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

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PROJECT PROPOSALS: THAILAND

THAILAND
OZONE DEPLETING SUBSTANCES PHASE OUT MULTICOMPONENT INVESTMENT PROJECT

EXECUTIVE PROJECT SUMMARY

Grantee:	Thailand
Executing Agency:	Department of Industrial Works
Beneficiaries:	Local enterprises introducing ODS reducing technologies
Total Project Cost:	US$ 26.8 million
Proposed OTF Grant:	US$ 21.1 million
Proposed Financing:	US$ 21.1 million (from OTF)
	US$ 5.7 million (from commercial sources)
ODS Use in the Country:	10,044 ODP mt/year
Project Impact: ODS Reduction	942 ODP mt/year
Tentative Grant Approval Date:	10/01/93
Peer Reviewers:	Messrs. Redfern (EA1CO), Rahill (EMTEN), Rhatigan (LA1EI)
Technical Review Panel:	Messrs. Suzuki (ASTES), Newcombe (ENVGC); Brown (IENIM); External reviewers: Mr. Art Fitzgerald, Mr. Lambert Kuijpers, Mr. Michael Jeffs (OORG)

1. **Background**. Since the mid 1970s, Thailand has been establishing policies for achieving rapid economic development and environmental protection, including support for the Montreal Protocol (MP) on Substances that Deplete the Ozone Layer (ODS). Thailand ratified the MP in July 1989 and is eligible for funding from the Multilateral Fund for the Implementation of the Montreal Protocol to finance ODS phase out programs. The Fund is managed by the Multilateral Fund Executive Committee (MFEC) and implemented by the World Bank, UNDP, UNEP and UNIDO. Funds for Bank implemented projects are channelled through the Bank administered Ozone Projects Trust Fund (OTF).

2. The Government is committed to establish a cost effective program for phasing out ODS. To coordinate its MP activities, a Ozone Layer Protection Unit has been established in the Department of Industrial Works (DIW), Ministry of Industry, which also serves as secretariat to a ODS Phase Out inter-agency Policy Committee. The Ministry of Science, Technology and Environment (MSTE) is responsible

for national environmental policies and enforcement. Both institutions have experience in the environmental field, but are under staffed and lack specific know-how on ODS phase out. The Industrial Finance Corporation of Thailand (IFCT), was assigned by the Government to act as financial agent to channel funds from the OTF to beneficiaries in Thailand. IFCT has a long track record as a development bank with extensive experience in financial and technical project appraisal.

3. Thailand is preparing a Country Program (CP) to be completed by June 1993 that defines a cost effective strategy, incremental costs, and policies and actions required to comply with MP obligations and to achieve early phase out. The CP is based on a Bank supported ODS Country Study completed by ICF consultants in 1992. UNDP is implementing an Institutional Strengthening Project which would assist DIW in developing the implementation capability for the CP. MITI and USEPA are assisting firms affiliated with Japanese and US companies and a UNEP/SIDA project provides TA on ODS phase out in the solvent sector.

4. Two Engineering Studies, for which the Bank was implementing agency, were commissioned by DIW to identify and prepare ODS phase out subprojects. The Multilateral Fund Executive Committee (MFEC) in its meeting in July, 1992 approved funding for the first two subprojects: a CFC Recycling Project for Mobile Air Conditioning and for a CFC Solvent Phase Out Project in Thai Airways for a total amount of US$ 1.0 million. Both projects are still under preparation. Another 20 subprojects have been identified in air-conditioning refrigeration, foam blowing, and electronics and metal cleaning, of which 14 have already been pre-appraised. These are included under this proposed ODS Multicomponent Investment Project. Funding will be requested from the MFEC for the 14 preappraised projects and a permission to proceed for the other 6 identified subprojects.

5. In 1991, Thailand consumed 15,600 tons ODS, equivalent to an Ozone Depleting Potential (ODP) of 10,044 tons or 0.16 kg ODP per capita. All ODS is imported. ODS was used in: (i) electronic/metal cleaning solvents, (43% as ODP), (ii) refrigeration/air conditioning (33%), (iii) foam (15%), (iv) fire-prevention (6%), and (v) aerosols (3%). ODS consumption increased by 23% p.a. between 1986 and 1990 due to fast economic growth. Electronics, refrigeration and air conditioning accounted for 80% of the increase in ODS consumption. Growth slowed down to 9% p.a. in 1991. By comparison, Philippines consumed a total of 2650 tons ODP and Malaysia 4779 tons ODP in 1990.

6. **Project Objectives**. The project objective is to support the Government program to phaseout ODS by (a) establishing an efficient mechanism for executing ODS phaseout projects through local institutions, and (b) implementing an initial group of cost effective priority subprojects. The proposed approach is to provide grant funding to several subprojects through a local financial institution to cover their incremental costs.

7. **Project Description**. The Project will support 20 subprojects in refrigeration, air conditioning, foams, solvents and recycling. Each subproject includes technical assistance to assist participating enterprises (PE) with technology transfer, design, training and implementation. A list of proposed subprojects is attached in Annex 1. Of the 20 identified subprojects, 14 subprojects, representing about 90% of the total project investment cost and about 85% of total grant amount, have been pre-appraised. Pre-appraisals for other subprojects over $500,000 will be presented to the MFEC for approval once finalized.

8. **Project Costs, Incremental Costs and Financing**. Estimated total investment program costs are US$26.829 million, including US$3.667 million in contingency and financial intermediation fees. Out

of this amount, US$21.105 million is eligible for OTF grant funding. Incremental costs are defined as per Bank and MFEC guidelines, i.e. as the net present value of incremental economic project costs (investment plus operating costs net of operating benefits) discounted at 10% in real terms. Firms with mixed local and foreign (developed country) ownership are eligible for OTF funding in proportion to their share of local ownership (see Annex 2). Following current MFEC practice, reimbursement of incremental operating costs for subprojects is limited to four years. An overall contingency allowance of 15% for pre-appraised projects and 30% for identified projects, and a financial agent fee of 3% have been included in the grant amount. The contingency will be allocated, as needed, by the Bank, to cover any justified subproject cost increases. If any one subproject shows a cost increase in excess of MFEC guidelines (i.e., $500,000 increase), the subproject will be resubmitted to MFEC for reapproval.

Project Costs Estimates

	Project COSTS (US$ million)		
	Investment Costs	Net Recurring Costs (4 Yrs)[a]	Proposed OTF Grant[b]
Pre-appraised subprojects	24.456	(0.217)	18.123
Identified subprojects	2.373	0.133	2.988
TOTAL Project	26.829	(0.084)	21.105

a/ Discounted at 10%. Negative numbers indicate operating savings.
b/ Eligible incremental cost = incremental cost x share of local ownership, including 15% contingency, and 3% fee for financial agent.

9. The incremental costs of investment subprojects would be financed by an OTF Grant to the Government. Eligible investment subprojects will receive the incremental cost portion of the total cost as grants channelled through a financial agent (FA) with the balance financed from commercial sources or from the enterprises' own resources. The financing plan is:

Financing Plan

Source	US $ million equivalent
OTF Grant	21.1
Commercial Loans/or Enterprise Own Funds	5.7
TOTAL	26.8

10. **Project Implementation.** DIW will have overall responsibility for the implementation of the ODS investment program. Specifically, DIW will ensure that ODS projects are consistent with the Country Program for ODS phaseout. DIW will review each subproject prior to appraisal to ensure that cost-effective technologies will be applied and that the subproject conforms to CP priorities. IFCT will be responsible for implementation of the investment component, including subproject appraisal, disbursement of OTF funds to the enterprises, and supervision of subproject implementation. IFCT will receive a fee equivalent to 3% of grants for its services, of which IFCT would receive one third (=1%) following approval of subproject appraisal reports by the Bank, and two thirds (=2%) upon disbursement of the grants to the subprojects. IFCT would be guided by subproject eligibility, appraisal and financing criteria for Montreal Protocol project (summarized in Annex 2), and would operate under terms and conditions as defined in Annex 4. IFCT will prepare appraisal reports in a format acceptable to the Bank.

11. The Bank will review each appraisal summary and report to ensure compliance with MFEC guidelines prior to approval of the grant (no free limit as required under the OTF agreement). Subproject proponents (enterprises) will be responsible for subproject implementation in accordance with subgrant contracts signed with IFCT. IFCT would submit a contract format acceptable to the Bank before appraisal of the ODS Multicomponent Investment Project.

12. **Reporting and Monitoring.** DIW will be responsible for monitoring the overall Project and attaining ODS phaseout targets. DIW and IFCT will prepare semi-annual progress reports. IFCT will submit an annual audit report acceptable to the Bank. The Bank's supervision will include reviewing progress and audit reports, and approving all subproject appraisal reports.

13. **Procurement.** Procurement of goods, works, and services will be in accordance with Bank Guidelines for lending through financial agent. IFCT will satisfy itself that the goods, works, and services to be purchased are for the subprojects and are reasonably priced, by ensuring that the grant recipient has canvassed the main sources of supply and purchased from the most advantageous source. Detailed procurement guidelines have been included in Annex 3. Consultants will be selected in accordance with the Bank Guidelines for the Use of Consultants.

14. Disbursement. A Special Account would be established to facilitate disbursement of OTF grants. IFCT would submit requests for replenishment of the Special Account based on Statement of Expenditures. Disbursement guidelines have been included in Annex 4. Project funds are expected to be disbursed according to the following schedule: 15% in calendar year 1993, 60% in 1994, and 25% in 1995.

15. Environmental Considerations. The Project is designed to protect the environment by reducing ODS emissions. However, substitution of ODS with other chemicals or technology may involve other environmental risks. Enterprises will prepare Environmental Assessments (EAs) according to local regulations, approved by DIW. IFCT will ensure that subprojects have complied with that obligation prior to disbursement. IFCT will submit a certification together with the appraisal report to the Bank that the enterprise has complied or is in the process of doing so.

16. Project Sustainability. The Project will assist the Government in establishing an efficient mechanism for developing and funding subprojects under the ODS phase out program. In order to achieve a sustainable and cost-effective phase out of ODS with a broad coverage of the various ODS consuming sectors, it will be essential - in addition to the enterprise specific support - to establish under the country program a policy framework that discourages the consumption of ODS and at the same time encourages the use of ODS substitutes and non-ODS technologies. Apart from policy interventions, rising market prices for ODS are expected to be the major incentive for an accelerated ODS phase out. Prices are expected to increase as the world's major ODS suppliers are committed to drastically reduce their ODS production. Simultaneously, these suppliers are developing or are already actively marketing ODS substitutes. Prices for these substitutes are expected to fall.

17. Project Benefits. The Project will help the Government implement an accelerated ODS phaseout program by providing financing for priority subprojects. The Project is expected to reduce ODS consumption directly by about 1000 MT ODP by 1995, or about 10% of current consumption. In addition, the project will enable export oriented firms to maintain their export markets by making a timely adjustment to non-ODS production technologies, as requested by importers from industrialized countries.

18. Project Risks. Institutional weakness of implementing agencies could slow down project execution and is being addressed under the Institutional Strengthening Project approved by the MFEC in March 93 and to be implemented by UNDP. Technical and commercial risks related to the introduction of technologies which are new to Thailand, will be minimized by providing TA to participating enterprises, by the use of technologies which have been internationally tested and commercialized, and by requiring, in selected cases, technical cooperation agreements between the enterprise and the international technology supplier.

19. Rationale for Use of Ozone Trust Fund. The Project is consistent with MFEC's and the Bank's Implementation Guidelines and Criteria for the use of OTF funds.

20. Lessons from Previous Bank Experience. OTF Projects are being developed simultaneously in Mexico, Venezuela, China, Malaysia, Philippines, Turkey, and other countries. None of these projects has been completed so far. However, early review indicates the need for: flexibility in Project design including provision for contingencies; well prepared and documented subprojects; and institutional strengthening, including training and TA.

ANNEX 1
THAILAND - ODS PHASE OUT MULTICOMPONENT INVESTMENT PROJECT
SUMMARY TABLE OF SUBPROJECT PROPOSALS

COMPANY	END USE	THAI OWNERSHIP (%)	ODS CONSUMPTION IN 1991 (MT ODP)	ODS USED (type)	ODS REDUCTION END OF 1995 (MT ODP)	INVESTMENT COST (US$ million)	NET RECURRING COST* (4 years)[1] (US$ million)	PROPOSED OTF GRANT (US$ million)[2]
PREAPPRAISED								
Hann Semiconductor	Solvent	78	14.5 1.6	CFC-113 TCA	16.1	0.861	0.232	0.878
GSS Army	Solvent	51	16.1	CFC-113	16.1	0.574	(0.050)	0.275
Saha Union	Solvent	80	27.4	CFC-113	27.4	2.620	0.100	2.235
Thai Heat Exchanger	Solvent	100	11.1	TCA	11.1	0.681	(0.320)	0.372
CI Group	Solvent	100	12.7	TCA	12.7	0.538	(0.304)	0.241
Thai Toshiba	Refrigerator	54.5	42 12.3	CFC-11 CFC-12	50.0	3.010	0.0	1.689
Kang Yong-Mitsubishi	Refrigerator	60	101 19	CFC-11 CFC-12	109.7	3.220	0.0	2.019
AP National-Matsushita	Refrigerator	55	45 7	CFC-11 CFC-12	47.4	3.220	0.0	1.823
Hitachi	Refrigerator	51	108 36	CFC-11 CFC-12	133.0	2.520	0.0	1.329
Sanyo Universal (2 factories)	Refrigerator	65	350 136	CFC-11 CFC-12	450.3	4.950	0.0	3.220
Sanyo Universal	Compressors	65	NA	CFC-12	NA	1.285	0.0	0.860
Kuthorn- Kirby	Compressors	69.6	NA	CFC-12	NA	0.832	0.0	0.596
Kamawat	Retrofit Auto AC	100	2	CFC-12	2	0.069	0.0	0.071
Technic Foam	Insulating Foam	100	30	CFC-11	44.9	0.026	0.125	0.151
Contingency (15%)								2.364
Subtotal Preappraised			991.7		920.7	24.456	(0.217)	18.123
IDENTIFIED								
Admiral	Refrigerator	100	6 2.5 0.8	CFC-11 CFC-12 TCA	8.6	1.210	0.015	1.262
Nippondenso	Auto Air Conditioners	56	NA	CFC-12	NA	0.618	0.0	0.357
TeamTronics	Solvent	100	29	CFC-113	12.4	0.228	0.011	0.239
Kian Gwan	Chiller	100	0.12	CFC-11	0.12	0.078	0.051	0.133
Imporial Queen	Chiller	100	0.17	CFC-11	0.17	0.063	0.046	0.111
Bangkok Post	Chiller	100	0.31	CFC-12	0.31	0.176	0.010	0.192
Contingency (30%)								0.688
Subtotal Identified			38.9		21.6	2.373	0.133	2.982
Grand Total	rev. 5/12/93		1030.6		942.3	26.829	(0.084)	21.105

1 Net Present Value of first four years of operating costs/savings discounted at 10%. Negative numbers indicate operating savings.

2 Grant Amount equals incremental cost multiplied by percent Thai ownership; includes 3% Financial Agent Fee.

ANNEX 1

THAILAND - ODS PHASE OUT INVESTMENT PROJECT

SUBPROJECT SUMMARIES

I. PREAPPRAISED SUBPROJECTS

A. SOLVENTS

1. Hana Semiconductors

Conversion of Electronic Cleaning Process from CFC-113/Alcohol Blended Solvent and 1,1,1 Trichloromethane to Wet Media Blasting and Aqueous Cleaning

This project will eliminate the use of CFC-113/methanol blend and 1,1,1 trichloromethane (TCA) in the cleaning of semiconductors and circuit card assemblies at Hana (BKK) Co., Ltd. (Hana). Hana PCB Division produces several types of circuit card assemblies for use inside cameras, computers, and other electronic equipment. Hana Semiconductor Division assembles semiconductor chips into complete electronic components. The phaseout of ozone depleting solvents (ODS) will be accomplished by replacing the current cleaning solvents with two different types of aqueous based processes. Hana PCB division will use aqueous cleaning to remove flux residues from soldered circuit cards. The aqueous cleaning process will utilize either pure water or water with additives such as surfactants to remove rosin flux residue from the circuit cards. Hana Semiconductor Division will eliminate the use of chlorofluorocarbons by replacing the cleaning operation with the use of a water-based plastic media blasting. This process is commonly referred to as wet-media blasting.

