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

Sixteenth Meeting
Montreal, 15-17 March 1995

REQUESTS FOR BILATERAL COOPERATION

This document consists of:

- Comments and recommendations from the Fund Secretariat
- Requests from the Governments of Germany and the United States of America
- Status report on on-going bilateral activities from the United States of America

REQUESTS FOR BILATERAL COOPERATION

1. Pursuant to Article 10 of the Protocol as amended and decision IV/18 of the Fourth Meeting of the Parties, the Executive Committee is charged with assessing bilateral requests.

2. A joint request from the governments of Germany and the United States of America was received to offset the costs for a project to produce CFC-free refrigerators in China against the 1994 contributions to the Fund by Germany and the United States. The project was first submitted in 1994 and has subsequently been modified. Since the project request exceeds US $500,000, a project evaluation sheet is provided which includes the comments and recommendations of the Fund Secretariat, the project proposal, and a technical review (see Annex I).

3. Another request was received from the Government of the United States of America (Annex II) to credit US $523,937 in bilateral cooperation with Argentina and China against the United States' 1995 contributions to the Fund. The cooperation will be provided for the following projects: "MACs Servicing Demonstration" (US $170,000) in cooperation with the Government of Argentina; the "MACs Servicing Demonstration" (US $172,500) in the mobile air conditioning sub-sector, "Refrigeration Management Project Preparation" (US $39,000) in the commercial refrigeration sub-sector, and "Halon Leak Reduction Demonstration" (US $142,437) in cooperation with the Government of China.

4. The Government of the United States of America also submitted a status report (see Annex III) on activities underway through its bilateral assistance programme for Multilateral Fund-supported activities.

General Comments

Joint request from Germany and the United States (US $2,980,783)

5. The comments and recommendations for the joint request are presented in Annex I.

Argentina: MACs Servicing Demonstration (US $170,000)

6. This request is for the collection and analysis of information about the MAC sector in Argentina, a demonstration of MAC recycling equipment and workshop and the installation of UNDP-procured recycling machines for the participating repair shops, training on HFC-134a equipment and a follow-up report on the performance of the demonstration.

7. USEPA in cooperation with Mexico and Venezuela has conducted two similar demonstration projects and the initial review of the data indicates that there is reason for continuing this process in other countries. The demonstration project includes further project preparation through an assessment of needs to ascertain if the original project formulation should

be expanded to include the participation of other repair facilities such as bus servicing facilities and refrigerated transport servicing depending upon their cost-effectiveness.

8. It should be noted that this cost does not include the cost for the recycling machines which will be provided by UNDP.

China: MACs Servicing Demonstration (US $172,500)

9. This demonstration project is similar in scope to the previous request for Argentina and those already conducted in Mexico and Venezuela and the one currently under implementation for Colombia. It is expected that this project will result in a reduction of from five to ten tonnes annually of CFC-12.

10. Unlike the proposal in Argentina which benefits from previous course material having been developed in Spanish, course materials will have to be translated into Chinese.

11. MAC recycling equipment will be provided by UNDP through its Global MACs project.

China: Refrigeration Management Demonstration Project Preparation (US $39,000)

12. Project preparation funds are being requested to develop a demonstration project that will collect information on commercial refrigeration in 30 stores in Beijing, China, implement a refrigerant conservation programme, develop specifications for equipment, provide technical support, plan and conduct a training workshop including representatives from food stores throughout China, and prepare documentation on the results of the demonstration.

China: Halon Leak Reduction Demonstration (US $142,437)

13. This demonstration project will result in the reduction of 3.5 per cent of halon 1211 emissions during the production process. The project includes the procurement of equipment, the conduct of a training workshop, and the demonstration of cost-effective emission procedures to other factories. The project includes the development and translation of training materials and the preparation of a report on the results of the demonstration.

Status Report

14. The status report is a comprehensive review of specific activities undertaken, outputs, lessons learned, and future activities associated with each project approved or submitted for approval to the Executive Committee. It clearly identifies actual progress and implementing agencies should be encouraged to provide a similar level of detail in their respective progress reports.

15. Most projects are ongoing with remaining project balances for the identified future activities which are specified in the project document. The additional institutional strengthening support for the Mexican OPU has been disbursed since it was approved at the last meeting of

the Executive Committee. EPA assisted China, Ecuador, Uruguay, and Venezuela in the provision of halon 1211 recycling machines and training and in some cases, technical assistance on standards and halon bank development. A detailed progress report on the demonstration network of halon 1211 recovery/recharge machines was presented which includes a review of activities undertaken, ODS phased out, information on the Chinese halon sector, and lessons learned from Fund-supported activities.

16. The Venezuela MAC demonstration project provided CFC-12 recovery/recycling machines and training to 17 repair shops. The project was conducted in coordination with the UNDP Global MACs project and resulted in 10 tonnes of reduced emissions with a cost-effectiveness of US $24,000 per tonne.

Recommendation

17. This request complies with the bilateral contribution guidelines (UNEP/OzL.Pro/ExCom/5/16, paragraph 55) and the criteria for assessing costs as bilateral contributions (UNEP/OzL.Pro/ExCom/7/30, Annex IV). The proposed amount to be applied against the United States' contributions to the Fund does not exceed 20 per cent of the United States' contributions for the year 1995.

18. It is, therefore, recommended that the United States Government's request should be approved in the amount of US $523,937 and the Treasurer should credit the requested amount against the 1995 contributions of the United States.

ANNEX I

This annex includes:

(a) Project Evaluation Sheet

(b) Request from Germany and the United States of America for 1994 funding

(c) Project document including technical review

ANNEX I

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	China
PROJECT TITLE:	Staged Project to produce CFC-free refrigerators in China (Stage 1b- Field Testing and Stage 2 - Changeover of foam blowing agent to cyclopentane and refrigerant cycle to isobutane at the Haier Refrigerator Factory
BUDGET:	US $3,480,783 (total project cost)
INCREMENTAL COSTS:	US $2,980,783
ODS PHASE-OUT:	174 MT of CFC-11 29 MT of CFC-12
COST EFFECTIVENESS[1]:	US $16.63/per kg ODP saved[2]
PROJECT DURATION:	1 year
IMPLEMENTING AGENCY:	Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Germany Environmental Protection Agency, USA
NATIONAL COORDINATING AGENCY:	National Environmental Protection Agency National Council of Light Industry
TECHNICAL REVIEW COMPLETED:	YES _X_ NO ___

SECRETARIAT'S COMMENTS

1. This proposal on staged project to produce CFC-free refrigerators at the Haier Refrigerator Factory in China is being submitted jointly by the Governments of the United States and Germany with the approval of the Government of China.

2. The project involves conversion of domestic refrigerator manufacturing facility to isobutane refrigerant and to cyclopentane as a blowing agent. This is the first time the

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[1] Determined as a ratio of incremental costs to the estimated annual saving of ODP (US $/ODP kg)

[2] Includes US $396,000 for Phase 1 (approved by the Tenth Meeting of the Executive Committee) an US $2,980,783 for Phase 1b and Phase 2 (this project)

Committee is requested to consider a project to convert from CFCs to hydrocarbons in both the refrigeration and foam systems in domestic refrigeration. The development of cost-effective strategy in the domestic refrigeration sector in China was requested by the Executive Committee at its 13th Meeting. The draft of the strategy will be discussed between the Secretariat and implementing agencies immediately after the 16th Meeting of the Executive Committee. Isobutane refrigerant and cyclopentane blowing agent are outlined as technologies of choice in the draft strategy. Therefore this project proposal should be considered as a demonstration project.

3. Stage 1a of this project was approved by the Tenth Meeting of the Executive Committee in June 1993. The goal of Stage 1a was to identify and optimize one or two designs which successfully and effectively use CFC substitutes, in cooperation with Chinese local institutions. The Stage 1a is completed. One refrigerator design was chosen that includes cyclopentane as the foam-blowing agent for the foam system, isobutane as the refrigerant, and an isobutane-compatible compressor to be provided by Americold Company (USA). Tests were carried out showing excellent cooling and energy use performance. Stage 1a has also provided a completed feasibility study that outlines steps and costs for full scale conversion of the plant to non ODS substitutes. Cost of Stage 1a was included when calculating the overall cost-effectiveness of the staged project.

4. The current proposal consists of Stage 1b and Stage 2. Stage 1b covers manufacturing and field-testing of 200 prototypes. The chosen refrigerator design will be fine-tuned and final adjustments will be incorporated into the factory changeover under Stage 2.

5. One factory line conversion under Stage 2 will provide assistance for installation, commissioning, employee training, trial operation and start-up, and safety precautions measures. Haier Refrigerator Factory will be using isobutane as a replacement of CFC-12 refrigerant and cyclopentane as a blowing agent to replace CFC-11 for polyurethane insulation foam.

6. Isobutane and cyclopentane technologies have been successfully used in Europe. A major European domestic refrigerator manufacturer will be directly involved in the conversion process at Haier Company.

7. The incremental costs of the project are estimated to be US $2,980,783. The portion of these costs at US $1,336,918 is requested to be credited in bilateral assistance against Germany's 1994 contribution to the Fund. The sum of US $1,643,865 is requested to be credited in bilateral assistance against United States' 1994 contribution to the Fund.

8. Requested incremental costs under Stage 1b and Stage 2 will cover all the necessary changes to the production facilities in refrigeration and foam systems. Use of isobutane and cyclopentane, potentially explosive substances when mixed with air, requires stringent safety measures. Fire protection system, exhausting and ventilation system, and on-the-job training will be provided to ensure worker and enterprise safety.

9. Incremental operating costs for full scale factory conversion are not requested.

10. Independent technical review of the project is completed.

SECRETARIAT'S RECOMMENDATIONS

11. This request complies with the bilateral contribution guidelines (UNEP/OzL.Pro/ExCom/5/16, paragraph 55) and the criteria for assessing costs as bilateral contributions (UNEP/OzL.Pro/ExCom/7/30, Annex IV). The proposed amounts to be applied against Germany and US contributions to the Fund do not exceed 20 per cent of Germany and US contributions.

12. The Secretariat recommends approval of the project proposed as a demonstration project in the amount of US $2,980,783.

13. It is recommended that the German Government's request be approved in the amount of US $1,336,918 and that the Treasurer should credit US $1,336,918 against Germany' contribution for the year 1994.

14. It is recommended that the United States Government's request be approved in the amount of US $1,643,865 and that the Treasurer should credit US $1,643,865 against the United States' contribution for the year 1994.

German Federal
Ministry for Economic
Cooperation and Development

United States
Environmental Protection
Agency

30 January 1995

Dr. Omar El-Arini
Chief Officer
Multilateral Fund for the Implementation
of the Montreal Protocol

Dear Dr. El-Arini,

Attached please find a bilateral project proposal for consideration by the Executive Committee at its 16th Meeting. This proposal is being submitted jointly by the Governments of the United States and Germany with the approval of the government of China. The proposal, which covers the final stages of a project originally approved by the Executive Committee at its 10th meeting, will lead to the final conversion of a large refrigerator line at the Haier factory in Qindao, China. This is a landmark project for the Multilateral Fund. It marks the first time that two bilateral donors and an Article 5 country have joined their expertise to develop and support a Multilateral Fund project proposal. More important, it marks the first domestic refrigerator conversion project under the Fund to demonstrate the effectiveness of cyclopentane and isobutane - 0 ODP technology. The project, which converts to O ODP technology in one step, will achieve over 200 tones of reductions with a cost effectiveness that is among the best the Fund has seen in the domestic refrigeration subsector.

This project proposal is being submitted in accordance with the Montreal Protocol and Multilateral Fund guidance concerning bilateral projects. This guidance allows Article 2 countries to offset up to 20% of their contribution for bilateral projects. Accordingly, approval of this project would in no way diminish the level of resources currently available in the Fund to finance other worthy projects. Instead, immediate use of the allowable bilateral offset will serve as an addition to the Fund's resources otherwise available for approval of projects at the 16th meeting. As required, the proposal covers only agreed incremental costs for activities that strictly relate to compliance with the provisions of the Protocol. The total bilateral offset that is being requested by Germany and the United States is well below the 20% threshold for bilateral activities that was approved by the Parties. China, which is a very active participant in this project, is fully supportive of its expeditious implementation, and has given its approval.

We are happy to submit this landmark project, and would be pleased to respond to any questions that the Secretariat or members of the Executive Committee may have. Please feel free to call us if you have any questions.

Sincerely,

Frank Rittner (Germany)

Paul Horwitz (United States)

Bilateral Assistance to an Article 5 Country in Phasing Out ODS: (Stage 1b - Field Testing and Stage 2 - Changeover of Foam Blowing Agent to Cyclopentane and Refrigerant Cycle to Isobutane in One Factory)

Project Description

Submitted to:

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

presented by:

Deutsche Gesellschaft für
Technische Zusammenarbeit (GTZ) GmbH
Postfach 5180, D-65726 Eschborn
Federal Republic of Germany

U.S. Environmental Protection Agency (EPA)
401 M Street SW
Washington, DC 20460
United States of America

January 27, 1995

Project Cover

Country:	China
Project Title:	Staged Project to Produce CFC-Free Refrigerators in China (Stage 1b - Field Testing and Stage 2 - Changeover of Foam Blowing Agent to Cyclopentane and Refrigerant Cycle to Isobutane in One Factory
Sector Covered:	Domestic refrigeration; Rigid foams and Refrigerant
Project Impact:	Phase out of annual consumption of 203 MT of CFC- 11 and CFC-12 (including servicing)
Project Duration:	1 year
Project Economic Lifetime:	10 years
Total Proposed Project Costs:	U.S. $ 3,480,783
Capital Costs:	
Operating Costs:	$ 0
Proposed MPF Financing:	U.S. $ 2,980,783
Cost Effectiveness:	U.S. $ 16,634/ton*
Unit Abatement Costs:	U.S. $ 2.39/kg
National Coordinating Agency:	National Environmental Protection Agency National Council of Light Industry
Coordination with Other Implementing Agencies:	UNEP __ UNDP x UNIDO x WB x
Supporting Agencies:	Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Eschborn, Germany U.S. Environmental Protection Agency, Washington, DC

*Includes $396,000 for Phase 1a (approved by the Executive committee 1993) and $2,980,783 for Phase 1b and Phase 2 (this proposal)

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Project Summary

China is a Party to the Protocol operating under Article 5 paragraph 1, and is eligible for funding from the Multilateral Fund.

