$43,000) was included to ensure adequate funding of project costs following appraisal. An additional US$9,000(3%) was added to the grant request to cover the fee for the financial agent that will appraise the project and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Zhengzhou is US$313,000 and was calculated as follows: investment costs, operating cost, 10% contingency and 3% financial 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 Zhengzhou.

Schedule

TASK	Q1	Q2	Q3	Q4
Project Preparation				
Specifications	x			
Tenders, Selection	x			
Purchase Orders	x			
Site preparation				
Building Adaptations		xx		
Civil Works		xx		
Tanks Installation		xx		
Equipment Modifications			xx	
Start-up, Trials,Training			xxx	
Commissioning				x

REQUIRED REGULATORY ACTIONS

Approval from local fire authorities is required. The company has already made the necessary contacts and expects no requirements that will impair the budget as set.

RESULTS:

Direct Project Impact: This project will eliminate the use of at least 260 tons of CFC-11/CFC-12 in the first year of implementation. The project employs commercially viable and environmentally acceptable technology.

Indirect Project Impact: The project will not influence quality and price of the products.

ANNEX 1

BREAKDOWN OF CAPITAL COSTS

	Project Capital Cost (US Dollars)
Technology transfer and all auxiliary equipment related to the conversion	
Extruder retrofitting(2 units)	130,000
Technology transfer	20,000
2 Explosion proof motors for 2 extruders	32,000
Building modifications	
Deflection wall at Butane storage area	15,000
Ventilation & exhaust system	40,000
Supply & installation of industrial blow-down fans(30 units)	20,000
Sensing system/gas detection	40,000
Control room	10,000
Additional heaters	10,000
In-service training	10,000
Equipment	
2 Butane storage tanks	80,000
Portable gas detector	4,000
Fire extinguishers	15,000
Static eliminator	8,000
Subtotal	434,000
Contingency(10%)	43,000
TOTAL CAPITAL COST:	**477,000**

ANNEX 2

ZHENGZHOU
INCREMENTAL OPERATING COSTS

ASSUMPTIONS

- Price of CFC-12: RMB 14,000/t
  CFC-11: RMB 11,000/t
  Butane: RMB 7,000/t
- Butane use identical to CFC-11/CFC-12
- Required extra additives: USD 30/t of resin
- Preventive maintenance: 5% of equipment related project costs: $ 20,000.
- Extra heating 100kw used 120 days per year at 50% capacity: 144,000KWh @ 0.60 = RMB 86,400
- 1 USD = 8.7 RMB

1. MATERIAL

o	Before: 260t CFC-11/CFC-12 @ 1,470	USD 382,350
o	Future: 260t Butane @ 825	USD 214,500
	additives	USD 51,000
		USD 116,850

2. OTHER RECURRENT INCREMENTAL COSTS

o	Recurrent training/monitoring costs	USD 10,000
o	Extra maintenance & utility	USD 30,000
o	Extra insurance	USD 20,000
	Total	USD 60,000

3. TOTAL ANNUAL RECURRENT INCREMENTAL COSTS

o	Annual Savings of	USD 56,850

4. Net Present Value of the Recurrent Incremental Savings **USD 173,000**
(4y/12% Discount)

Note: # Ratio in CFC-11/CFC-12 is 50/50.

ANNEX 3

CALCULATION OF UNIT ABATEMENT COST

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

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) = \$78,120

OC = \$0

OS/R = \$56,850

ODP = 260,000kg

A = \$0.08 per kg CFC

ZHENGZHOU PLASTIC PLANT

TECHNOLOGY

The enterprise produces extruded polyethylene and polystyrene sheet for packaging applications. The use of butane is proven for this application. It is generally cost effective but there are considerable safety issues related to the products flammability.

ENVIRONMENTAL IMPACT

Butane has a zero ODP and therefore is a long term solution. It also has a zero GWP. Butane is a VOC and its use without containment measures will contribute to low level ozone.

The major issue relates to the flammability of butane and especially because the factory is situated in a residential area. The appointment of company safety experts is noted and strongly supported. The training should concentrate on safety issues and adherence to the advice and requirements of local fire authorities is essential.

PROJECT COSTS

The capital costs are for necessary items. The incremental cost calculation is transparent and results in a saving.

The UAC of $ 0.08/kg ODS implies a very cost effective project.

IMPLEMENTATION TIMEFRAME

The timeframe is acceptable.

RECOMMENDATION

Approved as proposed.

GMFJ/kd/17/10/94