2. GSS Array

Conversion of Electronic Cleaning Process from CFC-113/Alcohol Blended Solvents to High-Purity Water Cleaning

This project will eliminate the use of CFC-113/methanol blended solvent in the cleaning of circuit card assemblies at GSS Array (GSS). GSS is a contract manufacturing facility producing high technology circuit card assemblies for use in telecommunications, medical electronics, and bar code scanners; the company also produces complete electronic assemblies. At GSS the phaseout of ozone depleting solvents (ODS) will be accomplished by replacing the current CFC-113/methanol in-line cleaner and a recently retired vapor degreaser with three in-line aqueous cleaners. The aqueous cleaners will be used to remove flux residues and light ionic contamination from the circuit cards. The project also includes the purchase and installation of a water recycling system.

3. Saha Union

Conversion of Electronic Cleaning Process from CFC-113/Ethanol Blended Solvents to High-Purity Hot Water Cleaning

This project will eliminate the use of CFC-113 in the cleaning of hard disk drives and affiliated components at Saha Union's Sriracha facility located south of Bangkok. The CFC-113 in-line cleaning process will be directly replaced with an Ultrapure Deionized (UDI) water process. Saha currently uses one 6-bath CFC-113 cleaner and one 3-bath CFC-113 cleaner. A single UDI in-line cleaner will replace both of these units. The UDI cleaning machine includes support equipment for water recycling, high-purity air production, and waste water treatment. The project also provides support for process development, installation of the new equipment, and environmental permitting. The conversion of Saha from CFC-113 cleaning processes to UDI cleaning will result in an annual reduction of 34 MT of ozone depleting substances. This is slightly more than one percent of the consumption of CFC-113 in Thailand in 1991.

4. Thai Heat Exchanger

Conversion of Metal Cleaning Processes from 1,1,1 Trichloromethane (TCA) to Aqueous Cleaning

This project will eliminate the use of 1,1,1 trichloromethane (TCA) in the cleaning of small and medium size heat exchangers, or radiators, at Thai Heat Exchange Co. Ltd. (THECO). THECO is one of the largest producers of heat exchangers for automotive, trucks, room air-conditioners, and refrigeration units in Thailand. THECO manufactures heat exchangers from the raw materials of aluminum sheet and copper and aluminum tubing. The phaseout of ozone depleting solvents (ODS) will be accomplished by replacing the current vapor degreasing cleaning process with an aqueous-based cleaning process and the addition of drying equipment.

5. CI Group

Conversion of Metal Cleaning Processes from 1,1,1 Trichloromethane (TCA) to Aqueous Cleaning

This project will eliminate the use of 1,1,1 trichloromethane (TCA) in the cleaning of small and medium size heat exchangers at C.I. Group Company, Ltd (CIG). CIG is a large producer of heat exchangers for automobiles, trucks, and refrigeration units in Thailand. CIG manufactures heat exchangers from the raw materials of aluminum sheet and copper and aluminum tubing. The phaseout of ozone depleting solvents (ODS) will be accomplished by one of two options that are dependent upon the outcome of initial testing by CIG. Only the second option is recommended for funding. One option involves substituting the current TCA vapor degreasing process with the use of evaporative lubricants. Since the lubricants evaporate there is no need to clean, but because they are hydrocarbons the lubricants are classified as volatile organic hydrocarbons (VOCs) and can contribute to air pollution. The second option, which is relatively benign to the environment, is to install an aqueous based cleaning process at the facility. Drying equipment is required to remove moisture after the aqueous cleaning process.

B. REFRIGERATOR

6. Thai Toshiba

Engineering Assistance for the Elimination of Ozone Depleting Substances Used in the Production of Household Refrigerators

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators manufactured at Thai Toshiba Electric Industries Co., Ltd. (TTEI) in Thailand. The project comprises two phases and will convert the production line to refrigerators using HFC-134a and HCFC-141b as the new refrigerant and foam blowing agent respectively. The first phase will provide for product development using CFC alternatives and for the purchase of specific equipment for the testing and manufacturing of the new refrigerators. During this phase, Thai Toshiba Electric Industries will seek engineering assistance and training from its parent company, Toshiba Corporation of Japan. The second phase will fully eliminate the use of CFC-12 and CFC-11 at TTEI by installing the new equipment necessary for mass production of CFC-free refrigerators. Phase Three, not addressed here, would involve actual production of domestic refrigerators using CFC alternatives. The project will result in the elimination of 12.3 MT/year of CFC-12 (refrigerant) and 42 MT/year of CFC-11 (foam blowing agent) after the conversion is completed.

7. Kang Yong

Engineering Assistance for the Elimination of Ozone Depleting Substances Used in the Production of Household Refrigerators

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators manufactured at Kang Yong Electric Co., Ltd. (KYE) in Thailand. The project comprises two phases and will convert the production line to refrigerators using HFC-134a and HCFC-141b as the new refrigerant and foam blowing agent respectively. The first phase will provide for product

development using CFC alternatives and for the purchase of specific equipment for the testing and manufacturing of the new refrigerators. During this phase, Kang Yong Electric will seek engineering assistance and training from its parent company, Mitsubishi Electric Corporation of Japan. The second phase will fully eliminate the use of CFC-12 and CFC-11 at KYE by installing the new equipment necessary for mass production of CFC-free refrigerators. Phase Three, not addressed here, would involve actual production of domestic refrigerators using CFC alternatives. The project will result in the elimination of 19 MT/year of CFC-12 (refrigerant) and 101 MT/year of CFC-11 (foam blowing agent) after the conversion is completed.

8. AP National
Engineering Assistance for the Elimination of Ozone Depleting Substances Used in the Production of Household Refrigerators

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators manufactured at A.P. National Co., Ltd. in Thailand. The project comprises two phases and will convert the production line to refrigerators using HFC-134a and HCFC-141b as the new refrigerant and foam blowing agent respectively. The first phase will provide for product development using CFC alternatives and for the purchase of specific equipment for the testing and manufacturing of the new refrigerators. During this phase, A.P. National will seek engineering assistance and training from its parent company, Matsushita Refrigeration Co. of Japan. The second phase will fully eliminate the use of CFC-12 and CFC-11 at National by installing the new equipment necessary for mass production of CFC-free refrigerators. Phase Three, not addressed here, would involve actual production of domestic refrigerators using CFC alternatives. The project will result in the elimination of 7 MT/year of CFC-12 (refrigerant) and 45 MT/year of CFC-11 (foam blowing agent) after the conversion is completed.

9. Hitachi
Engineering Assistance for the Elimination of Ozone Depleting Substances Used in the Production of Household Refrigerators

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators manufactured at Hitachi Consumer Products Co., Ltd. in Thailand. The project comprises two phases and will convert the production line to refrigerators using HFC-134a and HCFC-141b as the new refrigerant and foam blowing agent respectively. The first phase will provide for product development using CFC alternatives and for the purchase of specific equipment for the testing and manufacturing of the new refrigerators. During this phase, Hitachi Consumer Products will seek engineering assistance and training from its parent company, Hitachi Ltd. of Japan. The second phase will fully eliminate the use of CFC-12 and CFC-11 at Hitachi by installing the new equipment necessary for mass production of CFC-free refrigerators. Phase Three, not addressed here, would involve actual production of domestic refrigerators using CFC alternatives. The project will result in the elimination of 36 MT/year of CFC-12 (refrigerant) and 108 MT/year of CFC-11 (foam blowing agent) after the conversion is completed.

10. Sanyo
Engineering Assistance for the Elimination of Ozone Depleting Substances Used in the Production of Household Refrigerators

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators manufactured at Sanyo Universal Electric Co., Ltd. in Thailand. The project comprises two phases and will convert the production line to refrigerators using HFC-134a and HCFC-141b as the new refrigerant and foam blowing agent respectively. The first phase will provide for product development using CFC alternatives and for the purchase of specific equipment for the testing and manufacturing of the new refrigerators. During this phase, Sanyo Universal Electric will seek engineering assistance and training from its parent company, Sanyo Electric Co., Ltd. Japan. The second phase will fully eliminate the use of CFC-12 and CFC-11 at Sanyo by installing the new equipment necessary for mass production of CFC-free refrigerators. The third phase, not addressed

here, will involve actual production of domestic refrigerators using CFC alternatives. The project will result in the elimination of 136 MT/year of CFC-12 (refrigerant) and 350 MT/year of CFC-11 (foam blowing agent) after the conversion is completed.

C. COMPRESSORS

11. Sanyo Universal Electric
Conversion of Compressor Manufacture from CFC-12 to HFC-134a Designs

This OTF request is for funding phase 1 of a project that will convert Sanyo's Universal Electric Co. Ltd. (SUE) manufacturing facility from producing CFC 12 compressors to (non-CFC) HFC-134a compressors. In Phase 1, 1300 compressors will be produced for test purposes. In phase 2, which is not addressed under this grant, the project will reach full production capacity and will provide a major indigenous source of HFC-134a compressors for use in the production of non-CFC domestic refrigerators in Thailand. Technology for HFC-134a compressor manufacture has been transferred by Sanyo-Japan to SUE under a newly approved technical assistance agreement. This project is one of a series of similar projects under the Global Refrigeration Project as approved by the Executive Committee of the Multilateral Fund in September 1992. Several refrigerator manufacturers in Thailand have based their scheduled transition to non-CFC refrigerators on the successful completion of this project. While this project will not directly reduce ODS consumption, it is critical for the elimination of CFC-12 use in refrigerators.

12. Kuthorn Kirby Co. Ltd.
Conversion of Compressor Manufacture from CFC-12 to HFC-134a Designs

This OTF request is for funding phase 1 of a project that will convert Kuthorn Kirby Co. Ltd. (KKC) manufacturing facility from producing CFC 12 compressors to (non-CFC) HFC-134a compressors. In Phase 1, 1600 compressors will be produced for test purposes. In phase 2, which is not addressed under this grant, the project will reach full production capacity and will provide a major indigenous source of HFC-134a compressors for use in the production of non-CFC domestic refrigerators in Thailand. Technology for HFC-134a compressor manufacture has been transferred by Tecumseh and the motor technology by Kirby to KKC under the terms of an existing license agreement. This project is one of a series of similar projects under the Global Refrigeration Project as approved by the Executive Committee of the Multilateral Fund in September 1992. Several refrigerator manufacturers in Thailand have based their scheduled transition to non-CFC refrigerators on the successful completion of this project. While this project will not directly reduce ODS consumption, it is critical for the elimination of CFC-12 use in refrigerators.

D. MOBILE AIR CONDITIONING

13. Karnawat Co., Ltd.
Retrofitting of Mobile Air Conditioners - Demonstration Project

The project will demonstrate retrofitting mobile air conditioners (MACs) which use CFC-12 as the working fluid to HFC-134a. Some 2.3 million vehicles in thailand have air conditioning units installed, all of which use CFC-12 as the refrigerant. To change, service and repair these MACs 1,640 MT of CFC 12 are consumed annually in service stations spread out across the country. To phase out the use of CFC-12 in the MAC sector, two concurrent efforts must be carried out. One is to eliminate the current production of CFC-12 MACs; another is to minimize the demand of CFC-12 in the MACs' service sector. A cost-effective way to minimize such demand in the service sector is to retrofit existing MACs for HFC-134a. Retrofitting will ensure the continued utility of installed equipment with many years of remaining serviceable life. The project will comprise three phases. The first phase will involve the selection and acquisition of retrofit components. The second phase will involve the retrofitting of 50 mobile air-conditioning units, 25 of which will be installed in private cars and 25 installed in taxis. The third phase will involve close and regular monitoring of

the conditions of the retrofitted MACs. Karnawat is 100% Thai owned, which was taken into account in calculating the proposed OTF financing.

E. INSULATING FOAM

14. Tecnic Foam
Replacement of CFC-11 with HCFC-141b as a Foam Blowing Agent

This project will eliminate the use of CFC-11 for producing rigid polyurethane insulating foam at Technic Foam, Ltd. The phaseout will be accomplished by replacing CFC-11 with HCFC-141b as the foam blowing agent. This will require modifying existing equipment and chemical formulations, and providing technical assistance to Technic Foam's managers and workers. The project will eliminate an estimated 50 MT of CFC-11 per year.

II. IDENTIFIED SUBPROJECTS

A. REFRIGERATOR

15. Admiral
Engineering Assistance for the Elimination of Ozone Depleting Substances Used in Household Refrigerators, Structural Foams, and the Cleaning of Heat Exchangers

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators, freezers, and air-conditioners manufactured at Admiral Thailand Co., Ltd. The project will also eliminate the use of 1,1,1-trichloromethane (TCA) in the cleaning of heat exchangers. The phaseout will be accomplished by converting the production line to refrigerators using HFC-134a and HCFC-22 as the new refrigerant and foam blowing agent respectively. CFC-11 used in the structural foam of the air conditioners will be replaced by a fully blended polyol containing water. 1,1,1-Trichloromethane will be eliminated by replacing the existing metal cleaning process with semi-batch aqueous cleaning equipment. The project will consist of two phases. The first phase will provide for product development using CFC alternatives and for the purchase of specific equipment necessary for the testing and manufacturing of the new refrigerators and for the production of the structural foam . The aqueous cleaning equipment for the heat exchangers will be installed during this phase of the project. The second phase will fully eliminate the use of CFC-12 and CFC-11 at Admiral by installing the new equipment necessary for mass production of CFC-free refrigerators and structural foams. The project will result in the elimination of 2.5 MT/year of CFC-12 (refrigerant), 6 MT/year of CFC-11 (foam blowing agent) and 8 MT/year of 1,1,1-trichloromethane after the conversion is completed.

B. MOBILE AIR CONDITIONING

16. Nippondenso Thailand Sales
Development of Service Network for HFC-134a MACs

This project will convert Nippondenso's network of 150 mobile air-conditioning service shops from CFC-12 to shops for servicing new HFC-134a mobile air conditioners which will be installed in new cars starting in 1993. Under this project, Nippondenso will set up a demonstration center which will be used to train technicians from its own service network as well as technicians from other interested service shops. Tools and equipment required for servicing HFC-134a MACs will then be distributed free of charge to Nippondenso-authorized service shops. This project is a necessary complement to the automobile manufacturer's decision to produce cars with air conditioning units using HFC-134a as the working fluid. MACs require regular servicing. To ensure that product quality and utility is retained for the HFC-134a MAC systems, service shops will have to be equipped

that product quality and utility is retained for the HFC-134a MAC systems, service shops will have to be equipped to service these systems, and service engineers will have to receive proper training. The auto maker' decision to install 134a units will result in annual CFC savings of 625 MT.

C. SOLVENT

17. TeamTronics
Conversion of Electronic Cleaning from CFC-113 to Aqueous Cleaning

This project will eliminate the use of CFC-113 solvent in the cleaning of flexible circuit card assemblies at TeamTronics. TeamTronics is a contract manufacturing facility producing high technology circuit assemblies for use in electronic equipment such as computers. At TeamTronics, the phaseout of ozone depleting substances (ODS) will be accomplished by replacing the current CFC-113 batch cleaner with on in-line aqueous cleaner. The aqueous cleaners will be used to remove flux residues and light ionic contamination from the circuit cards. The project will result in the elimination of 15 MT per year of CFC-113 after the conversion is completed. TeamTronics is 100 percent Thai owned, which was taken into account in calculating the proposed OTF financing.