China's output of household refrigerators has grown at an average rate of 16% for the last three years to reach 6.2 million in 1993. Production of freezers in that year totaled 1.9 million units, for total production of 8.1 million refrigerators and freezers consuming 1.7 million kilograms of CFC-12 and 6.7 million kilograms of CFC-11.[1]

The Haier Refrigerator Factory is the second largest refrigerator factory in China, with an estimated six percent of the market in 1991. Haier manufactured 550,000 refrigerators and freezers in 1993, consuming nearly 400 tons of CFC-11 and CFC-12. Haier is known as a technological leader among refrigerator factories in China, and concentrates on efficient, safe production of high quality refrigerators. Work at Haier to convert to safe production of high quality zero-ODP refrigerators will serve as a template for promoting and implementing such conversions at other factories in China.

The U.S. Environmental Protection Agency has worked since 1989 with the Chinese government, national laboratories, universities, and refrigerator factories to develop and manufacture CFC-free refrigerators in China and accelerate phase-out of CFCs in China's domestic refrigeration sector. That work was significantly advanced when the Executive Committee approved Phase 1a of this project to convert line number 2 at Haier. This proposal would, with the cooperation with the German Gesellschaft für Technische Zusammenarbeit (GTZ), bring the conversion process to completion. Specifically, GTZ will, in agreement with the Chinese government and Haier, finance and be responsible for conversion of Haier Factory production line number 2 to cyclopentane blown foam. USEPA will finance and be responsible for model redesign and development and conversion of Haier Factory production line number 2 to isobutane. The joint project will phase out 203 tons per year of CFC consumption.

This project is part of a broader program initiated in 1989 when USEPA and the China National Environmental Protection Agency (NEPA) and the Ministry of Light Industry, now the National Council for Light Industry (NCLI), signed an agreement to cooperate to develop and promote CFC-replacement technology for China's household refrigerator industry. It was agreed that a wide range of CFC-replacement technologies would be examined in order to find the technology best suited to the Chinese situation. In addition to co-funding model redesign and factory conversion, the U.S. and China agreed that the program's goal would be to transfer any technologies developed through joint work to refrigerator manufacturers throughout China.

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[1] China National Council of Light Industry, CFC-11 and 12 Strategic Studies.

Since hydrocarbons and other CFC-replacement options under consideration at the time of the original application had not then been commercially adopted by industry, the OORG recommended and the project adopted a phased approach. Stage 1a, approved by the Executive Committee at its 10th meeting, involved development and testing of model prototypes. Successful completion of Stage 1a has lead to Stage 1b, the purpose of which is to complete pilot production and testing of 200 production-model prototypes, with an emphasis on reliability. In Stage 1b, these 200 units of the selected refrigerator model will be manufactured and will undergo extensive field testing. In Stage 2, one factory line will be converted to use the substitute technology developed, cyclopentane as a foamblowing agent and isobutane as a refrigerant. Given that the technology selected for the final prototype has now been commercially proven as an effective, safe substitute technology, this proposal includes funds for the balance of the project, phase 1b and phase 2.

1.0 PROJECT SCOPE

The proposed project will be jointly implemented by the German GTZ and USEPA in cooperation with the Chinese National Environmental Protection Agency, the China National Council for Light Industry, Haier Group Company, the Beijing Household Electric Appliance Institute, and Liebherr.

The China National Environmental Protection Agency (NEPA) is the government body responsible for bilateral and multilateral projects to implement the Montreal Protocol. USEPA has worked with NEPA to accelerate phase-out of CFCs in China under a science and technology cooperation agreement signed in 1989. A comparable agreement is currently being developed between China and Germany.

The National Council for Light Industry (NCLI) is the government body responsible for refrigerator production in China. NCLI has been designated as the Chinese implementing agency for this project.

The partner and selected demonstration plant in China is the Haier Refrigerator Factory in Qingdao, one of the largest household refrigerator manufacturers in China. Haier is a recognized quality leader, has won several quality awards, and is the only refrigerator company in China to have successfully met the ISO 9001 standard. Haier, NCLI, NEPA, and the Ministry of Foreign Trade and Economic Cooperation (MOFTEC) have agreed that Haier will serve as a demonstration project, and will be obligated to make the experience and knowledge gained through this project available in appropriate form to the rest of China's household refrigerator industry.

The Beijing Household Electric Appliance Research Institute (BHEARI) is one of China's premier national testing and development laboratories. In cooperation with the U.S. and with non-compensated, bilateral funding from USEPA, BHEARI has

established a center for development and testing of CFC-free refrigerators. BHEARI has provided technical assistance to factories, and has performed confirmation testing to verify factory test results. BHEARI engineers have studied at U.S. test labs and factories to learn about design techniques, test procedures and safety procedures. International experts have visited BHEARI and provided technical training in refrigerator design optimization. As a result of the experience gained through these activities and through its participation in the U.S.- China Refrigerator Project, BHEARI has established itself as an important resource in the field of CFC substitute research. BHEARI has declared its continued willingness to provide these services to additional refrigerator factories throughout China.

The German Gesellschaft für Technische Zusammenarbeit GmbH (GTZ) is the federal agency for all the German technical development and aid programs, specializing in technology and knowhow transfer. GTZ has been given the task of the implementing German bilateral CFC-phase-out projects. GTZ has created a CFC Projects working group to implement the joint proposal presented in this application and other German bilateral phase-out programs. In addition to GTZ's participation in the Haier conversion, GTZ is currently undertaking a similar project in India in close co-operation with the Swiss Development Cooperation (SDC). GTZ is also working to develop a knowhow pool for disseminating hydrocarbon technology in domestic refrigeration and is providing technical and engineering expertise and support for factory conversions with the help of German technology suppliers.

USEPA is the responsible agency for developing and implementing bilateral CFC phaseout projects on behalf of the U.S. Government. USEPA's Global Change Division (GCD) signed an agreement in 1989 (updated 1994) with China for EPA support of changeover of the Chinese refrigerator industry to CFC-free, energy efficient technology, working first with the Haier Group and facilitating the subsequent transfer of technology to other Chinese factories. Because of their joint interests in zero ODP technology transfer, USEPA and GTZ agreed in principle in October 1994 to join forces and cooperate closely to develop and promote widespread use of CFC-free, energy efficient technology in China.

Liebherr GmbH, the German market leader in domestic refrigerators, will act as the general contractor to deliver a turn-key conversion of the Haier Factory Line Number 2. Liebherr is one of the four leading companies in Europe and was the first West-German manufacturer to embark on converting its entire product line to zero-ODP hydrocarbons. Liebherr will work with Haier, GTZ, and EPA to coordinate the factory conversion with design and testing already completed in China and the U.S., and will implement the conversion in China with the same team that has just successfully completed conversion of the Liebherr factory in Germany (600,000 units/year).

USEPA and other project participants have also sought to coordinate project activities with the World Bank, the United Nations Development Programme (UNDP), and the

United Nations Industrial Development Organization (UNIDO) in their roles as implementing agencies to the Montreal Protocol Fund. This coordination has consisted of information exchange between project participants and the agencies, periodic briefings on respective activities, and discussion of opportunities for cooperation to ensure the successful phaseout of CFCs in China's domestic refrigeration sector. One example of this coordination is China's application to convert the Jiaxipera Compressor Factory, which has been designated as a future domestic supplier of isobutane-compatible compressors to China's household refrigerator industry.

2.0 PROJECT BACKGROUND

2.1 Sector Background

The Chinese domestic refrigerator and freezer industry consists of 40 manufacturers. The sector consumed 6,740 tons of CFCs in 1993, or 11% of national ODS consumption.

The total installed production capacity for refrigerators is 15 million refrigerators per year on 70 refrigerator production lines and 30 freezer production lines. Actual production in 1993 was 6.2 million. Haier produced 550,000 refrigerators and freezers in 1993.

2.2 Factory Background

Qingdao Haier Refrigerator Company, Ltd. is a household refrigerator manufacturing company located in Qingdao, P.R.C. Together with seven other manufacturing facilities it forms the Industry Section of the Haier Group. The Haier Group could be considered a "conglomerate" by western standards, as it consists of 29 different business enterprises. The refrigerator factory, established in 1985, was the original enterprise, then known as the Qingdao General Refrigerator Factory.

Haier initially licensed its production technology from Liebherr, a well established manufacturer of household refrigerators and the market leader in Germany. Since 1984 Haier's factory production equipment has been designed and/or specified by Liebherr. The product line design also is Liebherr's, and is typical of leading European product lines. The factory equipment is good quality machinery, sourced primarily in Europe. The door fabrication equipment is an automated line from Olma, Italy. The foam insulation equipment was supplied by Hennecke, a German subsidiary of Bayer, well known for quality equipment. The manufacturing line is automated, including a cabinet turn-over station and automatic sequencing for foam injection. Vacuum forming equipment also uses modern technology. The factory is performing well: Haier is known for top quality products.

Haier performs all its own sheet metal fabrication, vacuum forming operations for cabinet and door liners, and injection molding of plastic structural and decorative parts. Condensers are manufactured at another Haier plant. Compressors, some evaporators,

various controls and other electrical components are purchased from outside suppliers. Terrain restrictions (the plant is located in a hilly area) require that various fabrication operations be conducted in different buildings and on different floors of the main building.

The final assembly line of the production unit to be converted consists of typical moving slat conveyors, in the general form of a large "U". Material for assembly is stored off-line and fed into the various assembly stations as needed. System processing takes place "on line" with a dual evacuation procedure before charging. Final operational checks, electrical safety checks and refrigerant leak checks are conducted in a separate booth near the end of the assembly line .

Haier has two final assembly lines, identified as Factory Line #1 and Factory Line #2 with a total production capability of 500,000 to 600,000 units annually. The proposed project covers the conversion of Factory #2, with a present production of 220,000 units annually (Oct. 93 - Oct. 94).

2.3 Factory Quality Control

Haier has a good quality control system and trains employees to be highly quality conscious. Haier has received a certificate of registration for IS0 9001. Quality Control is a major effort at Haier; quality control personnel are identified by white uniform coats with shoulder pads decorated with a "Total Quality Control" emblem.

Haier's Sales and Service Department has 64 staff in Qingdao and a total of 4,000 employees in 450 centers across the country. Service requests are responded to within four days of the call. Each service request is entered into a computer log and tracked. Haier's service center also maintains an extensive computerized data base, which allows Haier to track each individual product and the customer to which the product was sold. The reported service call rate for all refrigerators in service is extremely low by any standard, only 4% per year of all Haier refrigerators in service.

2.4 Project Objective

The project's objective is to eliminate the use of CFC-11 and CFC-12 in the production of domestic refrigerators at Haier Factory Line #2 through conversion to the use of isobutane as refrigerant and cyclopentane as blowing agent for the polyurethane insulation foam. A further objective is to contribute to the development of the domestic knowhow pool to enhance the cost-effectiveness of future phase-out work in China's domestic refrigeration sector.

3.0 DESCRIPTION OF WORK TO DATE

3.1 Preliminary Work

Preliminary work, which was completed through the use of non-compensated bilateral

assistance, involved the identification of potential non-CFC refrigerants and foam-blowing agents. This preliminary work took place from March 1991 through April 1993. Accomplishments include:

- Identification of key personnel and organizations. Selection of key refrigerator and compressor factories for further work;

- Completion of preliminary assessment of equipment, testing capability (including equipment test cells and compressor testing equipment), and ability to alter factories;

- Initiation of work to adapt refrigerators to CFC-free materials; Exchange of information between China and the U.S. to facilitate technology transfer activities. Initiation of laboratory and factory testing and evaluation of alternative refrigerants, including performance, cost of changeover, safety, materials availability, materials compatibility, and compressor performance;

- Successful design, construction, operation and testing of an initial prototype refrigerator without CFC-12 based on conventional and Lorenz cycles. Testing checked for quality of operation and cooling characteristics.

- Provision by EPA of more than 250 kg of refrigerants and lubricating oils to China for product testing and development. The materials included 141b, 134a, 123, 143a, R32, R270, 142b, propane, cyclopropane, isobutane, butane, cyclopentane, n-pentane, ester oil, mineral oil, alkylbenzene, DuPont MP 33, and DuPont MP 39.

- In cooperation with Americold/Electrolux, provision by EPA of twelve 152a-compatible and twelve isobutane-compatible compressors for testing and development work in China. EPA has procured 240 additional isobutane-compatible compressors for production of final prototypes.

- Planning completed for the next stages of the project, including stage 1a, 1b and 2.

3.2 Stage 1a Project Description and Results

Stage 1 of this project was approved by the Executive Committee in June 1993. In Stage 1, a small number of model CFC-free prototypes was built and tested. The goal of stage 1a was to identify and optimize one or two designs which successfully and effectively use CFC substitutes. BHEARI, the Haier Refrigerator Factory, and the National Council of Light Industry were actively involved during this stage.

Stage 1a activities:

CFC-free Foam

Stage 1a determined the performance, location, and type of non-CFC foam insulation necessary to optimize refrigerator performance through testing in the laboratory and at the factory. Foam blowing agents considered included HCFC-141b and cyclopentane. Vacuum panel technology was also considered as an alternative insulating material.

HCFC-141b was not selected because it offers only a temporary solution. Vacuum panels were not selected because they are too expensive and not cost effective in this application. Cyclopentane has zero ODP and has been successfully implemented in Europe. It is compatible with materials currently used in the refrigerators and has been determined to be durable and structurally suitable for use in domestic refrigerators. A domestic supply of cyclopentane of appropriate quality can be made available in China. Therefore, the CFC-free foam blowing agent selected is cyclopentane.

ICI will assist Haier in foaming cabinets for work during Stage 1b. An agreement for transfer of cyclopentane production technology for Stage 2 has been reached between the Haier Factory and Liebherr.

Both current and improved performance were modeled. The Haier Factory worked with BHEARI and the University of Maryland to redesign and construct prototypes with the improvements necessary to maintain refrigerator performance with cyclopentane blown foam. Performance of redesigned units will be tested and confirmed after production of the final prototypes.

CFC-free Refrigerants, Compressors, and Lubricating Oils

The performance of 134a, 152a, 22/152a blends, pure hydrocarbons, and hydrocarbon blends, including cyclopropane, propane, butane, isobutane, cyclopentane, and n-pentane, was investigated. Isobutane was selected as the substitute refrigerant because it has zero ODP and negligible GWP, and offers a permanent conversion target, unlike 134a. Use of isobutane as a refrigerant has been successfully commercialized in Europe. Isobutane is compatible with materials currently used in refrigerators and compressors, unlike 134a, which would require greater changes to the compressor and lubricant. Isobutane is currently manufactured in China. Stage 1b will include determination of the appropriate purity of isobutane for the Haier demonstration model. Further technical assistance will be provided to Haier and other manufacturers in order to provide an information source for re-design of additional models for compatibility and reliable, long-term performance with isobutane.

Condensers, evaporators, anti-sweat devices based on test results from current Chinese technology were chosen and adapted to work with the chosen CFC-free refrigerant. Compressors from a variety of manufacturers were tested and the Americold compressor model HC-77-12 with 113 kcal capacity was chosen as the most appropriate for use with the new refrigerator design. This compressor has been subjected to life-cycle and compressor calorimeter tests, and runs reliably on mineral oil lubricant, as do current R-12 compressors. Compressors for Stage 1b will be supplied by Electrolux/Americold. Americold has tested compressors designed for isobutane in calorimeters and in lifecycle tests.

Haier intends to initially import isobutane compressors once the factory is converted, just as it currently imports R-12 compressors. Upon approval of this application, negotiations will be held with Electrolux/Americold and other potential suppliers for these purchases, which will be funded with factory funds.

To assure a long term domestic supply of compressors, Electrolux has entered into an agreement with the Jiaxipera Compressor Factory in Jiaxing to produce isobutane-compatible compressors in China. Jiaxipera is working with UNIDO in support of a proposal to the Executive Committee for funding assistance for this program.

In order to implement the isobutane plant conversion, Haier and Liebherr are prepared to sign an agreement regarding transfer of isobutane refrigerant technology. This transfer will ensure that appropriate safety measures are adopted for isobutane refrigerator production.

Overall Results

The overall result for Stage 1 is one refrigerator design that includes cyclopentane as the foam-blowing agent, isobutane as the refrigerant, and an isobutane-compatible compressor to be provided by Americold. The chosen design is the Haier BCD 220 model. This model has a volume of 220 liter units and has one freezer and one fresh food compartment. Tests at BHEARI, the University of Maryland, and the factory show excellent cooling and energy use performance. Stage 1 has also provided a completed feasibility study that outlines the steps and costs for factory changeover and other plans necessary for successful completion of Stage 2.

3.3 Stage 1b Activities and Expected Results

As described in the proposal submitted and approved at the 10th Executive Committee Meeting, in Stage 1b 200 final prototypes will be built and field-tested. Field test units will be foamed with cyclopentane as the blowing agent. ICI will provide the polyol and oversee the production of the cabinets. Americold will supply the isobutane compressors through a procurement by the USEPA. Haier Factory will build the refrigerators. Since permanent safety systems will not yet be in place, special measures will be taken in order to ensure worker safety during production of these units. Handling of cyclopentane and

foaming of the units will take place during off hours with a minimum staff. Portable leak detectors will be used to detect and rectify leaks before lower flammability and explosion limits are reached. Equipment and staff will be prepared in order to minimize or eliminate the risk of sparking or other mishaps.

The resulting prototypes will then be placed in apartment buildings in three cities representing the wide range of China's climactic conditions (most likely Beijing, Shanghai, and Guangzhou), and conduct performance testing. Prototype units will be tested for three seasons, including the extremes of winter and summer. Performance will be monitored, including ability to keep food at appropriate temperatures, chill time, reliability, noise, and customer satisfaction. A U.S. expert based in Beijing will work with the factory to design and interpret the field test protocol. An arrangement for safety testing of the new units at Underwriter's Laboratory (UL) has been established in order to determine that the units are safe for household use by American standards.

As a result of Stage 1b, fine tuning of the refrigerator design will include confirmation of the choice of cyclopentane and isobutane purity required, amount of foam and cyclopentane per cabinet, aging characteristics of foam in the cabinet, size of evaporator, condenser, capillary tube, and anti-sweat device, amount of refrigerant charge, and choice of compressor capacity. Final adjustments, if any, will be incorporated into the factory changeover. Results will then be made available to additional Chinese factories to support their efforts to phase out CFCs.

4.0 STAGE 2 -- FACTORY CONVERSION

Haier is prepared to phase out ODS in the refrigeration section as soon as the new technology has been acquired, the necessary machinery and equipment installed, and technical staff trained.

From among the technological options currently available on a commercial basis, Haier has chosen to replace CFC 12 with isobutane, because this technology has been successfully used in Germany, especially by Haier's long-term partner, Liebherr.

To replace the blowing agent (CFC 11) for polyurethane foam, Haier has decided to avoid using any transitional substance and to introduce cyclopentane, which is becoming the new world standard, as the ultimate solution.

See section 3.2 for more details regarding the choice of alternatives to CFC 11 and 12.

China seeks assistance for:

a. installation, commissioning, employee training, trial operation and start-up;
b. safety precautions;

c. procurement of new machinery and equipment;
d. rebuilding and partial replacement of equipment presently used.

4.1 Refrigeration System

Two major changes to the production facility are necessary in order to produce a CFC and FC-free refrigerator model. The first change involves the refrigeration system evacuation and charging equipment. Use of isobutane, a potentially explosive substance when mixed with air, requires that the evacuation and charging system be replaced to ensure worker and plant safety. As with foaming equipment, explosion-proof electrical components will be needed. These evacuation and charging stations perform the triple function of evacuation, purging and charging. It was determined to be less expensive to convert this equipment directly to use isobutane rather than first to install the more common, simple charging stations and then complete the conversion.

All major European manufacturers of refrigerators and compressors have switched to isobutane as replacement for CFC 12 as the new refrigerant for domestic refrigerators and freezers. By the end of 1994, all German manufacturers (e.g. AEG, Bosch-Siemens, Foron, Liebherr etc.) will have converted all their factories and household models (with exception of no-frost models due to the installed ventilator). By the end of 1995, refrigerator manufacturers expect that virtually the entire European industry will have converted to hydrocarbons. In August 1994, Electrolux, the European and world market leader announced its plans to have all their plants switched by the end of 1995. There are already more than one million completely hydrocarbon based refrigerators (foam and refrigerant) on the market. Not a single household or servicing accident has been reported. Isobutane as a refrigerant offers the possibility of additional benefits, including better energy efficiency if the refrigeration system is properly optimized, and lower noise level.

4.2 Foam System

The second major change to the factory is replacement of the foam injection facility for thermal insulation by a new system compatible with the flammable cyclopentane blowing agent for the polyurethane foam insulation. The injection system must be explosion-proof and incorporate other technical safety improvements. Components such as pumps, valves, piping, hoses and connectors have to be installed in such a fashion as to prevent any leakage of the cyclopentane into the surroundings. In addition to the equipment itself, detectors and alarm systems have to be installed in the manufacturing areas where cyclopentane will be handled. These include the storage areas, the area where the foam ingredients are mixed, and the piping involved for these operations. Additional fire fighting equipment will be required.

All refrigerator producers in Europe and many manufacturers in the Far East have already switched, or will switch in the near future, to cyclopentane as blowing agent because of its zero ODP, low GWP, and the lower cost of materials. Manufacturing technology for use of cyclopentane is mature and the control systems have been

established so that this technology may be applied in developing countries given adherence to strict processing regulations and production staff training. In order to assure an adequate margin of safety, the safety standards for this project will be equivalent to those in place in Europe.

4.3 Refrigeration Service

Liebherr's proven technology for hydrocarbon-based refrigerator servicing will be applied to Haier's established refrigerator service centers, where only minor changes will be required. Standard vacuum pumps and equipment of the CFC-12 servicing will be supplemented by a new portable filling stand, a lockring unit to close the refrigerant circuit, an adapter to the filling and vacuum pump and an exhaust pipe.

5.0 PROJECT INPUTS

5.1 Model Design and Development

The following equipment, materials, and support are needed for model design and development:

a. Tooling
b. Cyclopentane
c. Polyol
d. Refrigerant-grade isobutane
e. Isobutane-compatible compressors
f. Technical support (system optimization, testing)

In order to reduce overall project costs, production line modifications to produce final prototypes will be applied to the full factory conversion. For example, tooling procured to produce final prototypes will subsequently be incorporated into the full plant conversion. Where feasible, project costs will be reduced by use of unmodified equipment for both final prototype and product production.

5.2 Factory Line Conversion

Refrigeration System:

The following equipment will be provided either as replacement or in addition to existing equipment:

a. Vacuum stand 2x
b. Filling stand 1x
c. Pressure booster
d. Ultrasonic welding equipment

e. Leak detection equipment
f. Exhaust system

Foam System:

The following existing equipment will be replaced:

a. tank for cyclopentane with all necessary safety devices
b. equipment for pentane supply from tank to premixing station (pump, pipe, safety devices)
c. premixing station for cyclopentane and polyol
d. gas detector system with control board, gas sensors, ventilation sensors for safety purposes
e. exhausting and ventilation system
f. pentane replacement equipment for casing foaming unit (high pressure) HK 650
g. replacement unit for the oval rotating unit
h. inserting system
i. pentane replacement equipment for door foaming system (high pressure) HK 270
j. replacement set for door foaming unit

Refrigeration Service for one service station:

a. Portable filling station for R600a
b. Lockring equipment
c. Adapter for filling station

Disposal of replaced CFC equipment

This proposal will in the short run change out one refrigerator model. Work will continue thereafter to complete conversion of the factory. NEPA will at that time monitor the equipment to ensure that it will be disposed of properly and not used for production of ODS-containing products.

5.3 Training and Safety Certification

Replacement of CFC-11 by cyclopentane is now an advanced, proven technology and is the current state of the art in household refrigeration. The first real, world-wide implementation in the production process was initiated in April 1993 by Liebherr at its two factories in Germany and Austria. All of Liebherr's facilities exclusively use cyclopentane foam-blowing agent.

Liebherr's conversion has been approved and certified by the German TÜV-Südwest (the German Safety Control Agency). TÜV has certified the conversion of all other German refrigerator manufacturers since April 1993 (including more than 5 large manufacturers). As of April 1993 Liebherr has worked without any incident and has

produced nearly 2.0 million refrigerators/freezers with cyclopentane. During this period, Liebherr has acquired unique experience in this implemented technology, which is being steadily improved in day-to-day business. The present proposal comprises the latest experience in this field.

The technical layout and design of the Haier #2 production line has already been certified by the TÜV. Final approval and certification by TÜV will take place after installation of equipment and commissioning at Haier Factory Line #2, which will certify that the cyclopentane and isobutane installations meet present German safety standards. The refrigerators will be tested and certified by Underwriters Laboratories (UL) in order to ensure that they meet proposed American product safety standards. TÜV and UL are well known in the Chinese refrigerator industry for manufacturing and product safety, respectively. Since both businesspersons and the general public in China attach great importance to foreign certifying bodies, these certifications will ensure that the project's technical achievements are widely recognized. The refrigerators are intended for the Chinese domestic market, and are not for export purposes.

In the preparation, layout, execution and implementation of this conversion project, factory and product safety will be ensured through:

- training at Liebherr in Germany
- worker training at Haier
- overall technical information and documentation
- specific safety instructions
- permanent approbation and final certification of the factory line and manufacturing procedures by German TÜV experts
- certification according to German standards
- UL will test the redesigned prototype and provide suggestions for modifications, if necessary, to assure that the final model operates in a safe manner.

6.0 PROJECT INITIATION AND IMPLEMENTATION

6.1 USEPA/GTZ Cooperation

USEPA has worked in China for five years, in particular with the Haier company, on a program to develop CFC and FC-free, energy-saving refrigerators. Given their joint goals, USEPA and GTZ have agreed to cooperate in promoting wide-spread transfer and adoption of this technology in China, beginning with conversion of one factory line at the Haier factory to cyclopentane foaming agent and isobutane refrigerant. This is a joint application by the U.S. and Germany for approval of the proposed project as bilateral assistance to China.

6.2 Project Implementation

The time schedule foresees the implementation of the foaming component by the second

quarter of 1995 and of the filling equipment by the third quarter of 1995. Liebherr will deliver a turn-key operation for factory conversion, including personnel training.