D. CHILLER

18. Kian Gwan Office Bldg.
19. Imperial Queen Hotel
Demonstrate Conversion of CFC-11 Chillers at the Kian Gwan Building by York Air Conditioning and Refrigeration (Thailand) and at the Imperial Queen's Park Hotel by Jardine Trane Air Conditioning

This demonstration project will modify two 500 ton and one 1,215 ton CFC-11 centrifugal chillers so that they can operate using HCFC-123 as a refrigerant. The retrofits will be done by York Air Conditioning and Refrigeration (Thailand) for the Kian Gwan Company, and by Jardine Trane Air Conditioning for the Imperial Family of Hotels at its Imperial Queen's Park Hotel. The project will eliminate the use of ODSs in three chillers, will serve as a demonstration project to over 1000 building owners who use Trane and York chillers throughout Thailand, and provide experience in retrofitting chillers to two of Thailand's leading chiller service companies. York and Trane will undertake the conversions with the help of engineers from their parent companies. This project will also involve the purchase of recovery/recycling equipment that will be used to remove the CFC-11 refrigerant and purify it for reuse in existing chillers elsewhere, thereby reducing Thai consumption and imports of CFC-11. The recycling technology will be used by the chiller service companies at other sites to reduce ODS servicing related emissions. The chiller owners (Kian Gwan and the Imperial Family of Hotels) would be reimbursed for increased energy and refrigerant costs which will result from the conversions.

20. Bangkok Post

Conversion of CFC-12 Chillers at the Bangkok Post Building by Pido International Company

This project will convert three 400-ton CFC-12 centrifugal chillers at the Bangkok Post Building to operate using HFC-134a as the refrigerant. In addition to eliminating the use of ODSs at the facility, the project will serve as an example to building owners who use McQuay chillers throughout Thailand of the process of converting to alternative refrigerants and provide experience in retrofitting CFC-12 centrifugal chillers. Pido International, the representative of McQuay Air Conditioning in Thailand, will perform the conversion with help of engineering consultants from McQuay. The project will also include the purchase of a recovery/recycling machine that would be used to remove the CFC-12 refrigerant and purify it for reuse in existing chillers elsewhere, reducing Thai consumption and imports of CFC-11. The recycling technology will be used by the chiller service companies at other sites to reduce ODS servicing related emissions. Finally, the project will reimburse the chiller owners (Bangkok Post) for increased energy and refrigerant costs that they will incur as a result of the conversions.

ANNEX 2

THAILAND - ODS PHASE OUT INVESTMENT PROJECT

DRAFT SUBPROJECT ELIGIBILITY, FUNDING AND APPRAISAL CRITERIA

The major criteria are summarized below:

A. Subproject and Funding Eligibility

Subprojects should be on priority list as given in the CP or confirmed by DIW and the appraisal team as essential to achieve CP objectives. Subprojects should have direct and demonstrable results in reducing ODS consumption in the country. They should be cost effective and based on environmentally sound technologies or substitutes for the substances controlled by the MP, or recycling of controlled substances or substitutes, taking into account the national industrial policy of the Country.

OTF funding is a grant to the enterprise/agency/institution implementing the subproject. The grant is calculated in economic terms for the "incremental costs" as elaborated below. Methodology for calculating incremental costs should be consistent with eligibility as defined by MFEC and with the Bank's interpretation of incremental costs.

1. **Determination of Incremental Costs:** Incremental costs are defined as the net present value of incremental economic subproject costs (investment capital plus operating costs net of operating benefits) discounted at the economic cost of capital in the country (10% will be used in Thailand) in constant economic prices over the economic life of the subproject. When appropriate, risks associated with technology, market and financing of undertaking the subproject should be taken into consideration in.

In cases where the subproject proponent has to put up its own capital (or commercial loans) to co-finance part of the subproject costs, the necessity for providing sufficient financial incentive to undertake the subproject should be considered, i.e. enterprise obtains an acceptable return on its own capital. The Grant amount could then be determined in such a way that the Economic Rate or Return on the risk capital is 10% (real terms). For comparison, also a financial rate of return for the subproject should be calculated. If the financial rate of return differs substantially from the ERR (e.g. because of major distortions of market prices) and would be unacceptably low for the enterprise, the grant amount may be determined based on a minimum FRR. Such situation should be raised as an issue in the EPS/appraisal report. The minimum FRR should be determined based on an objective assessment of the country's local financial sector and should correspond to the best judgement of a reasonable return on capital expectation within the country's industrial sector. In many cases subproject proponents will view ODS phaseout investments as necessary business costs and may not require financial incentives in addition to a grant for incremental costs.

2. **Policy Considerations.** The purpose of the Multilateral Fund is to encourage countries/enterprises to undertake operations quickly to correct an external environmental problem, and to compensate for direct costs incurred by those operations. Overall economic/industrial policy reform is excluded from consideration by the MP guidelines and policies required to develop and implement the country's ODS phase out program are to be addressed in the ODS Country Program that is approved by the MFEC. However, policies that directly affect the successful implementation of the subproject should be identified and addressed in the EPS/appraisal report, preferably before the subproject is submitted to the MFEC.

3. Ownership. An enterprise/subproject is eligible for funding in direct proportion to local ownership percentage of the enterprise.

4. Exports. A subproject is eligible for funding provided unless it is located in a "free zone" and its products for export only.

5. Eligibility for Reimbursement. Under present informal MFEC guidelines, recurring costs net of operational savings are considered only for the first 4 years of project operation. Reimbursements for longer periods would have to be approved on a case by case basis. Direct taxes (import, excise, etc) are not eligible for reimbursement. However, normally UN/Bank projects would be exempt from such taxes. (The issue of taxes should be addressed in the appraisal process and if an issue, raised in the Project Summary and EPS.)

B. Elements of Subproject Appraisal

The subproject appraisal report prepared under the responsibility of IFCT should include:

1. Project scope - including full description, technology, source of supply; divided into (a) component relating to ODS phase out and (b) other components, such as expansion of output or product upgrading.

2. Schedule and quantity of ODS (expressed as ODS and ODP) phased out directly attributed to subproject, on annual and total basis.

3. Project costs, divided into (a) components relating to ODS phase out and (b) other components. Foreign exchange and local costs should also be shown according to standard project analysis methodology.

4. Review of technical feasibility of subproject should be undertaken to determine the soundness of the technical proposal.

5. Economic and financial analysis of subproject should be undertaken according to standard Bank methodology. Any significant difference between FRR and ERR should be explained. Any policy distortion that effects the successful implementation of the subproject or effecting the implementation of the country's ODS CP should be identified, analyzed and appropriate recommendations made in the EPS prior to submitting the EPS to the MFEC.

6. Financial analysis of enterprise. A set of minimum financial indicators to ensure enterprise viability and its ability to implement the subproject successfully should be determined based on local conditions and should be consistent with commercial financial practice in the country.

7. Financing arrangements, sources, terms and conditions, divided into (a) incremental costs related to ODS phase out to be financed as an OTF grant, (b) amount to be provided by enterprise from its own resources; and (c) local and/or foreign loans to be financed through commercial loans from local and/or foreign institutions (at commercial interest rates), should be shown and confirmed.

8. Project implementation arrangements including management, engineering and technology acquisition, procurement, installation, operation, marketing and schedule for all implementation steps should be included in the appraisal report.

9. Procurement and selection of consultants should follow procedures consistent with the relevant Bank Guidelines.

10. Environmental aspects of the subproject have to be documented and IFCT has to ensure that the subproject proponents has undertaken the necessary steps for obtaining an Environmental Assessment

(EA) according to local regulations and approved by DIW. IFCT will submit such certification together with the appraisal report to the Bank.

11. Reporting requirements by the subproject proponent would include progress reports to IFCT (with copy to DIW) according to the practice applied by IFCT in similar projects. As a minimum, the enterprise would submit one project progress report at the time when the proposed investment activities have been implemented and the new installations are operating. In cases where multiple disbursement tranches have been agreed, the enterprise would submit one progress report prior to each tranche release.

C. **Subproject Priority and Unit Abatement Costs**

Subprojects with the most cost effective technology and with the lowest unit abatement cost of ODS in the shortest period of time in terms of global impact should receive priority. Relative cost effectiveness is measured by "unit abatement cost", a comparative index defined by the following:

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

Where:

- A = Unit abatement cost, $/kg ODP saved/year (at full operation)
- C = Incremental capital cost, including all initial one time costs such as technology, training
- F = Capital recovery factor; the annualized capital cost charges, discounted at a standard discount rate of 10% per year, over the economic life of the project.
- OC = Annual Operating Costs at full operation
- OS = Annual Operating benefits at full operation
- W = Quantity of ODS saved annually expressed as ODP units

The purpose of unit abatement cost calculation is to give a relative ranking of projects across countries and within same sector. Lower unit abatement costs correspond to higher priority in cost effectiveness. The unit abatement cost is calculated at standard discount rates to facilitate cross country comparisons.

ANNEX 3

THAILAND - ODS PHASE OUT INVESTMENT PROJECT

PROCUREMENT ARRANGEMENTS

The Industrial Finance Corporation of Thailand, IFCT, will be responsible for ensuring that beneficiary enterprises follow the agreed procurement guidelines. It will help enterprises arrange procurement (international and local); where necessary, procurement should be handled by qualified procurement agencies authorized by the Government and acceptable to the Bank. Bidding documents will be prepared based on model bidding documents acceptable to the Bank (e.g. sample Bank bidding documents).

The following contracts and bid packages will be subject to prior review:

(a) over US$ 2 million;

(b) over US$ 200,000 but less than agreed number of bids being sought;

(c) for proprietary technology and equipment;

(d) for selection of consultants;

For Procurement of Equipment the following procedures would apply:

(i) contracts over US$ 2 million (excluding proprietary packages) would be procured under international competitive bidding (ICB)

(ii) contracts between $200,000 and $2 million would be procured on the basis of comparison of price quotations solicited from at least three qualified supplier from at least two countries;

(iii) contracts below $200,000 would be procured on the basis of comparison of price quotations solicited from at least three qualified suppliers.

Consultants (including those from local institutions) retained under the project would be recruited in accordance with the "Guidelines for the use of consultants by the World Bank", published by the World Bank in August 1990.

ANNEX 4

THAILAND - ODS PHASE OUT INVESTMENT PROJECT

ROLE OF THE FINANCIAL AGENT AND TERMS AND CONDITIONS FOR SPECIAL ACCOUNT AND STATEMENT OF EXPENDITURE

1. Overall responsibilities. DIW will have responsibility for ODS Country Program (CP) implementation and will ensure that ODS subprojects are consistent with the CP for ODS phase out. The Financial Agent, the Industrial Finance Corporation of Thailand, (IFCT), will be responsible for channeling funds from the Ozone Trust Fund (OTF) which is administered by the Bank, to the subprojects, including the appraisal of subproject proposals, the disbursement of OTF grants to subprojects, and supervision of subproject implementation.

2. Financial Agent Service Fee. IFCT will receive a fee equivalent to 3% of the subproject grant amount for its financial agency services. IFCT would receive one third (1%) upon approval of the subproject appraisal report by the Bank, and two thirds (2%) upon disbursement of the grants to the subprojects.

3. Processing Steps. Processing of subprojects requesting OTF funding includes:

(i) Project preparation: enterprises will be responsible for preparing pre-investment studies. It may request assistance from DIW in preparing projects.

(ii) DIW endorsement: DIW will endorse each subproject to ensure that the subproject proposal conforms to priorities established under the Country Program.

(iii) Technical review and Bank endorsement: The Bank will oversee technical reviews subproject proposals and endorse each project to ensure that they are consistent with MFEC guidelines.

(iv) MFEC approval: For projects over US$500,000, MFEC approval is required for each project. Individual MFEC approval is not required for subprojects less than US$500,000. Such subprojects are included in the Bank's work program which is approved by the MFEC.

(v) Subproject appraisal: IFCT will appraise subprojects based on criteria as outlined in Annex 2. IFCT would prepare appraisal summaries and reports in accordance with Bank format.

(vi) Bank Review and Grant Approval: IFCT will submit endorsed appraisal to the Bank which will review each appraisal report prepared by IFCT to ensure compliance with MP goals and procedures before approving the grant. (No free limit in accordance with MFEC guidelines).

(vii) Disbursement: Between Bank and IFCT: Upon OTF Grant effectiveness and receipt of a withdrawal application from the borrower, the Bank will make initial deposits of up to US$1.0 million into a Special Account which IFCT would open. Replenishment of the Special Account and all other disbursements would be made against full documentation except for expenditures under contracts below US$200,000 for which the Bank will accept Statements of Expenditures (SOE). Supporting documents for SOEs including contracts, procurement documentation, and payment should be kept in a central location for examination by independent auditors and Bank during supervision missions. Minimum application for replenishment of Special Account would be US$200,000. Bank will accept application for direct payment and issuance of special commitment (outside special account) only above minimum of US$50,000. In addition to details of disbursement procedures given

in Disbursement Handbook published by the Bank in 1992, a Disbursement Letter will be issued after the Grant is signed.

Between IFCT and Subproject: Up to US$ 2 million per contract, IFCT will disburse to the subproject proponent for eligible expenses without prior Bank review (see annex 3).

(viii) Disbursement in Tranches: For large projects (over US$0.5 million) with a large share (proposed minimum threshold: over 50%) of grant funding for operating costs (as opposed to investment costs), or for projects where for technical reasons investments take place in two or more phases, IFCT should propose a disbursement plan in two or more tranches. Release of the tranches would be based on receipt of progress reports satisfactory to IFCT and the final payment on submission by the enterprise of a final report (and approved by IFCT and the Bank) showing that all ODS phase out objectives have been achieved.

(ix) Procurement: IFCT will be responsible for ensuring that beneficiary enterprises follow the agreed procurement guidelines. It will help enterprises arrange procurement (international and local); where necessary, procurement should be handled by qualified procurement agencies authorized by the Government and acceptable to the Bank. Bidding documents will be prepared based on model bidding documents acceptable to the Bank (e.g. sample Bank bidding documents). Procurement Guidelines are included in Annex 3.

(x) Subproject Implementation: Each enterprise will be responsible for subproject implementation. For that purpose, it will sign a contract with IFCT upon receipt of the Grant; the contract will spell out the responsibilities of the enterprise and its commitment to undertake the necessary activities agreed upon in the subproject proposal to achieve the intended ODS reduction or phase out. Enterprises will be responsible for preparing progress reports and submitting to IFCT (with copy to DIW) according to the practice applied by IFCT in similar projects. As a minimum, the enterprise would submit one project progress report at the time when the proposed investment activities have been implemented and the new installations are operating. In cases where multiple disbursement tranches have been agreed, the enterprise would submit one progress report prior to each tranche release.

(xi) Subproject Supervision: IFCT will have prime responsibility for supervising implementation of subprojects while it is still disbursing to the subprojects. Even after the grant has been fully disbursed, IFCT will review and approve the progress reports submitted by the enterprises and,if necessary, verify them. IFCT's responsibility for subproject supervision ends after full disbursement and approval of the final enterprise progress report.

DIW has the right to monitor the progress of MP funded subprojects in fulfillment of its overall responsibility for the implementation of the MP ODS phase out Country Program.

(xii) Auditing and Reporting: IFCT will submit semi-annual reports on the status of the grant disbursements and the progress of the subprojects, acceptable to the Bank. Copies of these reports will be submitted to DIW. IFCT will also submit an annual audit report on the project account prepared by an independent auditor acceptable to the Bank.