6.3 Local Costs of Conversion

Local costs of conversion estimated at U.S.$500,000 will be borne by the Haier Company (as a Chinese contribution to the expenses of the project) for costs of conversion and model re-design as follows:

Cyclopentane foam	$286,080
Isobutane	$182,760
Model design	$31,160
Total	$500,000

The above costs include for cyclopentane foaming: installation of C-P conveying device; construction for C-P premix room; technology adjustment around foaming line; construction for safety storage space of C-P, and for isobutane R600a refrigeration: pipe line and container for conveying R600a; construction for safety storage space of R600a; improvement for assembly line as per new technology; segregating for vacuum filling and welding station of R600a (See I. 3). Also included are costs of modifying jigs and plugs in accordance with Liebherr's instructions.

6.4 Status of Government Agreements Germany/China and U.S./China

In German-Chinese government consultations, China has requested and Germany has agreed to provide bilateral support as of May 1994. This project had been discussed and agreed in principle in China also with the National Council of Light Industry (NCLI), the National Environmental Protection Agency of China (NEPA) and the Ministry of Foreign Trade & Economic Cooperation (MOFTEC) in May and June 1994. A detailed bilateral project agreement as required for development projects is in the process of negotiation between China and Germany.

The U.S. and China signed an agreement for science and technology cooperation in 1989, including cooperation in the area of environmental protection and technology transfer. A subsequent project agreement detailing U.S.- China cooperation in transferring CFC-free, energy-efficient technology to China's refrigerator industry was agreed to in principal in November 1993 and signed in May 1994 by USEPA, NEPA, and NCLI.

6.5 Liebherr GmbH / General Contractor

Liebherr Hausgeräte GmbH, Ochsenhausen, Germany is proposed as General Contractor to implement production line conversion as a turn-key operation in conformance with the standards of the conversion of Liebherr's own factory in Germany and German safety standards. Liebherr has an 11-year history of very close technical co-operation with

Haier and built this factory in 1986 as a turn-key operation. From an engineering perspective, conversion of the Haier factory is as if Liebherr were introducing hydrocarbon technology into one of its own factories.

6.6 Repair Service

As part of the project Haier will train its own service team appropriately with initial familiarization and supervision by Liebherr.

7.0 WORKPLAN AND SCHEDULE

Model design and development:

Re-tool as necessary to build 200 final prototypes	December 1994-January 1995
Produce 200 final prototypes	January 1995
Begin field testing of prototype performance	February 1995
Ship refrigerators to UL for safety testing	February 1995
Complete field testing of prototype performance	July 1995
Determine final changes, if any, to final design	July-August 1995

Cyclopentane conversion:

Delivery of foundation drawing for Cyclopentane tank by LIEBHERR	January 1995
Installation of foundation for cyclopentane tank by HAIER	January-March 1995
Training at Liebherr	January 1995
Delivery of foaming equipment	January-February 1995
Installation of foaming equipment	February-April 1995
Delivery of technical documents	January-March 1995

Isobutane conversion:

Delivery of equipment by LIEBHERR	August 1995
Delivery of technical documents	August 1995
Installation of filling equipment	September 1995

8.0 PROJECT COSTS

8.1 Investment Costs

Investment costs will cover model re-design and development costs and capital investment costs for modification of manufacturing facilities, new machinery, materials, testing equipment, training, installation and technical support. Equipment specifications and capital investment costs are shown in Annexes A, B, and C.

8.2 Operating costs

There is currently no request included in the budget for incremental operating expenses for full scale factory conversion. While isobutane compressors were initially more expensive than CFC ones, production quantities have increased and costs for isobutane compressors are expected to be comparable to CFC compressors, according to refrigerator and compressor industry sources. The results from Phase 1b will determine the need for more expensive high purity isobutane and cyclopentane. It is hoped that either lower cost materials will suffice or that the prices for higher purity materials will be reduced as demand and production increase.

8.3 Total Costs

For a detailed breakdown of investment costs, see Annexes A, B, and C. For calculation of unit abatement cost see Annex D, Unit Abatement Cost. Total funding requested from the Montreal Protocol is as follows (in U.S. dollars):

Total Project Costs
(U.S. $)

Cyclopentane component		$1,956,888
MPF funding request -- German bilateral contribution	1,336,918	
MPF funding request-- U.S. bilateral contribution	333,890	
China contribution	286,080	

Total Project Costs, U.S. $ (continued)

Isobutane component		$1,148,061
U.S. bilateral contribution	965,301	
China contribution	182,760	

Model redesign/Prototype production and testing		$ 375,834
U.S. bilateral contribution*	344,674	
China contribution	31,160	

Total project cost		**$3,480,783**
China contribution	500,000	
Total MPF funding request		**$2,980,783**
MPF funding request -- German bilateral contribution	1,336,918	
MPF funding request -- U.S. bilateral contribution	1,643,865	

*Note: Includes prototype design, production, and testing, in-country expenditures for product redesign, manufacture and testing of prototypes. Prototype tooling to be reused during full-scale production. Also includes travel, management, and overhead expenses incurred by Chinese project participants not covered under the host country contribution.

ANNEX A. SPECIFICATION OF MACHINERY FOR REFRIGERANT SYSTEM

A 1. Automatic Vacuum Stand for R 600a Refrigerant Circuit, Liebherr System
The vacuum stand evacuates and dries the refrigerant circuit and reveals any leaks. Main assemblies of an automatic vacuum stand for R 600a refrigerant circuit, Liebherr system:

1 pc. automatic vacuum stand complete casing with electrical and mechanical components, vacuum pistol with 4 m tube package, 3 m connection pipe with fittings to the supply pipelines
10 pcs. connection couplings
1 pcs. elastic autostat holder for the vacuum pistol

A 2. Automatic Vacuum and Refrigerant Filling Station for R 600a
The vacuum and refrigerant filling station evacuates and fills refrigerant circuits with R600a. This station can be used either for vacuum or for R600a or universally. Main assemblies of an automatic vacuum and refrigerant filling station stand for R 600a refrigerant circuit, Liebherr system:

1 pc. automatic vacuum stand complete frame with electrical and mechanical parts, vacuum pistol with 4 m tube package, 3 m connection pipe with fittings to the supply pipelines
1 pc. test cylinder for control of filling quantity
1 pc. elastic autostat holder for the vacuum pistol

A 3. Pressure Booster for R600a
The pressure booster installation increases the pressure of the refrigerant cylinder to the necessary supply pressure of the vacuum and refrigerant filling stations. The cylinder holder with built-in pressure control system monitors the liquid intake of R600a and terminates it in case of malfunction.

The pressure booster installation consist mainly of:
1 pc. refill and pressure increasing station for R 600a
1 pc. cylinder holder for two R 600a cylinders with pressure control and stop function

A 4. Ultrasonic Welding Station
After filling of the refrigerant circuit, the refrigerant filling connection piece of the compressor is closed gas-tight with hand held welding pliers.

The ultrasonic welding station consists chiefly of:
1 pc. casing for the electrical and mechanical components.
1 pc. ultrasonic-generator
1 set connection wire, length 6 m
1 pc. hand held welding tongs

A 5. Leak Detection for Isobutane
The control system continuously measures the concentration of isobutane in the air at possible emergency points like the isobutane cylinder storage, the pump station, the evacuation and filling station, the final assembly line, and all points where an isobutane

leakage is possible. In an emergency the control system will automatically implement several alarm and security precautions.

Proposed alarm plan of the isobutane control system:
Explosion concentration of isobutane-air mix:
lower explosion limit 1.8 vol. %
upper explosion limit 8.5 vol. %

Preliminary alarm at 20% of the lower explosion-limit:
On registration of 20% of the lower explosion-limit (isobutane concentration in the air of 0.36 vol. %) by one isobutane detector, the following precautions will be taken: rotating warning light turns on automatically red warning pilot lamp showing the affected sector will light up in the gas detection central control panel

Alarm at 40% of the lower explosion-limit:
On registration of 40% of the lower explosion-limit (isobutane concentration in the air of 0.72 vol. %) by one isobutane detector, the following precautions will be taken: rotating warning light and warning siren are switched on automatically red warning pilot lamp showing the affected sector will light up in the gas detection central control panel phase down of all machines and installations in the affected sector except for the isobutane control system and the exhausting system.

A 5.1. Main Assemblies of an Isobutane Leak Control Panel

1 pc. gas warning central control panel to bring together and process all signals from the detection points and to control the alarm precautions.
1 pc. switching cabinet to hold the racks for the control unit and the isobutane detectors
1 pc. emergency power supply
1 pc. memory-programmable control system
2 pc. hand held isobutane-air concentration devices

1 set warning device at the isobutane store for concentration control and local alarm precautions consisting mainly of:
1 pc. isobutane-detector with rack and installation equipment
1 pc. rotating warning light
1 pc. warning siren

1 set warning device at the isobutane pump station for concentration control and local alarm precautions consisting mainly of:
1 pc. isobutane-detector with rack and installation equipment
1 pc. rotating warning light
1 pc. warning siren

1 set warning device at the evacuation and filling stand for concentration control and local alarm precautions consisting mainly of:
3 pc. isobutane-detector with rack and installation equipment
1 pc. rotating warning light
1 pc. warning siren

1 set warning device at the final assembly line for concentration control and local alarm precautions consisting mainly of:
4 pc. isobutane-detector with rack and installation equipment
1 pc. rotating warning light
1 pc. warning siren

A 6. Forced Exhaust Equipment

Because isobutane is heavier than air and can concentrate in lower places to an explosive level in the air, exhaust and ventilation equipment are planned at the following emergency points.

Exhaust equipment for the isobutane storage, the pump station, the filling and evacuation stands and the testing cabinet.
consisting mainly of:
1 set exhaust pipeline from the emergency points to the exhauster 1 pc. exhauster with flow control
1 set exhaust pipeline to the exterior with pipeline holder elements

Exhauster at the final assembly line consisting mainly of:
1 pc. sampler with pipeline to the exhauster
1 pc. exhauster with flow control
1 set exhaust pipeline to the exterior with pipeline holder elements

Leak detection device for R 600a
The leak detection device shows leaks in the refrigerant circuit by means of acoustic alarms.
The leak detection consists manly of
1 pc. portable casings to hold the components
1 pc. snuffle head with 4 m snuffle pipeline
1 pc. take-off control panel with 4 m measuring control pipeline
1 pc. LED-panel

A 7. After-Sales Service

A 7.1. Filling Installation for R600a

With the filling equipment it is possible to refill repaired refrigerant circuits with R 600a. The following equipment has to be seen as a pilot service station.

A 7.2. Lockring-Complete Equipment

With the lockring equipment it is possible to close all fittings gastight

A 7.3. Punch for the Dryer

By piercing with the punch at the dryer it is possible to remove any R 600a still in the refrigerant circuit to the exterior via a 5 m long pipeline

A 7.4. Adapter

With the adapter it is possible to connect the refrigerator to the filling device.

ANNEX B. SPECIFICATION OF MACHINERY FOR THE FOAM SYSTEM

B 1. Pentane Tank Storage

The pentane tank storage serves for safe storage of liquid pentane in large quantities and is adapted to the extraordinary security requirements of pentane.
For security reasons the tank storage should be built outside the production hall and below ground level.

Main parts of a pentane tank:

1 pc. steel tank, double walled, for underground installation, explosion pressure-proof version. Proof pressure 2 bar, size 20 m3, diameter 2000 mm, length 6860 mm
2 pcs. steel shaft for filling and pump station
1 set apparatus, fittings and pipeline for filling, consumption, pressure equilibrium, leakage detector and overfill safety device

1 set equipment for emptying drums consisting mainly of:
1 pc. pneum. drum pump, stainless steel
1 pc. ventilation for the drum
1 pc. ground wire

B 2. Equipment for the Pentane Transfer

This equipment serves for the transport of the liquid pentane from the tank to the premixing station and is constructed for the special safety requirements of pentane.

The pump station is installed on the shaft of the pentane tank. The cyclopentane pipeline leads in an under ground construction to the building housing the premixing station.

Specification of the pneumatic diaphragm pump
volume level of the pump max. 20 l/min
pressure due to pressure in the pneumatic system

Main parts of the pentane transport equipment pump station consisting mainly of

2 pcs. compressed air diaphragm pump in stainless steel
2 pcs. pulsation damper in stainless steel
1 pcs. by-pass-line pressure valve in stainless steel
2 pcs. ball valve in stainless steel, DN 25
1 set compressed air fittings

Pipelines installed under ground from the tank to the premixing station consisting mainly of:

50 m steel pipeline
1 set tested fittings
1 set fixing equipment
1 pc. pulsation damper
1 pc. solenoid valve

B 3. Premixing Station

In the premixing station the polyol, the activator and pentane will be mixed according to the

difference metering principle in constant, pre-selectable quantities and can be pumped to each foaming unit as required.

To satisfy the different supply needs for the foaming units for the doors and the casings the premixing station is equipped with two activator dosage units.

Main parts of premix station:

1 pc. Pentamat for mixing polyol and pentane consisting mainly of:
1 pc. casing for the components
1 pc. metering pump for the polyol dosage
1 pc. spur gear unit motor, 1.1 kW, for gear pump
1 pc. double gear pump for the differential metering
1 pc. spur gear unit motor, 1.1 kW, for double gear pump
1 pc. flow sensor for polyol at the gear pump
1 pc. mass flow rate sensor for pentane
1 set contact pressure gauge for pressure monitoring
1 pc. static mixer
1 set fittings

2 pc. dosage unit for activator
consisting mainly of:
1 pc. membrane pump
1 set contact pressure gauge for pressure monitoring
1 pc. nozzle holder for nozzle

1 set equipment for drum-emptying consisting mainly of
1 pc. pneum. drum pump, stainless steel
1 pc. ventilation for the drum
1 pc. ground wire

1 pc. drum pump for activator consisting mainly of:
1 pc. piston pump
1 pc. compressed air drive
1 pc. media line
1 set equipment for compressed air supply

1 pc. drum pump for polyol consisting mainly of
1 pc. screw pump
1 pc. electric motor
1 pc. media line

1 set media line for component A from the premix station to the machine tanks of the casing and door foaming unit consisting mainly of:
1 set pipeline with pertinent fittings
1 set installation equipment
1 set pipeline insulation

B 4. Control System

1 set control system for supervising the following work places:

Foam delivery
- storage
- transport
- premix

Casing foam system
- dry unit
- wet unit

Door foam system
- wet unit
- dry unit

The control unit performs continuous checks of the pentane concentration in the air at the areas exposed to hazard:

- pentane tank storage / pentane pump station
- premix station
- casing foam system
- door foam system
- wherever a leakage of pentane is possible due to the system and automatically initiates several alarm and security measures.

Proposed alarm plan of the pentane control system:
explosion concentration of pentane-air mix:
lower explosion limit 1.4 vol. %
upper explosion limit 8.0 vol. %

Preliminary alarm at 20% of the lower explosion limit:
On registration of 20% of the lower explosion-limit (pentane concentration in the air of 0.28 vol. %) by one pentane detector, the following precautions will be taken: flashing warning light turns on automatically in the affected sector red warning pilot lamp showing the affected sector lights up in the gas detection central control panel flashing warning light turns on automatically in the gas detection central control panel

Alarm at 40% of the lower explosion limit:
On registration of 40% of the lower explosion limit (pentane concentration in the air of 0.56 vol. %) by one pentane detector, the following precautions will be taken: flashing warning light and warning siren switch on automatically in the affected sector red warning pilot lamp showing the affected sector lights up in the gas detection central control panel phase down of all machines and installations in the affected sector except for the isobutane control system and the exhausting system.

B 4.1. Main Assemblies of a Control System

1 pc. gas warning central control panel to bring together and process all signals from the

detection points and to control the alarm precautions.
1 pc. switching-cabinet to hold the racks for the control unit and the isobutane detectors
1 pc. emergency power supply
1 pc. memory-programmable control system
2 pc. mobile pentane detector

1 set warning device at the pentane tank storage / pentane pump station for concentration control and local alarm precautions, consisting mainly of:
1 pc. pentane detector with rack and installation equipment
1 set electronically equipment for the transfer of signal and control to and from the gas detection central
1 pc. flashing light
1 pc. siren

1 set warning device at the premix station consisting mainly of:
1 pc. pentane detector with rack and installation equipment
1 set electronic equipment for transfer of signals to and from the gas detection central control panel
1 pc. flashing light
1 pc. siren

1 set warning device at the casing foam system consisting mainly of:
1 pc. pentane detector with rack and installation equipment
1 set electronic equipment for the transfer of signals to and from the gas detection central control panel
1 pc. flashing light
1 pc. siren

1 set warning device at the door foam system consisting mainly of:
1 pc. pentane detector with rack and installation equipment
1 set electronic equipment for the transfer of signals to and from the gas detection central control panel
1 pc. flashing light
1 pc. siren

B 5. Forced Exhaust Equipment

for the supervision of the following work places

Foam delivery
storage
transport
premix

Casing foam system
dry unit
wet unit

Door foam system
wet unit
dry unit

Since pentane is heavier than air and can concentrate at lower places to an explosive level in the air, exhaust and ventilation equipment are planned at the following danger points.

1 set exhauster equipment for the pentane storage / pump station consisting mainly of:
1 set exhaust pipeline from the emergency points to the exhauster 1 pc. exhauster with flow control
1 set exhaust pipeline to the exterior with pipeline holder elements

1 set exhauster at the premix station consisting mainly of:
1 pc. gas basin
1 pc. sampler with pipeline to the exhauster
1 pc. exhauster with flow control
1 set exhaust pipeline to the exterior with pipeline holder elements

1 set exhauster for the casing foam system consisting mainly of
1 pc exhauster for cellar room
1 pc. exhauster for the foam mould at the foam position, moveable
1 pc. exhauster with flow control
1 set exhaust pipeline to the exterior with pipeline holder elements

1 set exhauster for the door foam system consisting mainly of:
1 pc. gas basin for the foam machine and the tank of component A
1 pc. exhauster for the foam machine
1 pc. exhauster for the foam mould at the foam position, moveable
1 pc. exhauster with stream control
1 set exhaust pipeline to the exterior with pipeline holder elements

B 6. Pentane Replacement Equipment for HK 660

For the use of pentane forced foam in the high pressure foaming machine the following equipment is needed. The reason for this lies in the different compatibility of the materials and the special safety requirements resulting from the use of pentane.

Main assemblies of a pentane replacement set for the HK 650

1 pc. replacement equipment for the metering aggregate for the component A faced parts in corrosion-proof design with:
1 pc. metering pump, high capacity, rotary shaft seal and leakage monitoring device
1 pc. leakage monitoring device for the mixing head MP
1 pc. set of fittings for the pre-selection of component A
1 pc. leakage-free special filter as replacement for the plate filter now used
1 pc. machine tank for component A consisting mainly of:
1 pc. work tank in stainless steel, size 250 l, operating pressure up to 10 bar, double walled

for temperature control, stirrer driven via coupling and motor 50 min1, special fittings for pentane, pressure control with pressure gauge for dry air or inert gas atmosphere
1 pc. temperature control system
* heating power 5 kW
* cooling power 4 Kw at 15 C water supply temperature and 60 l/min 1 pc. post filling control with level sensor device

1 set replacement equipment for electrical control with add-on components and software package

B 7. Replacement Equipment for Oval Circuit Unit
To avoid possible ignition through electrostatic charge at all places where a concentrated pentane-air mixture is possible, all relevant parts should be grounded.

The replacement equipment consists mainly of:
30 sets earth connection for foaming jig
18 pcs. contact band for foaming jig
1 pc. contact band for foam filling position
1 set connection wire to the ground

B 8. Inserting Unit
To avoid a flammable atmosphere during the foaming in the casing jig, it is expedient to flood the chamber with nitrogen.

Main assemblies of an inserting unit are:
lifting unit for positioning of the nitrogen injector
nitrogen injector with nitrogen supply, gas quantity measurement and pressure control
electrical control

B 9. Pentane Replacement Equipment for HK 270
For the use of pentane forced foam in the high pressure foaming machine the following equipment is needed. The reason for this lies in the different compatibility of the materials and the special safety requirements resulting from the use of pentane.

Main assemblies of a pentane replacement set for the HK 270

1 pc. replacement equipment for the metering aggregate for the component A faced parts in corrosion-proof design with:
1 pc. metering pump, high capacity, rotary shaft seal and leakage monitoring device
1 pc. leakage monitoring device for the mixing head MQ 8
1 pc. set of fittings for the pre-selection of component A
1 pc. leakage free special filter as replacement for the plate filter used

1 pc. machine tank for the component A consisting mainly of:
1 pc. work tank of stainless steel, size 250 l, operating pressure up to 10 bar, double walled for temperature control, stirrer driven via coupling and motor 50 min1, special fittings

for pentane, pressure control with pressure gauge for dry air or inert gas atmosphere

1 pc. temperature control system
* heating power 5 kW
* cooling power 4 kW at 15 C water entrance temperature and 60 l/min

1 pc. post

filling control with level sensor device

1 set replacement equipment for electrical control with add-on components and software package

1 set replacement equipment for the media and hydraulic tube lines for the tube installation in the area of the gas basin

B 10. Replacement Equipment for the Door Foaming Jig

To avoid possible ignition through electrostatic charge at all places where a concentrated pentane-air mixture is possible, all relevant parts should be grounded.

The replacement equipment consists mainly of:

14 set	ground foaming jig
18 pcs.	contact band for foaming jig
1 pc.	contact band for foam filling position
1 set	connection wire to the ground

B 11. Specification of Extras

Together with the equipment listed below, Liebherr will deliver:

1. Spare parts for one year's operation, including parts lists. To the extent that spare parts are not allowable for funding under the Montreal Protocol Fund, the costs are not included in this application.

2. Technical documentation, where applicable, for machines/equipment.

A. Instruction manual
B. Maintenance advice
C. Electric wiring diagram
D. Lubrication chart
E. Technical specification

3. Technical documentation for safety control and forced ventilation.

a. Description of installation with lay out plans
b. Electric wiring diagram
c. Parts list

4. Safety instructions for cyclopentane foaming in industrial buildings

5. Technical specification for cyclopentane

6. Technical description of the foaming system

7. General safety regulations for use of technical gases in Germany for cyclopentane.

8. Plan and specifications for excavation of the pit for the cyclopentane tank will be submitted through LIEBHERR 4 weeks after effective date of contract.

B 12. Engineering, Know-How, TÜV Inspection

Replacement of CFC-11 by cyclopentane foamblowing agent is an advanced, new technology. The first full-scale implementation in the production process took place in April 1993 at Liebherr, when the company's two factories in Germany and Austria were converted 100% to this new technology. This technical conversion was approved and certified by the German technical surveillance agency TÜV-Südwest, the only organization so far that has certified the conversion of all other German refrigerator manufacturers since April 1993 (altogether more than 5).

Since April 1993 Liebherr has worked without incident and produced nearly 2 million refrigerators/freezers with cyclopentane. In the meantime, Liebherr has acquired experience in commercializing cyclopentane foamblowing technology, which is being steadily improved in day-to-day business.

The present proposal therefore comprises the latest experience in this field. The technical layout and design of the inputs as per item 1.1 have already been checked by the TÜV and are generally approved. Final approval and certification by TÜV experts will take place after installation and commissioning at Qingdao Factory #2. The cyclopentane installation will then be inspected and certified to ensure conformation with all relevant German safety standards.

Liebherr has and will employ all its experience, skills and know-how in the preparation, layout, execution and implementation of this conversion project. This applies for all phases of this project and will be effected by

-training at Liebherr
-technical assistance (training on the job)
-overall technical information and documentation
-specific safety instructions
-permanent approbation and final certification by German TÜV
-certification according to German standards
-information and advice on suitable foam systems with optimized insulation effects.

The prices for engineering, know-how and TÜV inspection are net prices and do not include the actual Chinese withholding tax. This tax should be paid separately by Haier in the name of the seller.

B 13. Installation and Commissioning

Liebherr will execute the installation and commissioning of the inputs as per item 1.1 with the assistance of Haier staff and with provision by Haier of local support.

Haier will provide:

local transport in Qingdao

lunch in the factory on working days
medical care, if necessary

As the installation of the new/additional equipment is to take place without disturbing the daily production, several short-term installation trips will be required. After installation, commissioning and TÜV-certification, both parties will jointly sign a "certification of completion of installation".

B 14. Training

For the proper training of Haier staff at Liebherr's plant in Germany, the buyer will send 2 people for a maximum period of 1 man month in all to Liebherr.

The exact dates will be agreed upon by the parties later.
Haier will either send English speaking personnel or an additional Chinese-German interpreter.

All other conditions of training shall be as per annex of contract 87 MMG 12310 CD.

The training program will possibly include:

-basic knowledge in
cyclopentane
relevant foaming systems
effect of cyclopentane foam on polystyrene

-implementation of cyclopentane and PUR systems in practice for cabinet foaming
-installation for door foaming installation
-safety control systems
-forced exhaust systems
-special training with the TÜV specialist

ANNEX C: OVERVIEW OF INVESTMENT WITH EQUIPMENT SPECIFICATION AND COST BREAKDOWN

C.1. **Cyclopentane-blown foam**

Funding sources: German bilateral, U.S. bilateral, China

Factory conversion (German bilateral contribution)		$1,183,113
Equipment, fittings, and safety controls	811,713	
Engineering (including TüV inspection)	200,000	
Installation and training	171,400	
GTZ Overhead (German bilateral contribution)		$153,805
Local costs borne by China side		$286,080
CP conveying devise (4 sets)	31,200	
CP premix room construction	36,000	
Foaming line adjustments	62,400	
CP storage area construction	120,000	
Installation and adjustments	24,000	
Miscellaneous	12,480	
U.S. bilateral support		$333,890
Tooling for optimized components (Haier)	116,537	
Design and testing support	23,400	
Expert review	12,600	
Project implementation*	126,000	
Gas chromatograph	25,000	
Contingency (10%)	30,354	
Total cost, cyclopentane		**$1,956,888**
Contribution by China	286,080	
Total MPF funding request, cyclopentane		**$1,670,808**
German bilateral funding	1,336,918	
U.S. bilateral funding	333,890	

*Project implementation in this and subsequent tables includes logistical support, procurement support, translation and interpretation, data gathering and reporting, verification of results, financial recordkeeping, and communications.