4. Combined commercial and grant funding. In those subprojects where the total project costs exceeds the grant amount, IFCT could offer financing including a loan to be provided from IFCT's own sources. The subproject proponent would be free to accept the financing or to seek loan financing from other sources. Terms and conditions for this complementary financing would typically follow commercial practice. A confirmed financing plan will be required as part of the appraisal report before Bank's.

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand		
PROJECT TITLE:	Conversion to Wet Media Blasting and Aqueous Cleaning Solvents		
SECTOR COVERED:	Solvent Cleaning		
ODS USE IN SECTOR (1991):	3,270 MT ODP (3,200 MT CFC-113 & 7,100 MT TCA)		
PROJECT IMPACT:	Phase out 16 MT ODP per year (19 MT CFC-113 & 16 MT TCA)		
PROJECT DURATION:	9 months		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Costs[1]:	US$ US$	861,000 232,000
PROPOSED OTF FINANCING[2]:	US$ 1,010,000 (@ 77.8% Thai Ownership)		
COST EFFECTIVENESS:	US$ 13.29/kg ODP/year		
IMPLEMENTING ENTERPRISE:	Hana Semiconductor (BKK) Co., Ltd.		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This project will eliminate the use of CFC-113/methanol blend and TCA in the cleaning of semiconductors and circuit card assemblies at Hana (BKK) Co., Ltd. (Hana). The phaseout will be accomplished by replacing the current cleaning solvents with two different types of aqueous based processes. Hana PCB division will remove flux residues from soldered circuit cards, using an aqueous cleaning process which will utilize pure water. Hana Semiconductor Division will replace the cleaning operation with the use of a water-based plastic media blasting (wet-media blasting). The project also provides for equipment installation, wastewater treatment, engineering support and training, and ventilation improvements. The conversion to non-ozone depleting technology will eliminate annual consumption of 19 MT of CFC-113/alcohol mixture and 16 MT of TCA.

[1] Net present value of first four years of operating costs/savings.

[2] Includes 15% contingency and a 3% financial institution fee.

BACKGROUND

Solvent cleaning processes in Thailand, which account for approximately 40 percent of the country's total ODP-weighted consumption, widely utilize CFC-113 and 1,1,1 trichloroethane (TCA). ODS consumption in the solvents industry is split almost equally between electronics and metal cleaning processes. Electronic cleaning processes include circuit-card and electronic part cleaning. Metal part cleaning includes most gross cleaning processes of large or heavily soiled parts such as sheet metal cleaning, cleaning prior to painting or surface finishing, and removal of machine oils from manufactured parts. In 1991, the solvent cleaning sector consumed 3,200 MT of CFC-113 and more than 7,100 MT of TCA.

Hana Semiconductor (BKK) Co, Ltd., which is 77.8 percent Thai-owned, is composed of 3 divisions: the Semiconductor, Printed Circuit Board (PCB), and Coil Divisions. In 1992, Hana sold 150 million integrated circuit packages and four million electronic modules. The company currently consumes 19 MT of a CFC-113/alcohol mixture in the cleaning of PCB assemblies and 16 MT of TCA in the removal of wax from the molding process in integrated circuit manufacturing.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of CFC-113 and TCA in cleaning operations through adoption of aqueous cleaning processes.

PROJECT DESCRIPTION

Hana will eliminate the use of CFC-113 and TCA through adoption of aqueous-based processes. Hana currently uses two vapor degreasers which are to be removed and replaced. The CFC-113 used in the PCB division to remove flux residues from the soldering process will be replaced. In the Semiconductor division, the use of the wet media process will replace the use of TCA in the removal of mold release compound from the exterior of plastic molded electronic parts. Hana expects that the quantity of products to be cleaned will increase by over 50% in the next three years. The company received one of the wet-media blasting machines on loan for evaluation and plans to complete the procurement of that machine along with the addition of two similar machines in the near future. Project funding is requested for one of these machines.

Hana will incur costs for the following elements:

- Process development and material compatibility testing
- Purchase of three medium capacity wet-media blasting machines
- Purchase of one high-volume aqueous cleaning machine
- Installation costs and worker training
- Recurring costs (including labor, electricity, wastewater treatment, other ingredients)
- Costs of environmental permitting

PROJECT COSTS

The total project cost of US$1,093,000 equals the ODS reduction portion of the overall project (investment costs plus net incremental operating costs). This project will not provide Hana with any incremental revenues.

Investment Costs of US$861,000 include capital investment and transportation costs for wet-media blasting machines, air compressors, and water recycling and aqueous cleaning equipment.

Net Incremental Operating Costs of US$232,000 are equal to the net present value of the first four years of incremental operating costs. These net operating costs are due primarily to the increased electricity requirements, the costs of the new equipment, and the costs of wastewater treatment.

Local Ownership Fraction of 78% was considered to determine the amount of eligible OTF grant financing. The total project cost was multiplied by the fraction of local ownership to determine the proposed grant amount.

Other Costs. A 15% contingency (US$128,000) was also included to ensure adequate funding of project costs following project appraisal. An additional US$30,000 (3%) was added to the grant request to cover the fee for services of the financial institution (FI) that will appraise the projects and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Hana is US$1,010,000 and was calculated as follows: the total investment cost was added to the present value of the incremental operating cost over the first four years of the project. The resulting total project cost was multiplied by the percentage of Thai ownership (78 percent). This figure was increased by a 15 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee.

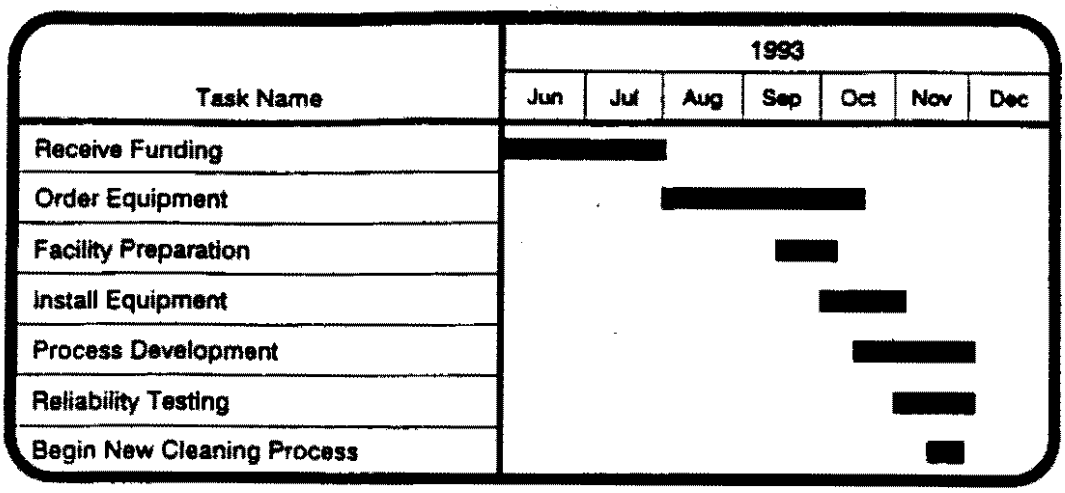
Although Hana exports 100 percent of its production, it is not located in a tax-free zone and is

therefore eligible for project funding from the Multilateral Fund.

PROJECT IMPLEMENTATION

Management: DIW will oversee the successful implementation of this project. The project will be carried out at Hana Semiconductor.

Schedule



ESTIMATED DISBURSEMENT: 80% in 1993, and 20% in 1994

TECHNICAL ASSESSMENT

This subproject is being reviewed by the OORG technical reviewer for solvents, Mr. Art FitzGerald. The review will be submitted by May 21.

northern telecom

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VIA TELECOPIER

May 28, 1993

Mr. Don Brown
The World Bank
1818 H Street, NW
Washington, D.C. 20433
U.S.A.

Dear Don:

Re: **Comments on Thailand Project**

I have reviewed the Thailand solvent projects for Hana Semiconductor, GSS Array, SAHA Union, THECO, CI Group, and TeamTronics, and have provided verbal comments to you. I have summarized these comments as follows:

- Was the no clean option considered for GSS Array, Hana Semiconductor, and TeamTronics? It appears that the type of products manufactured are candidates for the no-clean process, which would thus have avoided the need for waste water treatment facilities at these locations.

- In the case of SAHA Union, I ask if IBM's experts in San Jose, California were contacted with regard to the proposed process. If not, I recommend that Dr. Ming Ku, or other staff at San Jose, be brought into the project as it goes forward. IBM at San Jose has developed aqueous cleaning for the disc drives at that location and they would presumably have good information to share with SAHA which has IBM involvement.

- I'm not familiar with the plastic media cleaning process suggested for Hana Semiconductor and time constraints precluded any opportunity to familiarize myself with this concept. I am, therefore, unable to offer comments.

- The proposed technologies for cleaning of heat exchangers at CI Group and at THECO should work well and are considered appropriate alternates. Costs appear to be in the expected range for these technologies.

Generally speaking, my concerns rest with the selection of aqueous cleaning processes, especially in the case of manufacturing of consumer products, rather than promoting the concept of no clean as the preferred technology.

It has been shown by many companies that no clean is gaining acceptance as a preferred manufacturing technology -- for high tech/high reliability products such as in the telecommunications switching equipment, as well as for consumer products. The benefits include: removal of a manufacturing step; the avoidance of purchasing cleaning supplies; the avoidance of waste treatment and disposal; and, in many cases, improved product quality. I believe the industry trend towards no clean will continue which may, at some point in the future, make obsolete alternative cleaning systems such as aqueous.

There continue to be objectives to no clean by some manufacturers, often based on anticipated customer demand or reluctance to believe that high reliability electronic products can be manufactured without cleaning. A guide to selection of appropriate alternatives to CFC-113 and methyl chloroform cleaning in the electronics industry which would be based on industry experience gained over the past five years would be a useful document that could be used by the Bank, its consultants, and industry in developing countries. This concept was discussed at the OORG meeting and will be brought to the attention of the executive of the Industry Cooperative for Ozone Layer Protection (ICOLP) for consideration as something that experts from ICOLP member companies might develop.

Regards,

Art FitzGerald

Arthur D. FitzGerald
Director
Environmental Projects

ADF/jm
fl16

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand		
PROJECT TITLE:	Conversion to High-Purity Water Cleaning		
SECTOR COVERED:	Solvent Cleaning		
ODS USE IN SECTOR (1991):	3,270 MT ODP (3,200 MT CFC-113 & 7,100 MT TCA)		
PROJECT IMPACT:	Phase out 16 MT ODP per year (21 MT of CFC-113/Methanol Blend)		
PROJECT DURATION:	9 months		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Costs[1]:	US$ US$	574,000 (50,000)
PROPOSED OTF FINANCING[2]:	US$316,000 (@ 51% Thai Ownership)		
COST EFFECTIVENESS:	US$4.80/kg ODP/year		
IMPLEMENTING ENTERPRISE:	GSS Array Technology, Inc.		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This project will eliminate the use of CFC-113/methanol blended solvent in the cleaning of circuit card assemblies at GSS Array (GSS). The phaseout will be accomplished by replacing the current CFC-113/methanol in-line cleaner and a recently retired vapor degreaser with three in-line aqueous cleaners. The aqueous cleaners will be used to remove flux residues and light ionic contamination from the circuit cards. The project also includes the purchase and installation of a water recycling system. The conversion to non-ozone depleting technology will eliminate annual consumption of 21 MT of CFC-113/Methanol Blend. GSS is 51 percent Thai owned, which was taken into account in calculating the proposed OTF financing.

[1] Net present value of first four years of operating costs/savings.

[2] Includes 15% contingency and 3% financial institution fee.

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There continue to be objectives to no clean by some manufacturers, often based on anticipated customer demand or reluctance to believe that high reliability electronic products can be manufactured without cleaning. A guide to selection of appropriate alternatives to CFC-113 and methyl chloroform cleaning in the electronics industry which would be based on industry experience gained over the past five years would be a useful document that could be used by the Bank, its consultants, and industry in developing countries. This concept was discussed at the OORG meeting and will be brought to the attention of the executive of the Industry Cooperative for Ozone Layer Protection (ICOLP) for consideration as something that experts from ICOLP member companies might develop.

Regards,

Art FitzGerald

Arthur D. FitzGerald
Director
Environmental Projects

ADF/jm
fl16

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand	
PROJECT TITLE:	Conversion to High-Purity Hot Water Cleaning	
SECTOR COVERED:	Solvent Cleaning	
ODS USE IN SECTOR (1991):	3,270 MT ODP (3,200 MT CFC-113 & 7,100 MT TCA)	
PROJECT IMPACT:	Phase out 27 MT ODP per year (36 MT of CFC-113/alcohol blend, containing 34 MT of CFC-113)	
PROJECT DURATION:	9 months	
TOTAL PROJECT COST:	ODS Reduction Investment Cost:	US$ 2,620,000
	Incremental Operating Costs[1]:	US$ 100,000
PROPOSED OTF FINANCING[2]:	US$ 2,573,000 (@ 80% Thai Ownership)	
COST EFFECTIVENESS:	US$16.71/kg ODP/year	
IMPLEMENTING ENTERPRISE:	Saha Union Corporation, Ltd. (Sriracha Plant)	
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand	
IMPLEMENTING AGENCY:	The World Bank	
APPRAISAL DATE:	August, 1993	

PROJECT SUMMARY

This project will eliminate the use of CFC-113 in the cleaning of hard disk drives and affiliated components at Saha Union's Sriracha facility. The CFC-113 in-line cleaning process will be directly replaced with an Ultrapure Deionized (UDI) water process specified and supported by IBM. The project also provides support for water recycling, high-purity air production, waste water treatment, process development, installation of the new equipment, and environmental permitting. The conversion of Saha from CFC-113 cleaning processes to UDI cleaning will result in an annual reduction of 34 MT of ozone depleting substances.

[1] Net present value of first four years of operating costs/savings.

[2] Includes 15% contingency and 3% financial institution fee.

BACKGROUND

Solvent cleaning processes in Thailand, which account for approximately 40 percent of the country's total ODP-weighted consumption, widely utilize CFC-113 and 1,1,1 trichloroethane (TCA). ODS consumption in the solvents industry is split almost equally between electronics and metal cleaning processes. Electronic cleaning processes include circuit-card and electronic part cleaning. Metal part cleaning includes most gross cleaning processes of large or heavily soiled parts such as sheet metal cleaning, cleaning prior to painting or surface finishing, and removal of machine oils from manufactured parts. In 1991, the solvent cleaning sector consumed 3,200 MT of CFC-113 and more than 7,100 MT of TCA.

Saha Union (Saha) is an 80 percent Thai-owned company which manufactures computer hard disk drives, head arm assemblies, and head suspension assemblies for direct sale to IBM Thailand Ltd. Saha currently uses one 6-bath CFC-113 cleaner and one 3-bath CFC-113 cleaner, and consumes 36 MT per year of a CFC-113/ethanol azeotrope.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of CFC-113 in cleaning operations. The use of CFC-113 in electronics cleaning applications will be replaced with ultra high-purity water cleaning.

PROJECT DESCRIPTION

In this project, Saha will eliminate the use of a CFC-113 and ethanol azeotrope by adopting an Ultrapure Deionized (UDI) water cleaning process. The Saha customer requires that the company eliminate ODS consumption. Saha will discontinue use of the current CFC-113 cleaners after the installation of the new equipment is complete. The new equipment will be installed immediately adjacent to the current machine in a Class 10,000 clean room. The custom UDI in-line cleaning machine will be consigned to Saha by its customer; utilities to support the cleaning machine also constitute a major part of this project. The capacity of the new equipment will equal the capacity of the current machine. The project consists of the following elements:

- Ultraclean, low-moisture air equipment
- Ultrapure deionized water and air equipment
- Waste water treatment and recycling system
- Recurring activities (including solvent purchase, labor, electricity, wastewater treatment, etc.)