C.2. Isobutane

Funding sources: U.S. bilateral, China

Isobutane factory conversion (U.S. bilateral)		$573,233
Vacuum stand (2x)	136,067	
Filling stand	86,893	
Pressure booster	20,960	
Ultrasonic welding	53,820	
Leak detection	36,293	
Safety control for final assembly	132,333	
After-sales service	2,200	
Packing	4,000	
C + F	4,000	
Engineering (including TüV)	26,667	
Installation personnel (Liebherr staff, 65 person-days)	43,333	
International airfare	23,333	
Installation personnel in Qingdao (100 person days)	3,333	
U.S. bilateral support		$392,068
Design and testing (China/U.S.)	35,925	
UL safety testing	45,000	
Compressor calorimeter	55,000	
Materials	75,000	
Expert review	12,600	
Design support	6,900	
Project implementation	126,000	
Contingency (10%)	35,643	

C.2. **Isobutane (continued)**

Local costs (paid by China)		$182,760
Piping and containers	31,200	
Safety storage area construction	48,000	
Assembly line modifications	60,000	
Vacuum filling and welding segregation	12,000	
Installation and adjustments	24,000	
Miscellaneous	7,560	
Total project cost, isobutane		**$1,148,061**
MPF funding request (U.S. bilateral), isobutane		**$965,301**

C.3. **Model redesign/prototype production and testing**

Funding sources: U.S. bilateral, China

Local costs (borne by China) prototype production and testing in China		$31,160
U.S. bilateral support		$344,674
Prototype design and laboratory testing in China and U.S.	103,340	
Materials and shipping	15,000	
Project implementation	170,000	
Field testing	25,000	
Contingency (10%)	31,334	
Total project cost, model redesign		**$375,834**
MPF funding request (U.S. bilateral), model redesign		**$344,674**

C.4. Total project costs

Funding sources: U.S. bilateral, German bilateral, China

Cyclopentane component		$1,956,888
MPF funding request -- German bilateral contribution	1,336,918	
MPF funding request -- U.S. bilateral contribution	333,890	
China contribution	286,080	

Isobutane component		$1,148,061
U.S. bilateral contribution	965,301	
China contribution	182,760	

Model redesign/Prototype production and testing		$ 375,834
U.S. bilateral contribution	344,674	
China contribution	31,160	

Total project cost		**$3,480,783**
China contribution	500,000	
Total MPF funding request		**$2,980,783**
MPF funding request -- German bilateral contribution	1,336,918	
MPF funding request -- U.S. bilateral contribution	1,643,865	

ANNEX D: CALCULATION OF UNIT ABATEMENT COST:

A	ODS Phase-out		
A1	CFC reduction	MT	203*
A2	ODP of CFC 11 & 12		1
A3	ODP-weighted reduction		203
A4	Total ODP-weighted reduction		
B	Annualized capital cost		
B1	Total MPF funding requested		$2,980,783
B2	Equipment life (years)		10
B3	Discount rate		10.00%
B4	Annualized capital cost (B1 x 0.1627)		$484,973
D	Unit Abatement Cost		
D1	Annualized capital cost per kg ODS phased out (B4/(A4 x 1000))		$2.39
D3	Unit Abatement Cost		$2.39

*Calculation of CFC Reduction:

Kilograms CFC consumption per unit and total (Annual output = 220,000)
BCD 220 (Source: Haier)

	Per unit	Total
CFC-11	.790	173,800
CFC-12	.130	28,600
Total	.920	202,400
Servicing		220
Total		202,620

Dr. John H. Oxley
Consulting Engineer

D-29227 CELLE

TECHNICAL REVIEW

1. Country of Origin — Peoples' Republic of China

2. Project Title: — Stage 1b - Field Testing and Stage 2 - changeover of Foam Blowing Agent to Cyclopentane and Refrigerant Cycle to Isobutane in One Factory.

3. Sector/subsector: — Domestic Refrigeration

4. Introduction

The reviewer has already prepared a Technical Review of Stage 2 of this project proposal, which was to be presented separately to the Multilateral Fund under the title:

"Investment Project for Phasing out CFCs at Haier S.A., Quingdao," Date: 26 Oct 1994

This review which which will be referred to as Technical Review No.1, considered the factory conversion part of the present project and is attached. There is no substantial reason for modifying it, except to note that:

- the previous proposal provided for supplying the design of one refrigerator model only.

- the ODP phase out was estimated to be 163.22 metric tons, whereas it should have been 203 metric tons. This means that the original proposal was even more cost effective than estimated.

The present project proposal incorporates, in addition to the factory changeover, the joint USEPA/Chinese development optimisation and testing of new models of CFC free refrigerators as well training so that the Chinese will be able to independently design CFC free refrigerators required for phasing out the use of CFCs in the remainder of their domestic refrigeration industry. When it is realised that, though it is the second largest refrigerator factory in China, Haier only has 6% of the market and that the one refrigerator model design to be provided by Liebherr (the German refrigerator manufacturer, which is co-operating with the USEPA and the GTZ) is only part of Haier's production range, then the potential impact of this part of the project is most important.

5 Relationship to Country Programme

According to Chapter 2.1 of the project proposal the consumption of ODP in China is over 60,000 tons per year, which is considerably higher than quoted in the Country Programme. There is thus an urgent need for phasing out the use of CFCs in China and motivating the Government of the Peoples' Republic to support this.

It is clear that the activities financed by the USEPA as part of the first phase of this project, which was approved in 1993 have had an effect on the strategy of the country with regard to the sector, in particular with regard to the desireability of using cyclopentane blowing and isobutane as refrigerant. It is understood that the potential for energy savings, which the use of isobutane refrigeration circuits and model redesigns should provide is of great importance to the Government and is likely to be an important motivating factor for converting the remainder of the domestic refrigeration industry. As one of the reasons for the good cost effectiveness of the plant conversion described in this proposal is the fact that in China it is possible to carry out modifications, such as those on the jigs and plugs relatively cheaply locally in China, with minimal foreign intervention, this motivation is important.

6. Technology

The technology to be used is the same as that considered in the original proposal. See attached Technical Review No.1, para 5.

7. a) Both cyclopentane and isobutane have zero ODP.

b) The potential contribution of Phase 1 of the project to energy savings should have a very positive environmental impact in a country, which is plagued by pollution resulting from electricity production, often using low grade coal.

8. Project Costs

a) Cost of Equipment, b) Start-up/Commissioning cost,

See Technical Review no.1 paras 7 a), and 7 b).

c) Operating costs

The 10% of capital costs (US$ 174,835) foreseen in the original proposal to assist Haier during the production of the first new CFC free refrigerator model have been eliminated.

d) Other Costs

- The factory conversion does not include contingencies.
- Phase 1b US bilateral includes a 10 % contingency equal to a total of US$ 65,997
- Phase 1b US bilateral provides fo US $422,000 for project implementation. The reviewer has not been able to obtain a breakdown of how this money will be spent and therefore oan not comment.

e) Cost Effectiveness

The cost effectiveness of the factory conversion measured as conversion cost to be funded by the Multilateral Fund divided by annual kg of ODP to be phased out is US$ 9.4 per kg, which is exceptionally good for the sector. The cost effectiveness for the overall project, including the already approved Phase 1a is still good low (US$ 16.4/kg), particularly when the non-quantifiable benefits to the country's phase out programme are considered.

f) Implementation Time

The reviewers previous remarks, that the implementation time for the factory conversion are remarkably short, but nevertheless realistic, still hold good.

However, the reviewer is sceptical about the following:

- having prtotypes designed and tested in time for start-up of converted plant.

- determining within the time frame of the project the quality of cyclopentane and isobutane required, particularly if it is hoped that it will be possible to use products of lower purity than is presently being done in Europe.

- determining within the time frame of the project the amount of foam and cyclopentane per cabinet, particularly if this is to be less than currently used by European manufacturers.

These objections are, however, not serious, if the first model to be produced in the converted plant uses a Liebherr design and Liebherr technology, and the work of this part of the project is oriented towards the design and optimisation of future models.

9. Recommendations

In spite of reservations both in this and in Review No.1 it is recommended that the project be approved, PROVIDED IT IS CLEAR THAT THE FIRST MODEL TO BE BUILT WILL BE OF LIEBHERR DESIGN AND THAT THE WORK OF PHASE 1b BE ORIENTED TO ASSISTING THE CHINESE GOVERNMENT DEVELOP FUTURE MODELS BASED ON THE INDUSTIAL SCALE TECHNOLOGY TRANSFERRED DURING THE PROJECT AND THUS ACCELERATE THE PEOPLES' REPUBLIC OF CHINA PHASE OUT PROGRAMME.

Date 30/JAN/1995

John H. Oxley.

Dr. John H. Oxley
Consulting Engineer

D-29227 CELLE

TECHNICAL REVIEW

1. Country of Origin — Peoples' Republic of China

2. Project Title: — Investment Project for Phasing out CFCs at Haier S.A., Quingdao,
Date: 26 Oct 1994

3. Sector/subsector: — Domestic Refrigeration

4. Relationship to Country Programme

   a) Not known

   b) The precise strategy of the country with regards to the sector is not known to the reviewer. However, a part of the country's stategy is clearly to convert at least part of the domestic refrigeration sector to the use of hydrocarbons including the use of iso-butane as refrigerant. To support this the country is also planning to convert a compressor manufacturer so that it can produce iso-butane compressors.

5. Technology

   a) Cyclopentane foaming and the use of iso-butane as refrigerant are more hazardous than other available alternatives. However, the project proposal is based on a well known company, Liebherr, which has experience of using this technology in its own refrigerator manufacturing plants, taking responsibility for providing know-how engineering services, assistance during erection and start-up, and training. Furthermore the official German organisation responsible for approving that technology and plants are safe, namely the TUV will also check that this plant will meet German safety regulations and requirements.

   b) The technology involved is not transitional as both cyclopentane and iso-butane have zero ODP.

   c) The technology presently used in the plant was supplied in 1988 by Liebherr, which since then has maintained close co-operation with the counterpart. This is also most probably a factor, which contributes to the good cost effectiveness of the project.

The chinese government has considered the use of other technologies for the refrigeration sector. However, for this proposal niether the GTZ nor Liebherr have judged it necessary to consider other technology, as the plant is sufficiently well run to be able to cope with the type of technology proposed.

The technology is cost effective, and will enable the plant to be converted without loss of product quality.

6. Environmental Impact

a) Both cyclopentane and iso-butane have zero ODP.

7. Project Costs

a) Cost of Equipment

i For the foaming part, the proposal does not include an equipment cost break down in sufficient detail, to permit an item by item appraisal of equipment costs. The reviewer has therefore independantly calculated what the total equipment costs should be based on unit prices quoted in project documents already approved by the Multilateral Fund, and finds that this calculated total of equipment costs is signficantly higher than the one quoted in this proposal. The equipment costs can therefore be considered as being very reasonable.

ii For the refrigeration system, it should be noted that this is the first proposal presented to the Multilateral Fund, which is based on the use of iso-butane, which is inflammable and explosive. There is therefore no comparble cost data in documentation available from the Fund for comparison. However, when comparing with multiple explosion proof vacuum pumps, the solution chosen of having two large ones appears to be cost effective. The price of the filling stand is comparable with other information available to the reviewer.

iii The question of salvage value of scrapped equipment has not been addressed. The only items, which it might be possible to reuse elsewhere are the existing vacuum pumps, which are already virtually amortised and do not represent much money. Also it should be born in mind that the counterpart is contributing circa US $ 500,000, which is far in excess of the possible scrap value of some vacuum pumps, whic are almost ten years old.

b) Start-up/commissioning cost

These costs would appear reasonable. It should be noted that training is most important, when transfering technology based on the use of inflammable or explosive substances.

c) Operating costs

Incremental operating costs equal to 10 % of the capital costs are being claimed. This is the approach suggested by the World Bank. In this case as the capital costs are low for the size of plant and the ODP to be phased out, the approach is cost effective.

d) Other costs

It should be noted that the proposal is based on a firm quotation and does not include contingencies.

e) Cost Effectiveness

The cost effectiveness measured as total Project cost to be funded by the Multilateral Fund divided by annual kg of ODP to be phased out is US $ 16/kg ODP. This is very good indeed for the domestic refrigeration sector.

f) Implementation Time

The implementation time is remarkably short indeed. It is probably only feasible because of:

- the close relationship between Liebherr and Haier,
- the fact that Liebherr appears to have already closely studied the plant, and uses similar technology in its own plants.

g) Recommendations

In spite of the reservations regarding scrapped equipment, it is recommended that the project be approved as proposed, bearing in mind the cost effectivenes, and the contribution by the counterpart.

November 7th 1994 John H. Oxley.

ANNEX II

This annex includes a request from the United States of America for 1995 funding.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

30 January 1995

Dr. Omar El-Arini
Chief Officer
Multilateral Fund for the Implementation
of the Montreal Protocol

OFFICE OF
AIR AND RADIATION

Dear Dr. El-Arini,

Attached please find a request for Executive Committee approval of funding for new bilateral activities, and an update of the status of on-going bilateral projects that were previously approved by the Executive Committee.

With regard to the new funding requests, the United States is asking that the funds approved for these projects be offset against our outstanding contributions to the Fund. These new project proposals are being submitted in accordance with the Montreal Protocol and Multilateral Fund guidance concerning bilateral projects. This guidance allows Article 2 countries to offset up to 20% of their contribution for bilateral projects. Accordingly, approval of these projects would in no way diminish the level of resources currently available in the Fund to finance other worthy projects. Instead, immediate use of the allowable bilateral offset will serve as an addition to the Fund's resources otherwise available for approval of projects at the 16th meeting. As required, the proposals cover only agreed incremental costs for activities that strictly relate to compliance with the provisions of the Protocol. The total bilateral offset that is being requested by the U.S. projects being submitted to this meeting is well below the 20% threshold for bilateral activities that was approved by the Protocol Parties. The countries involved have given their approval for the US to count these expenditures against our Fund contributions.

We appreciate the opportunity to provide an update on the status of our bilateral activities, and we look forward to the review and approval of our new bilateral activities at the 16th Meeting of the Executive Committee. We would be pleased to respond to any questions that the Secretariat or members of the Executive Committee may have on any of these activities.

Sincerely,

Paul S. Horwitz

Summary of New Spending

Country	Project Description	Amount
Argentina	MACs Servicing Demonstration	US $ 170,000
China	Commercial Refrigeration Project Preparation	US $ 39,000
China	MACs Servicing Demonstration	US $ 172,500
China	Halon Leak Reduction Demonstration	US $ 142,437
Total requested against 1995 contributions		US $ 523,437
China	Domestic Refrigeration Project	US $1,643,865
Total requested against 1994 contributions		US $1,643,865
TOTAL REQUEST		US $2,167,802

PROJECT OUTLINE

Country:	Republica Argentina
Project Title:	Demonstration (MACs)
Sector Covered:	Refrigeration (MACs)
Sector ODS Consumption:	New Equipment: 200 Metric Tons; Servicing: 461MT
Incremental Cost:	US$170,000 (US bilateral, plus Global MACs project funding, primarily for equipment)
Bilateral Agency:	US EPA
National Coordinating Agency:	OPROZ (Ozone Office Program)/INTI (National Institute of Industrial Technology
Duration:	1995-1996

Description

US EPA and Argentina's Ozone Program Office (OPROZ) propose to design and implement an initial activity to reduce the use of CFC-12 in MACs servicing in Argentina. This activity, to be completed over approximately the next 12 months, will begin with data gathering and analysis. Based on this and discussions with OPROZ, further activities may include:

- A pilot project to introduce recycling such as a demonstration MACs recycling and training workshop;
- Training on practices to reduce CFC-12 used in MACs servicing;
- Furnishing recycling machines and related equipment to participating repair shops (to be funded by the UNDP Global MACs project);
- Followup data collection and preparation of a report to document the experience of Argentine repair shops with MACs recycling;
- Training on HFC 134a equipment;
- Working with OPROZ, in the course of implementing the demonstration project, to explore the possibility of further reduction measures that could be taken in the MACs sector.

The proposed project will incorporate the lessons learned during the preparation and implementation of the Mexico and Venezuela MACs demonstration projects, which are being conducted with UNDP, INE (Mexico), and FONDOIN (Venezuela). The Argentina project may include expanded participation by bus servicing facilities as well as refrigerated transport and the fishing fleet if, during project preparation, they are determined to be cost effective.

The proposed project would be supported by US bilateral assistance to Argentina and the UNDP Global MACs project (this request does not include Global MACs project expenditures, primarily for equipment).

Discussion:

US EPA and Argentina's OPROZ believe that MACs recycling and refrigerant containment represent an important opportunity to reduce CFC-12 emissions cost-effectively in Argentina, while at the same time reducing the impact of the CFC phase-out on automobile owners and others.

US EPA has found that the rapidly growing use of HFC-134a as well as "drop-in" replacements for CFC-12 present urgent issues, such as safety, leak detection, and risks of cross-contamination. These should be addressed as soon as possible. In our work in Mexico and Venezuela, we have found MACs repair shops to be very interested in obtaining more information about these matters. We anticipate that our initial data gathering in Argentina will support these findings and will also lead to the development of specific activities appropriate for the Argentine MACs sector.

The guiding principle of the project is to achieve cost-effective emission reductions in Argentina and to gather critical information to support possible future MACs sector work in Argentina. The project will strive, where possible, to use the materials developed for Mexico and Venezuela, taking into account that equipment and training needs vary from country to country.

Follow-on activities:

Follow-on activities will depend on the opportunities for cost-effective emissions reductions identified during this project and on the priorities of Argentina's OPROZ. Based on the experience gained in this project, it may be useful to expand the use of CFC-12 recycling equipment and other refrigerant conservation strategies throughout the MACs servicing sector, including buses, refrigerated transport and the fishing fleet, as well as automobiles.

PROJECT PROPOSAL

COUNTRY:	CHINA
PROJECT TITLE:	Project Preparation
SECTOR COVERED:	Commercial Refrigeration
SECTOR ODS CONSUMPTION:	7,500 MT/yr of CFC-12 (1991 est.)
INCREMENTAL COST:	$39,000
BILATERAL AGENCY:	USEPA
NATIONAL COORDINATING AGENCIES:	NEPA & Ministry of Internal Trade (MIT)
DURATION:	1995

Description:

At a series of meetings in April 1994, EPA and MIT discussed ongoing activities in China to address CFC phaseout, specificly in the rapidly growing commercial refrigeration sector. In followup meetings in November 1994, EPA and MIT discussed the progress in China's development of its commercial refrigeration sector strategy and possible projects for achieving reduction in CFC emissions and eliminating its use. This work was initiated with the aims of preparing project applications for submission to the Executive Committee. Activities include identifying the subsector of ODS users, collection of current information on the sector, and planning and preparation of project proposals.

PROJECT PROPOSAL

COUNTRY:	CHINA
PROJECT TITLE:	Demonstration Project
SECTOR COVERED:	Refrigeration (MACs Servicing)
SECTOR ODS CONSUMPTION:	540 MT (1991 est.)
INCREMENTAL COST:	$172,500
BILATERAL AGENCY:	USEPA
NATIONAL COORDINATING AGENCIES:	NATIONAL ENVIRONMENTAL PROTECTION AGENCY(NEPA) & MINISTRY OF MACHINERY INDUSTRY(MMI)
DURATION:	1995

Description:

US EPA proposes to cooperate with NEPA and MMI in the implementation of China's pilot project to reduce CFC-12 emissions from mobile air conditioning units. EPA's proposed program of activities includes coordination with UNDP under the Global MACs Project.

EPA has found in its work in Colombia, Mexico, the U.S., and Venezuela, that the MACs servicing sector varies substantially among countries. Therefore, it is very difficult to accurately predict emissions reductions for a demonstration project. However, we expect reduction of from 5 to 10 tons/year and would await an assessment of the cost-effectiveness of results before proposing further work in this area. Moreover, it seems likely , in our judgement, that the sector ODS consumption may now be considerably more than the 1991 Country Program estimate.

EPA's activities will include the following:

- assisting MMI to recruit automobile repair shops to receive training and equipment
- assisting UNDP with equipment procurement, including developing equipment specifications
- with MMI, conduct training workshops in China, including curriculum development, development of training materials, translation of materials, interpretation during workshops, coordinating workshop instructors and coordinating workshop sessions

- working with MMI, in the course of implementing the demonstration project, to explore the possibility of further reduction measures that could be taken in the MACs sector

- providing other technical support to MMI

- evaluation visits to repair shops after the provision of training and equipment

- preparation of a report to document the experience of the repair shops with MACs recycling

Estimated cost for equipment and related expenses are estimated to be $80,000-$100,000. Funding for this component will be provided through the UNDP Global MACs Project.

Follow-on activities:

Follow-on activities will depend on the opportunities for cost-effective emissions reductions identified during this project and on the priorities of MMI.

PROJECT PROPOSAL

COUNTRY:	CHINA
PROJECT TITLE:	Demonstration Project to Reduce Leakage during the Production of Halon 1211 & Halon 1211 Fire Extinguishers
SECTOR COVERED:	Halon 1211
SECTOR ODS CONSUMPTION:	4,000 MT/year (1991)
INCREMENTAL COST:	$142,437
BILATERAL AGENCY:	USEPA
NATIONAL COORDINATING AGENCIES:	NEPA & MINISTRY OF PUBLIC SECURITY (MPS)
DURATION:	1995

Description:

US EPA proposes to cooperate with MPS to demonstrate cost-effective modifications for factories to reduce unnecessary halon emissions. Leakage during the production of virgin halon 1211 and the manufacture of halon 1211 containing equipment constitutes a major source of unnecessary halon emissions in China. Halon 1211 producers can leak as much as 3.5 percent during production operations, and manufacturers of halon 1211 portable extinguishers can leak up to 3 percent of their total halon use each year. Most leakage is attributed to the poor quality rubber seals and hoses that are used to transport halon in the enterprise. China has indicated that it will not increase halon production.

The halon leak reduction project addresses emissions reductions at a halon production factory and a halon extinguisher production factory. The two sites selected for the project are the Foshan Electrochemical General Factory and the Panyu Yushan Fire Equipment Factory. The results of this project will be used to demonstrate the potential benefits of reducing halon emissions to other facilities. However, the requested project budget will only fund full changeover of seals and hosing at the above two sites.

EPA's activities will include the following:

- assisting UNDP with equipment procurement, including developing equipment specifications with the U.S. Navy
- with MPS, Navy, and participating factories, conduct training workshop in China to

demonstrate cost-effective halon emissions reductions to other factories; activities include curriculum development, development of training materials, translation of materials, interpretation during workshops, coordinating workshop instructors and coordinating workshop sessions

- providing technical support to MPS, Navy, and the participating factories
- providing other technical support to the participating sites upon delivery and installation of equipment
- preparation of a report to document the experience of the factories in reducing halon emissions

The above project cost includes equipment and related expenses, which are estimated to be $52,000.

Follow-on activities:

Follow-on activities will depend on the opportunities for cost-effective emissions reductions identified during this project and on the priorities of MPS.

ANNEX III

This annex includes a status report on bilateral activities from the United States of America.

EPA

O_3 PARTNERSHIPS

Progress Report on the Demonstration Network of Halon 1211 Recovery/Recharge Machines in China

January 30, 1995

Progress Report on the Demonstration Network of Halon 1211 Recovery/recharge Machines in China

I. Summary

In March 1994, EPA received approval from the Executive Committee to further support China's program to establish an initial demonstration network of halon 1211 recovery/recharge machines. This approved project built on the earlier program which was reported to the Executive Committee in the Sept. 1993 bilateral report. The information on machine operation in this report relates to both projects.

EPA, in cooperation with the U.S. Navy, ordered and shipped an initial set of 23 machines to China in August 1993. An additional 127 units and spare parts kits were ordered under this current project; the last shipment of 40 machines and spare parts kits was delivered to China in mid-December 1994. In support of the project, UNDP locally procured 127 air compressors to operate the machines. EPA and the Navy conducted follow-up technical support and evaluation visits with machine operators August-November 1994 to the factories and service shops that had received the machines.

Four workshops were developed and conducted in China under this program. A total of 181 Chinese fire protection experts have been trained: 42 experts were trained in Beijing (April 1993), 52 were trained in Hangzhou (Sept. 1993), 34 were trained in Guangzhou (Sept. 1993), and 53 were trained at the Oct. workshop in Nanjing. With each workshop, responsibility shifted progressively to MPS which took complete responsibility for organizing the final workshop.

With the 23 machines that were delivered for the three training workshops held in 1993, China has an initial network of 150 units. 70 machines are operating in halon and extinguisher factories and in fire equipment service shops in the main cities of Beijing, Tianjin, and Shanghai, and in 15 provinces throughout China. MPS has distributed another 23 machines in 13 additional provinces; exact locations were not available at the time this report was developed. MPS is working to place the remaining machines, including those that arrived in China this past December, by early 1995.

II. Locations of machines

The locations for the machines is listed as an attachment to this report. For the 70 machines in operation, 3 are in halon 1211 production plants, 25 are in halon 1211 equipment factories, and 42 are in fire protection equipment service shops.

The initial 23 machines that were provided to China during the three 1993 workshops were placed relatively quickly in facilities in and around the three training cities (Beijing,

Hangzhou, and Guangzhou). They were placed in each of the three types of halon facilities: halon production plants, equipment factories, and service shops.

The results from these initial placement of machines were generally good. While many of the machines were used actively, others in the initial batch encountered minor difficulties with ancillary equipment, which was to be expected. EPA, the Navy, and FRC International, the manufacturer of the recovery/recharge machines, worked with MPS to resolve these difficulties as quickly as possible. Often these initial problems involved slight misunderstandings by the machine operators on aspects of machine operation.

The initial three machines delivered for training purposes were supplied with U.S.-built air compressors to assure compatibility with the recovery/recharge machines. However, the remaining recovery/recharge machines were supplied with Chinese-built compressors which proved to work successfully, were more compatible with the Chinese electrical supply, were cheaper, and had lower shipping costs.

In addition to the problems with equipment, the recycling program had to overcome some resistance from the operators and often from the receiving facility. Recycling and the operation of the machine were new concepts and completely unfamiliar operations to the majority of factories. In the past, all excess halon remaining in tanks and extinguishers would be vented -- a very quick, uncomplicated task. The machine was a new, unfamiliar component in existing facility operations and introduced additional tasks.

As facilities increased their familiarity with recycling and the use of the machines, MPS was able to make final decisions on which facilities would keep machines on a long-term basis, based on each facility's needs and operational constraints. Several machines were redeployed to other recipients.

The initial deployment of machines served to familiarize MPS as well as the actual operators with how to make the best use of the machines. Although it slowed machine distribution to have to re-evaluate machine use by various facilities, MPS assumed responsibility for ensuring that the demonstration network for recycling in China would actually produce results. This evaluation is an ongoing process, but experience to date demonstrates that the service shops have been able to make the most significant use of the machines. This is reflected in the fact that about 60% of the machines in operation can be found in service shops.

IV. Summary of ODS reductions

The 70 machines that are now in operation are recovering an estimated 38.2 MT/yr of halon 1211. On this basis, it is estimated that when the 127 machines are fully deployed, 69.3 MT/yr (207.9 MT/yr ODP-weighted) of halon 1211 would be recovered in its initial year. However, future use of the machines is expected to rise as familiarity increases and

halon phaseout activities make halon more scarce. Based on the first year of experience, the one-year cost-effectiveness is estimated at US$4.71 per kilogram (ODP-weighted) based on a total project cost of US$980,000 which includes the US$155,000 that UNDP used to locally procure air compressors.

Halon production facilities:

Halon 1211 production in China is concentrated in Zhejiang, Guangdong, and Shandong Provinces. In 1993, China has 15 enterprises with a total of 30 halon 1211 production lines. Actual production for 1993 is reported as approximately 4,000 tons. In 1994, production was approximately 4,887 metric tons. Estimated unconstrained growth in this sector is 15 percent until the year 2000 and 10 percent thereafter. The halon produced is used in the following applications:

70% - handheld and pushcart extinguishers
15% - fixed systems
15% - repair and servicing

Only one factory produces halon 1301. Its annual production capacity is 50 tons; the amount actually produced in 1993 was 50 tons. All halon 1301 produced goes into fixed systems.