The UDI in-line cleaning machine project is a complete turnkey system consisting of various components (i.e. reverse-osmosis water filtration, distillation, air-filtration) to ensure adequate process control. The UDI water supply system is designed to supply more than 85 cubic meters of heated ultrapure deionized water per day to the cleaning machine. This system is a complicated network of basic water treatment systems integrated to produce hot, high-purity, low particulate water. High purity air (40 cubic meters per minute) is used to dry the parts at the exit of the UDI cleaner. The waste water treatment system is designed to recycle the UDI water through the UDI water supply system, at a rate of approximately 94 percent of source water.

PROJECT COSTS

The total project cost of US$2,715,000 equals the ODS reduction portion of the overall project (investment costs plus net incremental operating costs). This project will not provide Saha with any incremental revenues.

Investment Costs of US$2,615,000 include the purchase, shipping, insurance and installation of a water cleaning machine and recycling equipment, and associated costs of utility installation.

Net Incremental Operating Costs of US$100,000 are equal to the net present value of the first four years of incremental operating costs. These net operating costs are due primarily to the increased electricity requirements and the costs of wastewater treatment.

Local Ownership Fraction of 80% was considered to determine the amount of eligible OTF grant financing. The total project cost was multiplied by the fraction of local ownership to determine the proposed grant amount.

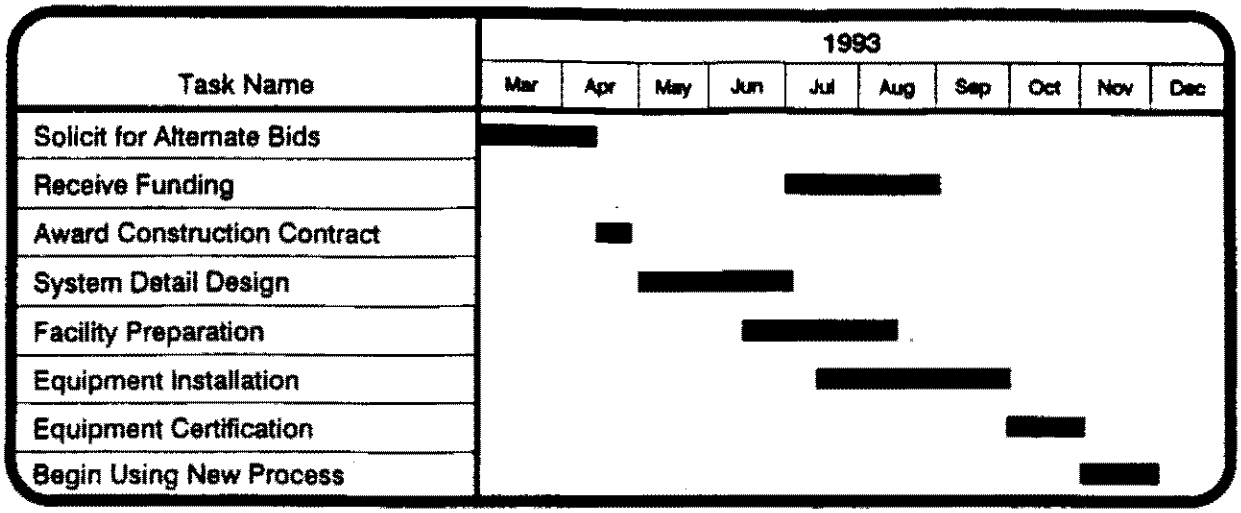
Other Costs. A 15% contingency (US$326,000) was also included to ensure adequate funding of project costs following project appraisal. An additional US$75,000 (3%) was added to the grant request to cover the fee for services of the financial institution (FI) that will appraise the projects and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Saha is US$2,573,000 and was calculated as follows: the total investment cost was added to the present value of the incremental operating cost over the first four years of the project. The resulting total project cost was multiplied by the percentage of Thai ownership (80 percent). This figure was increased by a 15 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee.

PROJECT IMPLEMENTATION

Management: DIW will oversee the successful implementation of this project. The project will be carried out at Saha Union.

Schedule



ESTIMATED DISBURSEMENT: 90% in 1993, and 10% in 1994

TECHNICAL ASSESSMENT

This subproject is being reviewed by the OORG technical reviewer for solvents, Mr. Art FitzGerald. The review will be submitted by May 21.

May 26 '93 12:22 NO.009 P.02

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VIA TELECOPIER

May 28, 1993

Mr. Don Brown
The World Bank
1818 H Street, NW
Washington, D.C. 20433
U.S.A.

Dear Don:

Re: **Comments on Thailand Project**

I have reviewed the Thailand solvent projects for Hana Semiconductor, GSS Array, SAHA Union, THECO, CI Group, and TeamTronics, and have provided verbal comments to you. I have summarized these comments as follows:

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Generally speaking, my concerns rest with the selection of aqueous cleaning processes, especially in the case of manufacturing of consumer products, rather than promoting the concept of no clean as the preferred technology.

It has been shown by many companies that no clean is gaining acceptance as a preferred manufacturing technology -- for high tech/high reliability products such as in the telecommunications switching equipment, as well as for consumer products. The benefits include: removal of a manufacturing step; the avoidance of purchasing cleaning supplies; the avoidance of waste treatment and disposal; and, in many cases, improved product quality. I believe the industry trend towards no clean will continue which may, at some point in the future, make obsolete alternative cleaning systems such as aqueous.

There continue to be objectives to no clean by some manufacturers, often based on anticipated customer demand or reluctance to believe that high reliability electronic products can be manufactured without cleaning. A guide to selection of appropriate alternatives to CFC-113 and methyl chloroform cleaning in the electronics industry which would be based on industry experience gained over the past five years would be a useful document that could be used by the Bank, its consultants, and industry in developing countries. This concept was discussed at the OORG meeting and will be brought to the attention of the executive of the Industry Cooperative for Ozone Layer Protection (ICOLP) for consideration as something that experts from ICOLP member companies might develop.

Regards,

Arthur D. FitzGerald
Director
Environmental Projects

ADF/jm
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The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand		
PROJECT TITLE:	Conversion to Aqueous Cleaning		
SECTOR COVERED:	Solvent Cleaning		
ODS USE IN SECTOR (1991):	3,270 MT ODP (3,200 MT CFC-113 & 7,100 MT TCA)		
PROJECT IMPACT:	Phase out 11 MT ODP (111 MT of TCA)		
PROJECT DURATION:	9 months		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Costs[1]:	US$ US$	681,000 (320,000)
PROPOSED OTF FINANCING[2]:	US$ 428,000 (@ 100% Thai Ownership)		
COST EFFECTIVENESS:	US$0.90/kg ODP/year		
IMPLEMENTING ENTERPRISE:	Thai Heat Exchange Company, Ltd. (THECO)		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This project will eliminate the use of 1,1,1 trichloroethane (TCA) in the cleaning of small and medium size heat exchangers manufactured for automobiles, trucks, room air conditioners and refrigeration units at Thai Heat Exchange Co. Ltd. (THECO). The phaseout will be accomplished by replacing the current vapor degreasing cleaning process with an aqueous-based cleaning process and the addition of drying equipment. The conversion to non-ozone depleting technology will eliminate annual consumption of 111 MT of TCA. THECO is 100 percent Thai owned, which was taken into account in calculating the proposed OTF financing.

[1] Net present value of first four years of operating costs/savings.

[2] Includes 15% contingency and 3% financial institution fee.

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Project Cover Sheet

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SECTOR COVERED:	Solvent Cleaning		
ODS USE IN SECTOR (1991):	3,270 MT ODP (3,200 MT CFC-113 & 7,100 MT TCA)		
PROJECT IMPACT:	Phase out 13 MT ODP per year (127 MT of TCA)		
PROJECT DURATION:	9 months		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Costs[1]:	US$ US$	538,000 (304,000)
PROPOSED OTF FINANCING[2]:	US$ 277,000 (@ 100% Thai Ownership)		
COST EFFECTIVENESS:	(US$0.67)/kg ODP/year[3]		
IMPLEMENTING ENTERPRISE:	C.I. Group Company, Ltd. (CIG)		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This project will eliminate the use of 1,1,1 trichloroethane (TCA) in the cleaning of small and medium size heat exchangers manufactured for automobiles, trucks, and refrigeration units at C.I. Group Company, Ltd (CIG). The phaseout will be accomplished by installing an aqueous-based cleaning process and water recycling equipment. Drying equipment is required to remove moisture after the aqueous cleaning process. The conversion to non-ozone depleting technology will eliminate annual consumption of 127 MT of TCA. CIG is 100 percent Thai owned, which was taken into account in calculating the proposed OTF financing.

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[1] Net present value of first four years of operating costs/savings.

[2] Includes 15% contingency and 3% financial institution fee.

[3] This number is derived from annualized incremental capital costs of US$88,000, first year incremental annual operating costs of US$(96,000), and savings of 12.7 MT (weighted) of ODS per year.

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The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand		
PROJECT TITLE:	Elimination of ODS Used in the Production of Household Refrigerators		
SECTOR COVERED:	Household Refrigerator		
ODS USE IN SECTOR (1992):	1080 MT ODP (430 MT CFC-12 & 650 MT CFC-11)		
PROJECT IMPACT:	Eliminate 50 MT ODP per year (12 MT CFC-12 & 42 MT CFC-11)		
PROJECT DURATION:	Phase I: 2 years Phase II: 1 year		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Cost[1]:	US$ US$	3,001,000 0
PROPOSED OTF FINANCING[2]:	US$ 1,940,000 (@ 54.5% Thai Ownership)		
COST EFFECTIVENESS:	Not Applicable		
IMPLEMENTING ENTERPRISE:	Thai Toshiba Electric Industries Co., Ltd.		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators manufactured at Thai Toshiba Electric Industries Co., Ltd. (TTEI). The project comprises two phases and will convert the production line to refrigerators using HFC-134a and HCFC-141b as the new refrigerant and foam blowing agent, respectively. The first phase will provide for product development using CFC alternatives and will identify all equipment and process changes needed to implement the alternative technology. During this phase, Thai Toshiba Electric Industries will acquire engineering assistance and training from its parent company, Toshiba Corporation of Japan. In Phase II, TTEI will purchase and install the new equipment necessary for mass production of CFC-free refrigerators. The project will result in the elimination of 12 MT/year of CFC-12 (refrigerant) and 42 MT/year of CFC-11 (foam blowing agent) after the conversion is completed.

[1] Net present value of first four years of operating costs/savings.

[2] Includes 15% contingency and 3% financial institution fee.

BACKGROUND

The domestic refrigeration industry in Thailand uses CFC-12 to charge new appliances and during servicing, and uses CFC-11 in the production of polyurethane (PU) insulation foam. The demand for household refrigerators and freezers in Thailand is increasing at a rate greater than 10% per year, and most units sold in Thailand are made locally by seven major manufacturers: Sanyo, Toshiba, Hitachi, Sharp Appliances, Mitsubishi, A.P. National, and Admiral. Most of these refrigerators are equipped with compressors manufactured in Thailand by Sanyo and Kulthorn Kirby. In 1992, the sector used a total of 430 MT of CFC-12 (210 MT to charge new appliances and 220 MT for servicing), and about 650 MT of CFC-11.

Thai Toshiba Electric Industries Co., Ltd. (TTEI), which is 54.5 percent Thai owned, produces approximately 120,000 refrigerators annually, comprising nine different models. The plant has two production lines with a total capacity of 140,000 sets a year, and TTEI expects to reach its maximum capacity by the end of 1993. In 1992, the company consumed 12 MT of CFC-12 and 42 MT of CFC-11. The average CFC-12 charge size in its refrigerators is .11 kg. TTEI has begun using a 30 percent CFC-11 reduced foam formulation in its refrigerators and uses about 0.40 kg of CFC-11 per set.

PROJECT OBJECTIVE

The objective of this project is to phase out CFC-12 and CFC-11 used in household refrigerators and freezers at Thai Toshiba Electric Industries.

PROJECT DESCRIPTION

In this project, Thai Toshiba Electric Industries will eliminate the use of CFC-12 and CFC-11 in household refrigerators by converting its manufacturing facility to one compatible with HFC-134a and HCFC-141b, the new refrigerant and foam blowing agent respectively. The project will be divided into two phases. The first phase will provide for engineering assistance, training, and acquisition of specific equipment for testing the new refrigerators. The second phase will allow for the elimination of CFC-12 and CFC-11 through the ordering and installation of new equipment necessary for mass production of CFC-free refrigerators. In the third phase, not addressed in this project, actual production of CFC-free refrigerators will take place. Incremental operating costs would only occur in Phase III.

The main objective of the project's first phase consists of developing reliable new CFC-free refrigerators at TTEI. This task is particularly difficult to accomplish given the considerable engineering design modifications and the necessary testing that have to be done in a relatively short period of time. In order to minimize the risks associated with the conversion process, TTEI will acquire technical assistance during Phase I from its parent company, Toshiba Corporation of Japan. This technical assistance represents a continuation of existing arrangements between the two companies. TTEI has used similar arrangements in the past to develop its existing line of refrigerator models. As part of the technical agreement, Toshiba Corporation of Japan will do the following:

- Design the different refrigerator models
- Conduct approval tests for each refrigerator model
- Conduct approval tests for the compressors made in Thailand
- Provide production drawings for the new models
- Provide training on manufacturing, maintenance, and quality control
- Provide engineering assistance for manufacturing development and operations.

Phase I will provide TTEI with technology developed by the parent company in Japan, modifying it where necessary to account for differences in Thai manufacturing conditions and refrigerator models.

Additional funding requested in the proposal for Phase I will be used to acquire a controlled ambient test room with an accompanying data acquisition system in order to test the refrigerators and make sure that they are manufactured according to design specifications.

Phase II of the project will consist of finalizing the transition to CFC-free technology for mass production. During this transition time, both CFC and non-CFC refrigerators will be produced on the same line. TTEI will purchase and install an additional set of charging equipment (for HFC-134a) as well as a new polyurethane injection foam machine and other equipment. Because of the flammability of HCFC-141b, additional safety precautions will be taken, such as increasing the ventilation of the room where the machine will be installed. Care will be taken during this period to avoid cross contamination of refrigerants and compressor oils. Six halogen leak detectors for HFC-134a will also be purchased.

Because HCFC-141b has a higher thermal conductivity than CFC-11, there is the possibility that the insulation thickness of the refrigerators will have to be increased to maintain satisfactory levels of energy consumption. A change in insulation thickness will require the procurement of a set of new dies, molds and jigs, the cost of which has been estimated at $1.6 million.

Final decisions on all of the equipment purchasing and retrofitting (including new equipment for increased insulation thickness), except for minimal equipment required to build field test models, will be made

after Phase I is complete and test results are analyzed. Equipment items included in this project are based on preliminary test results and experience of Japanese parent companies.

PROJECT COSTS

Total Project Cost

The total project cost of US$3.01 million equals the ODS reduction portion of the overall project (investment costs plus net incremental operating costs). This project will not provide Thai Toshiba Electric Industries with incremental revenues.

Investment Costs of US$3.01 million include costs associated with CFC-free refrigerator product development, technical assistance from Toshiba of Japan, testing, new equipment for mass production, and training.

Net Incremental Operating Costs: Because full scale production of refrigerators with HFC-134 and HCFC-141b will not occur until 1996, incremental operating costs have not been included as part of this project. Incremental operating costs will be reexamined at a later date.

Local Ownership Fraction of 54.5% was considered to determine the amount of eligible OTF grant financing. The total project cost was multiplied by the fraction of local ownership to determine the proposed grant amount.

Other Costs. A 15% contingency (US$246,000) was also included to ensure adequate funding of project costs following project appraisal. An additional US$57,000 (3%) was added to the grant request to cover the fee for services of the financial institution (FI) that will appraise the projects and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Thai Toshiba is US$1,943,000 and was calculated as follows: the total investment cost was added to the present value of the incremental operating cost over the first four years of the project. The resulting total project cost was multiplied by the percentage of Thai ownership (54.5 percent). This figure was increased by a 15 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee.

PROJECT IMPLEMENTATION

Management: DIW will oversee the successful implementation of this project. The project will be carried out at TTEI. Toshiba Corporation of Japan will provide technical assistance to TTEI during project execution.

Schedule

TASK	1993	1994	1995	1996
Phase I: Model Development, Technical Assistance	xxxx	xxxx		
Testing and Training	x	xxxx	xx	
Phase II: Procurement and Installation of Equipment			xxxx	
Conversion of Production Line to Non-CFC Technology			x	
Full Production of Non-CFC Refrigerators				x

Note: x = one quarter of the year

ESTIMATED DISBURSEMENT: 20% in 1993, 20% in 1994, and 60% in 1995

TECHNICAL ASSESSMENT

This subproject has been reviewed by the OORG technical reviewer, Dr. Michael Jeffs. The project was supported. Suggestions made relative to estimates of equipment costs will be pursued during project appraisal. In addition to Dr. Jeff's review, comments were received from OORG reviewer Dr. L. Kuijpers. A formal review from Mr. Kuijpers will be submitted by May 25.

ICI Polyurethanes

Mr. D. Brown
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Belgium

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Telex 26151 ICIEVB B
Telefax (02) 759 55 01

5th May, 1993

THAILAND SUB PROJECT PROPOSALS

Dear Don,

Documents were received on 3/5/93.

General comments are :

- Enterprises which are subsidiaries of Japanese refrigerator manufacturers are proposing the use of HCFC 141b foam technology - this is in line with the changes now being implemented in Japan by the parent companies. However, this could be a comparatively short term option in Japan. There is an increasing level of interest in the performance of cyclopentane-based foam which is now being implemented in Europe. Further, at least two Japanese manufacturers are to base part of their production on composites of vacuum insulation panels with CO_2 (water)-blown polyurethane foam.

- HCFC 141b foam technology is now well proven and gives equivalent insulation values to foam based on CFC 11 despite its higher gas thermal conductivity.

- HCFC 22 foam technology is not used unless it is protected by steel panels because of deterioration of thermal insulation with time. The technology proposed by Admiral is not supported for use in refrigerators with plastic liners. The blend HCFC 22 / HCFC 142b overcomes this ageing problem and is in use elsewhere.

- Several projects call for the purchase of new foam injection machines as well as vacuum forming equipment for liners and jigs. Individual comments are given for the enterprises but in general the need for these items should be reviewed at the end of phase 1.

distributor or manufacturer price?

- The HCFC 141b price projection quoted in exhibit 1 of the feasibility study is too high. Current prices are about 50% of the quoted 1994 price level.
- Difficulty of gauging value of technical assistance from parent companies.

Dr. G. M. F. Jaffe - OORG MD 152
GMFJ/kd/41'

cc : Mr. T. Waltz

Kingdom of Thailand

PRELIMINARY REVIEW OF A NUMBER OF PROJECTS

Conversion of Domestic Manufacturing to HFC-134a and to HCFC-141b in Polyurethane Foams; Conversion of Chillers to HFC-134a

Projects Described by The World Bank, March 1993

1. **Introduction of HCFC-141b for foams and the conversion process to HFC-134a for cooling at THAI TOSHIBA Industries;**
2. **Idem, at ADMIRAL Industries;**
3. **Idem, at HITACHI Industries;**
4. **Idem, at KANG YONG Industries;**
5. **Idem, at AP National Industries;**
6. **Two Chiller Conversion Projects to HFC-134a.**

Kuijpers, LJM (OORG)
Eindhoven, 1993 03 11
RWR-570-LK-93106 -lk

REMARKS REGARDING THE PROPOSALS

1. Foam Blowing

All projects describe a conversion from CFC-11 to HCFC-141b. In a first instance, it is remarkable that there is a large price difference between the conversions proposed for the different industries (take e.g. the difference between AP and Toshiba, 0.25 and 1.79 million). Indeed, HCFC-141b seems to be the preferred route for the Japanese, although, until recently, they have also maintained the HCFC-123 option. It may be that they will stick to the HCFC-141b option, however, in Europe there is a tendency (whether or not realistic) to study cyclopentane, a flammable high boiling refrigerant. About its performance nothing is known so far (conductivity value is worse compared to others, I do not know about long term behaviour).
One should bear in mind that the European manufacturers have been evaluating both 22/142b and 141b for quite some time; they achieved slightly inferior results with 22/142b: however, the long term behavior is not so good, due to diffusion of HCFC-22. Nevertheless, almost all manufacturers switched to HFC-134a (no chlorine anymore, due to environmental group pressure in Germany) shortly before the Domotechnica fair (apart from one). So I do not know whether this could play a role in Japan and in the daughter companies as well.
The best thing is to ask the OORG foam expert as well (Jeffs, ICI), regarding the time involved in optimizing HFC-134a foams. Dependent on this one could solve the question on whether or not to invest in the HCFC-141b route in Thai companies or to postpone a decision to later this year.

2. Refrigeration, general observations

The CFC-12 consumption of the five companies amounts to about 78 tonnes, while a total consumption of 250 tonnes in this sector is mentioned. Is there another large manufacturer involved ?
The above does not hold for CFC-11, 300 tonnes compared to 500 tonnes is used by the firms considered.

Several companies should do something regarding their use of CFC-11, i.e. apply reduction measures (take e.g. Kang Yong and AP which probably use CFC-11 also for cleaning) since the consumption is large compared to the CFC-12 consumption.

3. Refrigeration, specific topics

There is technology support from the mother companies, the costs however vary widely not dependent on the size of the company, e.g. 592,000 for Matsushita supporting the small AP firm. More information (e.g. contracts) on what is specifically covered in each of the cases is absolutely necessary. There is also a question on whether or not the relationship to Kultorn Kirby should not be described more precisely. Description so far (Kirby will provide the companies with compressors for testing) is not at all sufficient. It is often the compressor manufacturer (with its specific lubricant properties and so on) that determines the technology transfer. Design of the appliances and the manufacturing process can be supported by the mother company.
Kirby plays a key role in Thai companies, for this reason more precise information would be extremely useful.
This will also determine whether or not CFC-12 and HFC-134a appliances can be manufactured using the same assembly line.

In particular the technology transfer issue is important; the phased approach presented is in principle OK.

There is also a question regarding test rooms. What is determining the size and the costs for a test room. There is again a remarkable difference between the Admiral company and Hitachi, the smallest and largest in size. The same holds for the differences in costs for refrigerant and oil charging equipment. Maybe this could be explained somewehat more detailed in the proposal. Some firms will invest in leak detectors; does this not hold for all of them ?
A consistent approach and evaluation would be desireable.

Taking the amounts of CFCs involved costs vary from about 18 to 145 USD per kg of CFC (11 and 12) phased out per year. Is this an acceptable figure ?

4. Chillers

As far as the chiller conversion is concerned, there are no significant remarks.
For the HFC-134a conversion, the cost is in the order of USD 30 per kg of CFC-12 not used, which is a high figure, and which should be supported by considerations on the lifetime and economic value of the equipment.
As far as the HCFC-123 conversion, no remarks.

Eindhoven, 11 March 1993

L.J.M. Kuijpers

ENTERPRISE : THAI TOSHIBA INDUSTRIES

RECOMMENDATION

Supported subject to the comments below (particularly relating to Phase 2).

RELEVANCY AND ADEQUACY OF INFORMATION

Further information should be sought on the need for a new foam machine, modifications to the existing machine and environment measurement for the line.

TECHNICAL SOUNDNESS

HCFC 141b foam technology is well proven and use has shown no deterioration in insulation value. Hence, the need to purchase new dies, moulds and jigs is unlikely as there should be no change in foam thickness.

LESSON FROM EXPERIENCE

None

ENVIRONMENTAL ISSUES

HCFC 141b is a transitional material which will have to be replaced by a zero ODP blowing agent. Its use contributes to a saving of 49.7 ODP te.

SAFETY ISSUES

Adequate precautions are apparently planned for the flammable nature of HCFC 141b.

COST EFFECTIVENESS

The items for foam insulation in Phase 2 should be reappraised.

OTHERS

None

Thailand

REVIEW OF FIVE PHASE-1 CONVERSION PROJECTS

Conversion of Domestic Appliance Manufacturing to HFC-134a

Project Proposals by The World Bank, April 1993

First Phase of Appliance Manufacture Conversion from CFC-12 to HFC-134a at
Thai-Toshiba
Hitachi Consumer Products
AP National
Admiral Thailand
Kang Yong Electric Industries.

Kuijpers, LJM (OORG) Eindhoven,
1993 05 06
RTU-UNEP-LK-93170 -lk

REVIEW OF THE PHASE 1 PROPOSALS

Recommendation

All project descriptions propose a phase 1 of a two step approach, in agreement with the recommmendations by the OORG group of the Bank. In most cases there is sufficient back up from the developed country appliance manufacturer, where it also applies to additional tests (mainly in Japan).

However, most of the remarks from my earlier review still apply to these latest project proposals:
1. The relationship (and timescale of introduction) with the compressor manufacturers has still many uncertainties since the compressor manufacturers have still to convert their production with the support from others. This implies that the appliance manufacturers will depend on relationships that depend on other relationships where still uncertain parameters are involved.
2. The size of the production of the different manufacturers is quite different, from about 140,000 down to 4,800 (Admiral). Nevertheless, the costs for technical support and for new equipment to be bought do not have any relationship to the production volume.
3. The costs for technical assistance seem to be random, and quite high. As an example, technical assistance for AP National (USD 700,000, production volume 74,000) cannot be compared to others (e.g. Sanyo (USD 454,800, production volume 600,000 pieces). This issue needs to be clarified first.

It is recommended to first establish criteria for the costs for technical assistance -whether or not related to the production volume, e.g. with certain maxima, before that these projects should be approved.
It should also be realized that the conversion will be dependent on the success of the conversion process at compressor manufacturers (projects still to be approved).

Taking these arguments into account, it is difficult to give an overall recommendation for (dis)approval. Costs for Admiral are too high, there is no back up from another manufacturer. Technical assistance costs for AP National are (too) high.

2. Relevance and adequacy of information provided

The project proposals give adequate short descriptions of what is envisaged to be accomplished during a first phase.
The technical assistance agreements are not very well specified (comparable to the Sanyo project), the idea is obtained that a reliable appliance production can be guaranteed (e.g. by additional testing in Japan etc.). However, costs for technical assistance seem to be random:

- Sanyo (separate proposal):	USD 434,800	for a volume of 600,000 places.
- TTEI:	USD 510,800	140,000 "
- Kang Yong	USD 320,000	115,000 "
- AF National	USD 700,000	74,000 "
- Hitachi	USD 480,000	142,000 "
- Admiral (astironte)	USD 150,000	4,800 ".

3. Technical soundness

In the conversion to HFC-134a, it is in particular the certainty that a reliable product can be manufactured, which has to do with adapting local manufacturing processes that will cost money. It will always be difficult to manufacture CFC-12 and HFC-134a appliances at the same moment, unless very special precautions are taken.
The reliability of the appliance will also depend on the quality (and the type) of the compressor. This cannot be estimated at this moment.
Since Kulthorn Kirby is one of the main manufacturers of compressors involved, it should be ascertained whether this company can solve problems which might occur at the manufacturers at the same time.

4. Cost effectiveness

Cost effectiveness cannot be discussed. There are only some questions as already mentioned above:

1. Does "technical assistance" imply a relationship to the production volume ?.
2. Costs for lab equipment (test room) and for charging equipment are quite different. E.g. the costs for charging at Admiral is equal to others with a much bigger production volume.
3. It is difficult to judge upon whether some manufactuers need test rooms, others not.

6/5 1993

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand		
PROJECT TITLE:	Elimination of ODS Used in the Production of Household Refrigerators		
SECTOR COVERED:	Household Refrigerator		
ODS USE IN SECTOR (1992):	1080 MT ODP (430 MT CFC-12 & 650 MT CFC-11)		
PROJECT IMPACT:	Eliminate 109 MT ODP per year (19 MT CFC-12 & 101 MT CFC-11)		
PROJECT DURATION:	Phase I: 2 years Phase II: 1 year		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Cost[1]:	US$ US$	3,270,000 0
PROPOSED OTF FINANCING[2]:	US$2,320,000 (@ 60% Thai Ownership)		
COST EFFECTIVENESS:	Not Applicable		
IMPLEMENTING ENTERPRISE:	Kang Yong Electric Co., Ltd.		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators manufactured at Kang Yong Electric Co., Ltd. (KYE) in Thailand. The project comprises two phases and will convert the production line to refrigerators using HFC-134a and HCFC-141b as the new refrigerant and foam blowing agent respectively. The first phase will provide for product development using CFC alternatives and will identify all equipment and process changes needed to implement the alternative technology. During this phase, Kang Yong Electric will obtain engineering assistance and training from its parent company, Mitsubishi Electric Corporation of Japan. In Phase II KYE will purchase and install new equipment necessary for mass production of CFC-free refrigerators. The project will result in the elimination of 19 MT/year of CFC-12 (refrigerant) and 101 MT/year of CFC-11 (foam blowing agent) after the conversion is completed.

[1] Net present value of first four years of operating costs/savings.

[2] Includes 15% contingency and 3% financial institution fee.

BACKGROUND

The domestic refrigeration industry in Thailand uses CFC-12 for charging new appliances and during servicing, and uses CFC-11 in the production of polyurethane (PU) insulation foam. The demand for household refrigerators and freezers in Thailand is increasing at a rate greater than 10% per year, and most units sold in Thailand are made locally by seven major manufacturers: Sanyo, Toshiba, Hitachi, Sharp Appliances, Mitsubishi, A.P. National, and Admiral. Most of these refrigerators are equipped with compressors manufactured in Thailand by Sanyo and Kulthorn Kirby. In 1992, the sector used a total of 430 MT of CFC-12 (210 MT to charge new appliances and 220 MT for servicing), and about 650 MT of CFC-11.

Kang Yong Electric Co., Ltd. (KYE), which is 60 percent of the company is Thai owned, produces approximately 115,000 refrigerators annually comprising seven different models. The plant has one production line with a total capacity of 162,000 sets a year. KYE expects to reach its maximum capacity by the end of 1996. In 1992, the company consumed 19 MT of CFC-12 and 101 MT of CFC-11. The typical CFC-12 charge size in its refrigerators is 0.115 kg. KYE uses an average of 0.60 kg of CFC-11 as a foam blowing agent per set but began using a 20 percent CFC-11 reduced formulation in December of 1992.

PROJECT OBJECTIVE

The objective of this project is to phase out CFC-12 and CFC-11 used in household refrigerators and freezers at Kang Yong Electric Co., Ltd.

PROJECT DESCRIPTION

In this project, Kang Yong Electric will eliminate the use of CFC-12 and CFC-11 in household refrigerators by converting its manufacturing facility to one compatible with HFC-134a and HCFC-141b, the new refrigerant and foam blowing agent respectively. The project will be divided into two phases. The first phase will provide for engineering assistance, training, and acquisition of specific equipment for testing the new refrigerators. The second phase will allow for the elimination of CFC-12 and CFC-11 through the ordering and installation of new equipment necessary for mass production of CFC-free refrigerators. In the third phase, not addressed in this project, actual production of CFC-free refrigerators will take place. Operating costs would only occur in Phase III.