As part of the halon recycling demonstration program in China, three halon 1211 production facilities received machines. These are listed below along with their annual production capacity:

Shougang Fire Extinguishant Factory	800 MT
Foshan Electrochemical General Factory	800 MT
Xiaoshan Fire Protection Chemical Factory	500 MT

MPS reported that many of the factories operate significantly below their production capacity.

The machines operating in these facilities are mainly used to recover halon from large tanks (700 kg and 1 MT capacity). The schedule of machine use varies greatly among the different facilities. Some were very active in their recycling efforts and others had a more sporadic schedule for machine use.

For a typical production facility making regular use of the machine, monthly halon recovery is reported at about 200 kg with an annual recovery of 2,400 kg. With the selling price of halon 1211 at 24 renminbi(RMB)/kg, the annual savings to the facility would be 57,600 RMB per year (approximately $6,900 USD/yr).

The associated costs to the facility include labor (a machine operator's wage runs about 700 RMB/mo.) and electricity (0.6 RMB/kwh; 7kwh is needed to run the machine). Operators spend about 45 minutes recovering halon from the 700kg and one hour recovering from the 1MT tank. With machine use at about 20 hours per month and 240 hours per year, total annual costs for recovery are about 875 RMB (US$105) for labor and 1,080 RMB (US$130) for electricity. Net annual savings for an active production facility as part of this demonstration network would be 55,645 RMB (US$6,151).

With active recycling by the three production facilities, 7.2 MT of halon 1211 would be recovered annually.

Fire extinguishing equipment manufacturers:

There are 80 factories that produce all types of extinguishers (1kg, 2kg, 3kg, 4kg, 6kg, and 25kg). Annual production capacity is 2.2 million units; actual 1993 production is 1.4 million units. In 1994, production was 1.6 million units.

There are 25 factories that manufacture fixed systems. They consume approximately 600 tons of halon 1211 per year and all of the halon 1301 produced.

As part of the halon recycling demonstration program in China, 25 halon extinguisher and fire equipment manufacturing facilities received machines. The facilities report using the machines during equipment servicing to recover halon 1211 remaining in extinguishers and from large tanks and to refill new extinguishers. One facility in Hangzhou reported using the machines during servicing, maintenance, and testing. The leaking extinguishers are removed from the production line and the halon is then recovered.

In comparison to the production facilities, the equipment manufacturers report more variation in their utilization of the machines. In the fire equipment factories, some facilities have cited that time is a significant constraint to active recycling and use of the machines. These facilities often have very high volume of extinguishers to be manufactured and serviced -- up to 2,000 to 3,000 extinguishers may be serviced during a peak month. The time necessary to recover the halon from individual extinguishers is cited as prohibitive to factory operation and income. However, other factories have reported that their use of the recovery/recharge machines was purely economic; during peak times where they can go through 80-90 large tanks in a month, recovery is worth the effort.

For a typical equipment manufacturing facility making regular use of the machine, monthly halon recovery is reported at about 40 kg with an annual recovery of 480 kg. With the selling price of halon 1211 at 24 renminbi(RMB)/kg, the annual savings to the facility would be 11,520 RMB per year (approximately $1,380 USD/yr). The associated costs to the facility include labor (700 RMB/mo.) and electricity (0.6 RMB/kw). With machine use at about 6 hours per month and 72 hours per year, total annual costs for recovery are about 175

RMB (US$21) for labor and 324 RMB (US$39) for electricity. Net annual savings for an active equipment manufacturing facility as part of this demonstration network would be 11,021 RMB (US$1,320).

With active recycling by the 25 equipment manufacturing facilities, 12 MT of halon 1211 could be recovered annually.

Repair/service centers:

900 repair/service centers consume approximately 600 tons of halon per year. These facilities service an estimated total of 400,000 extinguishers (1kg to 25 kg sizes) per year. A typical shop may service about 2,000 extinguishers, of which about 500 are halon extinguishers. In addition, some of these shops are extensions of and support the operations of the bigger fire equipment factories.

As part of the halon recycling demonstration program in China, 42 fire protection equipment service shops received machines. The facilities report using the machines to recover halon from extinguishers during servicing and for transferring the halon to larger tanks which are used for storage and refilling the refurbished canisters. Operation of the machines is done for a couple of hours a day, several days a week.

The service shops have reported more frequent use of the machines than either of the other types of facilities. They are not as concerned with overhead production costs and time constraints as in the production facilities above. One shop in Beijing did report spending approximately 3,000 RMB (US$360) to upgrade its electrical wiring and to buy a scale for its recycling operations. The service shops are using the machines to reduce unnecessary emissions and improve their savings. For them, recycling and using the machines are good business practices especially when, as another service shop in Beijing reported, the shop can still charge their customers the same repair price as before they received the machine.

For a typical equipment service shop making regular use of the machine, monthly halon recovery is reported at about 37 kg with an annual recovery of 444 kg. With the selling price of halon 1211 at 24 renminbi(RMB)/kg, the annual savings to the facility would be 10,656 RMB per year (approximately $1,280 USD/yr). The associated costs to the facility include labor (700 RMB/mo.) and electricity (0.6 RMB/kw). With machine use at about 24 hours per month and 288 hours per year, total annual costs for recovery are about 1,050 RMB (US$126) for labor and 1,296 RMB (US$156) for electricity. Net annual savings for an active equipment servicing shops as part of this demonstration network would be 8,310 RMB (US$1,000).

With active recycling by the 42 equipment service shops, 19 MT of halon 1211 could be recovered annually.

V. Observations

The following are general impressions and information that have been conveyed by the machine operators, facility owners, and MPS regarding the halon 1211 recycling demonstration program.

- MPS reported that overall the machines were being used well. There have been some mechanical problems with some units, and what MPS thinks are misunderstandings about how to operate a few others, but overall they are being used satisfactorily.

- In servicing shops and extinguisher factories, the amount of halon recovered from shipping containers is often more significant than that recovered from the extinguishers.

- In extinguisher factories, the machines are mainly used when repairing leaking or defective extinguishers to help recover the halon as well as reduce emissions from small portable extinguishers. The machines are also used to recover vapor heels from larger tanks.

- In selecting machine sites, MPS has been concerned with utilization and recordkeeping; machines are allocated to these organizations that can use them most effectively and are willing to maintain records.

- MPS reports that while factories are more aware now of the ozone issue, they continue to be more driven by savings in costs.

- MPS noted that end-users will often vent the halon before returning the extinguisher to the service shops for maintenance; MPS is taking steps to educate users that this practice is unnecessary.

- MPS noted that the workshops have been good for publicizing the issue of halon phaseout. MPS has received more requests for information about halon alternatives and plant closures and attributes this increase to the workshops.

- Storage, production, and shipping areas are all plagued with leaks. All leaks represent unnecessary halon emissions.

- Many people were confused regarding the cost of electricity needed to run the machines and the value of the recovered halon. Future projects need to make the business case during the workshops. In the final workshop held in Oct. 1994, Chinese facilities who were already operating machines made presentations to address this issue.

VI. Lessons learned

This demonstration project has been extremely effective in introducing conservation and recycling measures to the manufacturing and servicing component of the halon sector in China. The training workshops provided a forum to link global efforts on halon phaseout with MPS's own efforts to begin addressing the growing problem in China. In addition, the workshops have been recognized by the Chinese participants, by other agencies and technical experts as being one of the first tangible activities, and the machines as tangible evidence of technical support and funding, in the country to reach significant numbers of affected end-users of ODSs.

In planning the project, EPA and the Navy had anticipated some time for the Chinese operators to adopt recycling and the machines. While this proved to be the case, considering that China until very recently has actively nurtured and promoted its halon industry, it is understandable that factories running financially successful operations expressed significant resistance to change. Future activities should more aggressively persuade machine operators of the compelling business reasons to recover and recycle halon.

Through recycling, MPS and the factories have taken the initiative to identify other areas to reduce unnecessary halon emissions and to save costs. Factories have examined equipment such as storage tanks, production lines, filling and shipping areas to see where improvements in seals, hosing, and operation could reduce the amounts of halon lost to leakage.

Addressing the large number of end-users as this project did has provided MPS with a stronger basis to develop and implement much needed policy and regulations regarding halon production and use. With educated end-users and the support of its provincial fire bureaus, MPS has initiated measures such as a ban on non-essential halon use and development of its sector strategy to phase out halons.

Attachment

List of Halon 1211 Recovery/Recharge Machine Recipients

FACILITY	TYPE	NO.MACHINES
Beijing:		
Beijing Dahongmen Fire Equipment Factory	E	1
Beijing Guangwai Fire Equipment Factory	S	1
Longtan Fire Equipment Factory	S	1
Chaoyang Anzhen Fire Equipment Repair Factory	S	1
Hua'an Fire Equipment Factory	E	1
Beijing Xinghua Fire Equipment Factory	E	1
Tianjin:		
Tianjin Fire Equipment General Factory	E	1
Tianjin Jianshan Fire Equipment Factory	E	1
Taiwanlu Primary School Fire Equipment Service Factory	S	1
Tianjin Xiaohaidi Fire Equipment Service Factory	S	1
Tianjin Hongqiao Fire Equipment Service Factory	S	1
Shandong Province:		
Shouguang Fire Extinguishant Factory	P	1
Yantai Fire Protection Water Supply Equipment Factory	E	1
Weifang Yanhua Fire Equipment Factory	E	1
Qingdao Loushan Fire Equipment Factory	S	1
Jiangsu Province:		
Nanjing Fire Equipment Repair Factory	S	1
Nanjing Heli Fire Equipment Factory	E	1
Nanjing Jiangpu Fire Equipment Factory	E	1
Nanjing Fire Equipment Factory	E	1
Changzhou Fire Equipment Factory	S	1
Zhenjiang Fire Equipment Factory	S	1
Lishui County Fire Equipment Factory	S	1
Taixing City Fire Equipment Factoy	S	1
Guannan County Fire Equipment Factory	S	1
Xuzhou Fire Equipment Factory	E	1
Hainan Province:		
Quality Inspection Station, Fire Protection Bureau of Hainan Public Security Bureau	S	1
Haikou Zhehai Industrial Company	S	1
Service Station of Sanya Fire Protection Branch	S	1
Guangxi Autonomous Region:		
Service Factory of Nanning Fire Protection Branch	S	1
Wuzhou Fire Equipment Factory	S	1
Fire Equipment Service Factory of Security Company of Liuzhou Railway Bureau	S	1
Jiangxi Province:		
Service Factory of Jiangxi Fire Equipment Company	S	1
Hubei Province:		
Wuhan Jiang'an Fire Equipment Factory	S	1
Jiangling Fire Equipment Factory	S	1
Liaoning Province:		
Shenyang Bao'an Fire Equipment Factory	E	1
Taiyuan Fire Equipment Repair Factory	S	1
Dalian Fire Equipment Repair Factory	S	1
Jinzhou Fire Equipment Repair Factory	S	1
Da'an Fire Equipment Repair Factory	S	1
Shanghai:		
Shanghai Kailun Fire Equipment Factory	E	1
Shanghai Songjiang Fire Equipment Service Department	S	1
Pudong Xinqu Renhe Fire Equipment Management Departmt.	S	1
Changping Fire Equipment Management and Service Dept.	S	1
Longhua Fire Equipment Management Department	S	1
Shanghai Minhang Fire Equipment Service Department	S	1
Fire Equipment Service Department of Shanghai Petro-chemical General Factory	S	1
Hongkou Fire Equipment Service Department	S	1
Zhenden Fire Equipment General Factory	E	1

Guangdong Province:		
Guangzhou Fire Equipment Factory	E	1
Guangdong Foshan Electro-chemical General Factory	P	1
Panyu Shengjie Fire Equipment Factory	E	1
Nan'an Fire Equipment Factory	E	1
Baiyun Fire Equipment Service Factory	S	1
Zhejiang Province:		
Hangzhou Fire Equipment Factory	E	1
Zhejiang Fire Equipment Factory	E	1
Xiaoshan Fire Protection Chemical Factory	P	1
Anhui Province:		
Anqing Fire Equipment Repair Factory	S	1
Fire Equipment Service Station of Wuhu Public Security	S	1
Hefei Xiangyang Fire Equipment Factory	E	1
Fire Equipment Factory of Bengbu Public Security Bureau	E	1
Suzhou Fire Equipment Repair Factory	S	1
Henan Province:		
Zhengzhou Zhongyuan Fire Equipment Factory	E	1
Zhengzhou Qiahui Huangha Fire Equipment Factory	E	1
Fujian Province:		
Fujian Fire Equipment Service Station	S	1
Fuzhou Fire Equipment Service Station	S	1
Xiamen Hongxing Fire Equipment Factory	E	1
Shangxi Province:		
Datong Railway Fire Equipment Service Factory	S	1
Shanxi Zhen'an Fire Equipment Company Service Factory	S	1
Xinjiang Autonomous Region:		
Xishan Fire Equipment Factory of Xinjiang Communications Bureau	E	1
Yunnan Province:		
Service Center of Kunming Fire Equipment Factory	S	1
Other provinces where additional machines are distributed:		
Heilongjiang Province		2
Jilin Province		2
Shaanxi Province		2
Sichuan Province		4
Hebei Province		2
Guizhou Province		1
Guangxi Province		2
Jiangsu Province		2
Hubei Province		2
Nei Mongol		1
Qinghai Province		1
Gansu Province		1
Jiangxi Province		1
Subtotal		93
Additional machines to be placed		57
TOTAL		150

P = halon 1211 and/or equipment producer
E = halon 1211 equipment manufacturer
S = halon 1211 equipment servicing shop