The main objective of the project's first phase consists of developing reliable new CFC-free refrigerators at KYE. This task is particularly difficult to accomplish given the considerable engineering design modifications and the necessary testing that have to be done in a relatively short period of time. In order to minimize the risks associated with the conversion process, KYE will acquire technical assistance during Phase I from its parent company, Mitsubishi Electric Corporation of Japan. This technical assistance represents a continuation of existing arrangements between the two companies. Kang Yong Electric has used similar arrangements in the past to develop its existing line of refrigerator models. As part of the technical agreement, Mitsubishi Electric Corporation of Japan will do the following:

- Design the different refrigerator models
- Conduct approval tests for each refrigerator model
- Conduct approval tests for the compressors made in Thailand
- Provide production drawings for the new models
- Provide training on manufacturing, maintenance, and quality control
- Provide engineering assistance for manufacturing development and operations.

Phase I will provide KYE with technology developed by the parent company in Japan, modifying it where necessary to account for differences in Thai manufacturing conditions and refrigerator models.

Additional funding requested in the proposal for Phase I will be used to acquire a new controlled ambient test room with an accompanying data acquisition system in order to test the refrigerators and make sure that they are manufactured according to design specifications.

Phase II of the project will consist of finalizing the transition to CFC-free technology for mass production. During this transition time, both CFC and non-CFC refrigerators will be produced on the same line. KYE will purchase and install an additional set of charging equipment (for HFC-134a and ester oil) as well as a new polyurethane injection foam machine. Care will be taken to avoid moisture absorption in ester oil by acquiring a compressor oil processing system. Kang Yong plans to purchase compressors free of oil to avoid the possibility of oil contamination by the compressor manufacturer. New halogen leak detectors for HFC-134a will also be purchased. Because of the flammability of HCFC-141b, additional safety precautions will be taken, such as increasing the ventilation of the room where the machine will be installed. Modifications will be made to the mass production test room to increase the cooling test time and improve the ventilation and air conditioning system.

There is evidence that the new plastic ABS material for the cabinet liner required with HCFC-141b cannot be formed with the existing equipment. Therefore, a new vacuum forming machine estimated at $1.26 million might need to be purchased. In addition, the new foam may need more time for curing, which, if verified by tests, would require that the foaming line be lengthened. The cost of this modification in the line

has been estimated at $400,000.

Final decisions on all of the equipment purchasing and retrofitting, except for minimal equipment required to build field test models, will be made after Phase I is complete and test results are analyzed. Equipment items included in this project are based on preliminary test results and experience of Japanese parent companies.

PROJECT COSTS

Total Project Cost

The total project cost of US$3.27 million equals the ODS reduction portion of the overall project (investment costs plus net incremental operating costs). This project will not provide Kang Yong Electric with incremental revenues.

Investment Costs of US$3.27 million include costs associated with CFC-free refrigerator product development, technical assistance from Mitsubishi of Japan, testing, equipment for mass production, and training.

Net Incremental Operating Costs: Because full scale production of refrigerators with HFC-134 and HCFC-141b will not occur until 1996, incremental operating costs have not been included as part of this project. Incremental operating costs will be reexamined at a later date.

Local Ownership Fraction of 60% was considered to determine the amount of eligible OTF grant financing. The total project cost was multiplied by the fraction of local ownership to determine the proposed grant amount.

Other Costs. A 15% contingency (US$294,000) was also included to ensure adequate funding of project costs following project appraisal. An additional US$68,000 (3%) was added to the grant request to cover the fee for services of the financial institution (FI) that will appraise the projects and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Kang Yong Electric Co., Ltd. is US$2,324,000 and was calculated as follows: the total investment cost was added to the present value of the incremental operating cost over the first four years of the project. The resulting total project cost was multiplied by the percentage of Thai ownership (60 percent). This figure was increased by a 15 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee.

PROJECT IMPLEMENTATION

Management: DIW will oversee the successful implementation of this project. The project will be carried out at Kang Yong Electric. Mitsubishi Electric Corp. of Japan will provide technical assistance to KYE during project execution.

Schedule

TASK	1993	1994	1995	1996
Phase I: Model Development, Technical Assistance	xxxx	xxxx		
Testing and Training	x	xxxx	xx	
Phase II: Procurement and Installation of Equipment			xxxx	
Conversion of Production Line to Non-CFC Technology			x	
Full Production of Non-CFC Refrigerators				x

Note: x = one quarter of the year

ESTIMATED DISBURSEMENT: 20% in 1993, 20% in 1994, and 60% in 1995

TECHNICAL ASSESSMENT

This subproject has been reviewed by the OORG technical reviewer, Dr. Michael Jeffs. The project was supported. Suggestions made relative to estimates of equipment costs will be pursued during project appraisal. In addition to Dr. Jeff's review, comments were received from OORG reviewer Dr. L. Kuijpers. A formal review from Mr. Kuijpers will be submitted by May 25.

ICI Polyurethanes

Mr. D. Brown
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B-3078 Everberg
Belgium
Telephone (02) 758 92 11
Telex 26151 ICIEVB B
Telefax (02) 759 55 01

5th May, 1993

THAILAND SUB PROJECT PROPOSALS

Dear Don,

Documents were received on 3/5/93.

General comments are :

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distributor or manufacturer price?

- The HCFC 141b price projection quoted in exhibit 1 of the feasibility study is too high. Current prices are about 50% of the quoted 1994 price level.
- Difficulty of gauging value of technical assistance from parent companies.

Dr. G. M. F. Jaffe - OORG MD 152
GMFJ/kd/41'

cc : Mr. T. Waltz

ENTERPRISE : KAM YONG ELECTRIC

RECOMMENDATION

Supported subject to the comments below.

RELEVANCY AND ADEQUACY OF INFORMATION

Good coverage, including dependency of Phase 2 purchases on Phase 1 results. Quotations for equipment needed.

TECHNICAL SOUNDNESS

HCFC 141b foam technology is well proven and use has shown no deterioration in insulation value compared to CFC 11-blown foam. It is noted, with approval that decisions on the need for a foaming machine and line modifications will be taken at the end of Phase 1.

LESSON FROM EXPERIENCE

None

ENVIRONMENTAL ISSUES

HCFC 141b is a transitional substance which will eventually have to be replaced by a zero ODP blowing agent. Its use contributes to a saving of 109 ODP te per year.

SAFETY ISSUES

No mention made of measures to ensure safe working with HCFC 141b by adequate ventilation.

COST EFFECTIVENESS

Dependent on need for items in Phase 2.

OTHERS

None

Kingdom of Thailand

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Eindhoven, 11 March 1993

L.J.M. Kuijpers

Thailand

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It will always be difficult to manufacture CFC-12 and HFC-134a appliances at the same moment, unless very special precautions are taken.
The reliability of the appliance will also depend on the quality (and the type) of the compressor. This cannot be estimated at this moment.
Since Kulthorn Kirby is one of the main manufacturers of compressors involved, it should be ascertained whether this company can solve problems which might occur at the manufacturers at the same time.

4. Cost effectiveness

Cost effectiveness cannot be discussed. There are only some questions as already mentioned above:

1. Does "technical assistance" imply a relationship to the production volume ?.
2. Costs for lab equipment (test room) and for charging equipment are quite different. E.g. the costs for charging at Admiral is equal to others with a much bigger production volume.
3. It is difficult to judge upon whether some manufacturers need test rooms, others not.

6/5 1993

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand		
PROJECT TITLE:	Elimination of ODS Used in the Production of Household Refrigerators		
SECTOR COVERED:	Household Refrigerator		
ODS USE IN SECTOR (1992):	1080 MT ODP (430 MT CFC-12 & 650 MT CFC-11)		
PROJECT IMPACT:	Eliminate 47 MT ODP per year (7 MT CFC-12 & 45 MT CFC-11)		
PROJECT DURATION:	Phase I: 2 years Phase II: 1 year		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Cost[1]:	US$ US$	3,220,000 0
PROPOSED OTF FINANCING[2]:	US$ 2,098,000 (@ 55% Thai Ownership)		
COST EFFECTIVENESS:	Not Applicable		
IMPLEMENTING ENTERPRISE:	A.P. National Co., Ltd.		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators manufactured at A.P. National Co., Ltd. in Thailand. The project comprises two phases and will convert the production line to refrigerators using HFC-134a and HCFC-141b as the new refrigerant and foam blowing agent respectively. The first phase will provide for product development using CFC alternatives and will identify all equipment and process changes needed to implement the alternative technology. During this phase, A.P. National will receive engineering assistance and training from its parent company, Matsushita Refrigeration Co. of Japan. During Phase II National will purchase and install the new equipment necessary for mass production of CFC-free refrigerators. The project will result in the elimination of 7 MT/year of CFC-12 (refrigerant) and 45 MT/year of CFC-11 (foam blowing agent) after the conversion is completed.

[1] Net present value of first four years of operating costs/savings.

[2] Includes 15 contingency and 3% financial institution fee.

BACKGROUND

The domestic refrigeration industry in Thailand uses CFC-12 for charging new appliances and during servicing, and uses CFC-11 in the production of polyurethane (PU) insulation foam. The demand for household refrigerators and freezers in Thailand is increasing at a rate greater than 10% per year, and most units sold in Thailand are made locally by seven major manufacturers: Sanyo, Toshiba, Hitachi, Sharp Appliances, Mitsubishi, A.P. National, and Admiral. Most of these refrigerators are equipped with compressors manufactured in Thailand by Sanyo and Kulthorn Kirby. In 1992, the sector used a total of 430 MT of CFC-12 (210 MT to charge new appliances and 220 MT for servicing), and about 650 MT of CFC-11.

A.P. National Co., Ltd. (National), which is 55 percent Thai owned, produces approximately 74,000 refrigerators annually comprising eleven different models. The plant has one production line with a total capacity of 120,000 sets a year. National expects to reach its maximum capacity by 1996. In 1992, the company consumed seven MT of CFC-12 and 45 MT of CFC-11. The average CFC-12 charge size in its refrigerators is 0.12 kg. National has been using a 30 percent CFC-11 reduced foam formulation in its polyurethane foam since 1992 and currently uses about 0.34 kg of CFC-11 per refrigerator.

PROJECT OBJECTIVE

The objective of this project is to phase out CFC-12 and CFC-11 used in household refrigerators and freezers at A.P. National.

PROJECT DESCRIPTION

In this project, A.P. National will eliminate the use of CFC-12 and CFC-11 in household refrigerators by converting its manufacturing facility to one compatible with HFC-134a and HCFC-141b, the new refrigerant and foam blowing agent respectively. The project will be divided into two phases. The first phase will provide for engineering assistance, training, and acquisition of specific equipment for testing the new refrigerators. The second phase will allow for the elimination of CFC-12 and CFC-11 through the ordering and installation of the new equipment necessary for mass production of CFC-free refrigerators. In the third phase, not addressed in this project, actual production of CFC-free refrigerators will take place. Incremental operating costs would only occur in Phase III.

The main objective of the project's first phase consists of developing reliable new CFC-free refrigerators at A.P. National. This task is particularly difficult to accomplish given the considerable engineering design modifications and the necessary testing that have to be done in a relatively short period of time. In order to minimize the risks associated with the conversion process, A.P. National will acquire technical assistance during Phase I from its parent company, Matsushita Refrigeration Co. of Japan. This technical assistance represents a continuation of existing arrangements between the two companies. A.P. National has used similar arrangements in the past to develop its existing line of refrigerator models. As part of the technical agreement, Matsushita Refrigeration of Japan will do the following:

- Design the different refrigerator models
- Conduct approval tests for each refrigerator model
- Conduct approval tests for the compressors made in Thailand
- Provide production drawings for the new models
- Provide training on manufacturing, maintenance, and quality control
- Provide engineering assistance for manufacturing development and operations.

Phase I will to provide A.P. National with technology developed by the parent company in Japan, modifying it where necessary to account for differences in Thai manufacturing conditions and refrigerator models.

Additional funding requested in the proposal for Phase I will be used to acquire controlled ambient test rooms with data acquisition systems in order to test the refrigerators and make sure that they are manufactured according to design specifications.

Phase II of the project will consist of finalizing the transition to CFC-free technology for mass production. During this transition time, both CFC and non-CFC refrigerators will be produced on the same line. A.P. National will purchase and install an additional set of charging equipment (for HFC-134a and ester oil) as well as two new polyurethane injection foam machines for doors and cabinets. A.P. National plans to purchase compressors free of oil and to charge purified oil on their production line to ensure avoidance of contamination by the compressor vendor.

To reduce evaporative losses of HCFC-141b, a cooling unit will be installed in the chemical storage room. Care will be taken during this period to avoid cross contamination of refrigerants and compressor oils. Because of the flammability of HCFC-141b, additional safety precautions will be taken, such as increasing the ventilation of the room where the machine will be installed. New halogen leak detectors for HFC-134a will also be purchased.

There is evidence that the new ABS plastic for the cabinet liner required with HCFC-141b cannot be formed with the existing equipment. National believes that its current forming equipment can be modified to accommodate the new ABS plastic. The modification, which consists of replacing the actual circular heaters, will cost approximately $110,000 (as opposed to approximately $1,000,000 for a new unit).

Final decisions on all of the equipment purchasing and retrofitting, except for minimal equipment required to build field test models, will be made after Phase I is complete and test results are analyzed. Equipment items included in this project are based on preliminary test results and experience of Japanese parent companies.

PROJECT COSTS

Total Project Cost

The total project cost of US$ 3.22 million equals the ODS reduction portion of the overall project (investment costs plus net incremental operating costs). This project will not provide A.P. National Co., Ltd. with incremental revenues.

Investment Costs of US$3.22 million include costs associated with CFC-free refrigerator product development, technical assistance from Matsushita of Japan, testing, equipment for mass production, and training.

Net Incremental Operating Costs: Because full scale production of refrigerators with HFC-134 and HCFC-141b will not occur until 1996, incremental operating costs have not been included as part of this project. Incremental operating costs will be reexamined at a later date.

Local Ownership Fraction of 55% was considered to determine the amount of eligible OTF grant financing. The total project cost was multiplied by the fraction of local ownership to determine the proposed grant amount.

Other Costs. A 15% contingency (US$266,000) was also included to ensure adequate funding of project costs following project appraisal. An additional US$61,000 (3%) was added to the grant request to cover the fee for services of the financial institution (FI) that will appraise the projects and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for A.P. National Co., Ltd. is US$2,098,000 and was calculated as follows: the total investment cost was added to the present value of the incremental operating cost over the first four years of the project. The resulting total project cost was multiplied by the percentage of Thai ownership (55 percent). This figure was increased by a 15 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee.

PROJECT IMPLEMENTATION

Management: DIW will oversee the successful implementation of this project. The project will be carried out at A.P. National. Matsushita Refrigeration Co. of Japan will provide technical assistance to National during project execution.

Schedule

TASK	1993	1994	1995	1996
Phase I: Model Development, Technical Assistance	xxxx	xxxx		
Testing and Training	x	xxxx	xx	
Phase II: Procurement and Installation of Equipment			xxxx	
Conversion of Production Line to Non-CFC Technology			x	
Full Production of Non-CFC Refrigerators				x

Note: x = one quarter of the year

ESTIMATED DISBURSEMENT: 20% in 1993, 20% in 1994, and 60% in 1995

TECHNICAL ASSESSMENT

This subproject has been reviewed by the OORG technical reviewer, Dr. Michael Jeffs. The project was supported. Suggestions made relative to estimates of equipment costs will be pursued during project appraisal. In addition to Dr. Jeff's review, comments were received from OORG reviewer Dr. L. Kuijpers. A formal review from Mr. Kuijpers will be submitted by May 25.

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5th May, 1993

THAILAND SUB PROJECT PROPOSALS

Dear Don,

Documents were received on 3/5/93.

General comments are :

- Enterprises which are subsidiaries of Japanese refrigerator manufacturers are proposing the use of HCFC 141b foam technology - this is in line with the changes now being implemented in Japan by the parent companies. However, this could be a comparatively short term option in Japan. There is an increasing level of interest in the performance of cyclopentane-based foam which is now being implemented in Europe. Further, at least two Japanese manufacturers are to base part of their production on composites of vacuum insulation panels with CO_2 (water)-blown polyurethane foam.

- HCFC 141b foam technology is now well proven and gives equivalent insulation values to foam based on CFC 11 despite its higher gas thermal conductivity.

- HCFC 22 foam technology is not used unless it is protected by steel panels because of deterioration of thermal insulation with time. The technology proposed by Admiral is not supported for use in refrigerators with plastic liners. The blend HCFC 22 / HCFC 142b overcomes this ageing problem and is in use elsewhere.

- Several projects call for the purchase of new foam injection machines as well as vacuum forming equipment for liners and jigs. Individual comments are given for the enterprises but in general the need for these items should be reviewed at the end of phase 1.

distributor or manufacturer price?

- The HCFC 141b price projection quoted in exhibit 1 of the feasibility study is too high. Current prices are about 50% of the quoted 1994 price level.
- Difficulty of gauging value of technical assistance from parent companies.

Dr. G. M. F. Jaffe - OORG MD 152
GMFJ/kd/41'

cc : Mr. T. Waltz

ENTERPRISE : AP NATIONAL

RECOMMENDATION

Supported subject to the comments below.

RELEVANCY AND ADEQUACY OF INFORMATION

No information on need for 2 foam injection machines in Phase 2, nor are quotations attached.

TECHNICAL SOUNDNESS

HCFC 141b foam technology is well proven and has shown equivalent insulation value to CFC 11-based foam.

LESSON FROM EXPERIENCE

None

ENVIRONMENTAL ISSUES

HCFC 141b is a transitional substance which will have to be replaced by a zero ODP blowing agent. Use contributes to a saving of 47 ODP te per year.

SAFETY ISSUES

No mention of provision of adequate ventilation because of flammability of HCFC 141b.

COST EFFECTIVENESS

Major capital items are 2 foaming machines at $ 800,000. No reason given for their purchase and cost is exorbitant. No quotations noted. This issue needs resolution.

OTHERS

None

Kingdom of Thailand

PRELIMINARY REVIEW OF A NUMBER OF PROJECTS

Conversion of Domestic Manufacturing to HFC-134a and to HCFC-141b in Polyurethane Foams; Conversion of Chillers to HFC-134a

Projects Described by The World Bank, March 1993

1. **Introduction of HCFC-141b for foams and the conversion process to HFC-134a for cooling at THAI TOSHIBA Industries;**
2. **Idem, at ADMIRAL Industries;**
3. **Idem, at HITACHI Industries;**
4. **Idem, at KANG YONG Industries;**
5. **Idem, at AP National Industries;**
6. **Two Chiller Conversion Projects to HFC-134a.**

Kuijpers, LJM (OORG)
Eindhoven, 1993 03 11
RWR-570-LK-93106 -lk

REMARKS REGARDING THE PROPOSALS

1. Foam Blowing

All projects describe a conversion from CFC-11 to HCFC-141b. In a first instance, it is remarkable that there is a large price difference between the conversions proposed for the different industries (take e.g. the difference between AP and Toshiba, 0.25 and 1.79 million). Indeed, HCFC-141b seems to be the preferred route for the Japanese, although, until recently, they have also maintained the HCFC-123 option. It may be that they will stick to the HCFC-141b option, however, in Europe there is a tendency (whether or not realistic) to study cyclopentane, a flammable high boiling refrigerant. About its performance nothing is known so far (conductivity value is worse compared to others, I do not know about long term behaviour).
One should bear in mind that the European manufacturers have been evaluating both 22/142b and 141b for quite some time; they achieved slightly inferior results with 22/142b; however, the long term behavior is not so good, due to diffusion of HCFC-22. Nevertheless, almost all manufacturers switched to HFC-134a (no chlorine anymore, due to environmental group pressure in Germany) shortly before the Domotechnica fair (apart from one). So I do not know whether this could play a role in Japan and in the daughter companies as well.
The best thing is to ask the OORG foam expert as well (Jeffs, ICI), regarding the time involved in optimizing HFC-134a foams. Dependent on this one could solve the question on whether or not to invest in the HCFC-141b route in Thai companies or to postpone a decision to later this year.

2. Refrigeration, general observations

The CFC-12 consumption of the five companies amounts to about 78 tonnes, while a total consumption of 250 tonnes in this sector is mentioned. Is there another large manufacturer involved ?
The above does not hold for CFC-11, 300 tonnes compared to 500 tonnes is used by the firms considered.

Several companies should do something regarding their use of CFC-11, i.e. apply reduction measures (take e.g. Kang Yong and AP which probably use CFC-11 also for cleaning) since the consumption is large compared to the CFC-12 consumption.

3. Refrigeration, specific topics

There is technology support from the mother companies, the costs however vary widely not dependent on the size of the company, e.g. 592,000 for Matsushita supporting the small AP firm. More information (e.g. contracts) on what is specifically covered in each of the cases is absolutely necessary. There is also a question on whether or not the relationship to Kultorn Kirby should not be described more precisely. Description so far (Kirby will provide the companies with compressors for testing) is not at all sufficient. It is often the compressor manufacturer (with its specific lubricant properties and so on) that determines the technology transfer. Design of the appliances and the manufacturing process can be supported by the mother company.
Kirby plays a key role in Thai companies, for this reason more precise information would be extremely useful.
This will also determine whether or not CFC-12 and HFC-134a appliances can be manufactured using the same assembly line.

In particular the technology transfer issue is important; the phased approach presented is in principle OK.

There is also a question regarding test rooms. What is determining the size and the costs for a test room. There is again a remarkable difference between the Admiral company and Hitachi, the smallest and largest in size. The same holds for the differences in costs for refrigerant and oil charging equipment. Maybe this could be explained somewehat more detailed in the proposal. Some firms will invest in leak detectors; does this not hold for all of them ?
A consistent approach and evaluation would be desireable.

Taking the amounts of CFCs involved costs vary from about 18 to 145 USD per kg of CFC (11 and 12) phased out per year. Is this an acceptable figure ?

4. Chillers

As far as the chiller conversion is concerned, there are no significant remarks.
For the HFC-134a conversion, the cost is in the order of USD 30 per kg of CFC-12 not used, which is a high figure, and which should be supported by considerations on the lifetime and economic value of the equipment.
As far as the HCFC-123 conversion, no remarks.

Eindhoven, 11 March 1993

L.J.M. Kuijpers

Thailand

REVIEW OF FIVE PHASE-1 CONVERSION PROJECTS

Conversion of Domestic Appliance Manufacturing to HFC-134a

Project Proposals by The World Bank, April 1993

First Phase of Appliance Manufacture Conversion from CFC-12 to HFC-134a at
Thai-Toshiba
Hitachi Consumer Products
AP National
Admiral Thailand
Kang Yong Electric Industries.

Kuijpers, LJM (OORG) Eindhoven,
1993 05 06
RTU-UNEP-LK-93170 -1k

REVIEW OF THE PHASE 1 PROPOSALS

Recommendation

All project descriptions propose a phase 1 of a two step approach, in agreement with the recommmendations by the OORG group of the Bank. In most cases there is sufficient back up from the developed country appliance manufacturer, where it also applies to additional tests (mainly in Japan).

However, most of the remarks from my earlier review still apply to these latest project proposals:
1. The relationship (and timescale of introduction) with the compressor manufacturers has still many uncertainties since the compressor manufacturers have still to convert their production with the support from others. This implies that the appliance manufacturers will depend on relationships that depend on other relationships where still uncertain parameters are involved.
2. The size of the production of the different manufacturers is quite different, from about 140,000 down to 4,800 (Admiral). Nevertheless, the costs for technical support and for new equipment to be bought do not have any relationship to the production volume.
3. The costs for technical assistance seem to be random, and quite high. As an example, technical assistance for AP National (USD 700,000, production volume 74,000) cannot be compared to others (e.g. Sanyo (USD 454,800, production volume 600,000 pieces). This issue needs to be clarified first.

It is recommended to first establish criteria for the costs for technical assistance -whether or not related to the production volume, e.g. with certain maxima, before that these projects should be approved.
It should also be realized that the conversion will be dependent on the success of the conversion process at compressor manufacturers (projects still to be approved).

Taking these arguments into account, it is difficult to give an overall recommendation for (dis)approval. Costs for Admiral are too high, there is no back up from another manufacturer. Technical assistance costs for AP National are (too) high.

2. Relevance and adequacy of information provided

The project proposals give adequate short descriptions of what is envisaged to be accomplished during a first phase.
The technical assistance agreements are not very well specified (comparable to the Sanyo project), the idea is obtained that a reliable appliance production can be guaranteed (e.g. by additional testing in Japan etc.). However, costs for technical assistance seem to be random:

- Sanyo (separate proposal):	USD 454,800	for a volume of 600,000 pieces.
- TTEI:	USD 510,800	140,000 "
- Kang Yong	USD 320,000	115,000 "
- AP National	USD 700,000	74,000 "
- Hitachi	USD 480,000	142,000 "
- Admiral (estimate)	USD 150,000	4,800 ".

3. Technical soundness

In the conversion to HFC-134a, it is in particular the certainty that a reliable product can be manufactured, which has to do with adapting local manufacturing processes that will cost money. It will always be difficult to manufacture CFC-12 and HFC-134a appliances at the same moment, unless very special precautions are taken.
The reliability of the appliance will also depend on the quality (and the type) of the compressor. This cannot be estimated at this moment.
Since Kulthorn Kirby is one of the main manufacturers of compressors involved, it should be ascertained whether this company can solve problems which might occur at the manufacturers at the same time.

4. Cost effectiveness

Cost effectiveness cannot be discussed. There are only some questions as already mentioned above:

1. Does "technical assistance" imply a relationship to the production volume ?.
2. Costs for lab equipment (test room) and for charging equipment are quite different. E.g. the costs for charging at Admiral is equal to others with a much bigger production volume.
3. It is difficult to judge upon whether some manufactuers need test rooms, others not.

6/5 1993

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand		
PROJECT TITLE:	Elimination of ODS Used in the Production of Household Refrigerators		
SECTOR COVERED:	Household Refrigerator		
ODS USE IN SECTOR (1992):	1080 MT ODP (430 MT CFC-12 & 650 MT CFC-11)		
PROJECT IMPACT:	Eliminate 132 MT ODP per year (36 MT CFC-12 & 108 MT CFC-11)		
PROJECT DURATION:	Phase I: 2 years Phase II: 1 year		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Cost[1]:	US$ US$	2,520,000 0
PROPOSED OTF FINANCING[2]:	US$ 1,520,000 million (@ 51% Thai Ownership)		
COST EFFECTIVENESS:	Undefined		
IMPLEMENTING ENTERPRISE:	Hitachi Consumer Products (Thailand) Co.		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators manufactured at Hitachi Consumer Products Co., Ltd. in Thailand. The project comprises two phases and will convert the production line to refrigerators using HFC-134a and HCFC-141b as the new refrigerant and foam blowing agent respectively. The first phase will provide for product development using CFC alternatives and will identify all equipment and process changes needed to implement the alternative technology. During this phase, Hitachi Consumer Products will obtain engineering assistance and training from its parent company, Hitachi Ltd. of Japan. In Phase II, Hitachi will purchase all the new equipment necessary for mass production of CFC-free refrigerators. The project will result in the elimination of 36 MT/year of CFC-12 (refrigerant) and 108 MT/year of CFC-11 (foam blowing agent) after the conversion is completed.

[1] Net present value of first four years of operating costs/savings.

[2] Includes 15% contingency and 3% financial institution fee.

BACKGROUND

The domestic refrigeration industry in Thailand uses CFC-12 for charging new appliances and during servicing, and uses CFC-11 in the production of polyurethane (PU) insulation foam. The demand for household refrigerators and freezers in Thailand is increasing at a rate greater than 10% per year, and most units sold in Thailand are made locally by seven major manufacturers: Sanyo, Toshiba, Hitachi, Sharp Appliances, Mitsubishi, A.P. National, and Admiral. Most of these refrigerators are equipped with compressors manufactured in Thailand by Sanyo and Kulthorn Kirby. In 1992, the sector used a total of 430 MT of CFC-12 (210 MT to charge new appliances and 220 MT for servicing), and about 650 MT of CFC-11.

Hitachi Consumer Products (Thailand) Co., Ltd. (Hitachi), which is 51 percent Thai owned, produces approximately 142,000 refrigerators annually, comprising eleven different models. The plant has one production line with a total capacity of 250,000 sets a year. Hitachi expects to reach its maximum capacity by 1994. In 1992, the company consumed 36 MT of CFC-12 and 108 MT of CFC-11. The average CFC-12 charge size in its refrigerators is 0.18 kg. Hitachi has begun using 40 percent CFC-11 reduction formulation in its foam since 1989 and uses about 0.55 kg of CFC-11 per set.

PROJECT OBJECTIVE

The objective of this project is to phase out CFC-12 and CFC-11 used in household refrigerators and freezers at Hitachi Consumer Products.

PROJECT DESCRIPTION

In this project, Hitachi Consumer Products will eliminate the use of CFC-12 and CFC-11 in household refrigerators by converting its manufacturing facility to one compatible with HFC-134a and HCFC-141b, the new refrigerant and foam blowing agent respectively. The project will be divided into two phases. The first phase will provide for engineering assistance, training ,and acquisition of specific equipment for testing the new refrigerators. The second phase will allow for the elimination of CFC-12 and CFC-11 through the order and installion of new equipment necessary for mass production of CFC-free refrigerators. In the third phase, not addressed in this project, actual production of CFC-free refrigerators will take place. Operating costs would only occur in Phase III.

The main objective of the project's first phase consists of developing reliable new CFC-free refrigerators at Hitachi. This task is particularly difficult to accomplish given the considerable engineering design modifications and the necessary testing that have to be done in a relatively short period of time. In order to minimize the risks associated the conversion process, Hitachi will acquire technical assistance during Phase I from its parent company Hitachi Ltd. of Japan. This technical assistance represents a continuation of existing arrangements between the two companies. Hitachi has used similar arrangements in the past to develop its existing line of refrigerator models. As part of the technical agreement, Hitachi Ltd. of Japan will do the following:

- Design the different refrigerator models
- Conduct approval tests for each refrigerator model
- Conduct approval tests for the compressors made in Thailand
- Provide production drawings for the new models
- Provide training on manufacturing, maintenance and quality control.

Phase I will provide Hitachi with technology developed by the parent company in Japan, modifying it where necessary to account for differences in Thai manufacturing conditions and refrigerator models.

Additional funding requested in the proposal for Phase I will be used to acquire a controlled ambient test room with an accompanying data acquisition system in order to test the refrigerators and make sure that they are manufactured according to design specifications.

Phase II of the project will consist of finalizing the transition to CFC-free technology for mass production. During this transition time, both CFC and non-CFC refrigerators will be produced on the same line. Hitachi will purchase and install an additional set of charging equipment for HFC-134a. Because of the flammability of HCFC-141b, additional safety precautions will be taken, such as increasing the ventilation of the room where the machine will be installed. Care will be taken during this period to avoid cross contamination of refrigerants and compressor oils. New halogen leak detectors for HFC-134a will also be purchased.

Because HCFC-141b has a higher thermal conductivity than CFC-11, there is the possibility that the insulation thickness of the refrigerators will have to be increased to maintain satisfactory levels of energy consumption. A change in insulation thickness would require the procurement of a set of new dies, molds and jigs, the cost of which has been estimated at $600,000. In addition, there is evidence that the new ABS plastic for the cabinet liner required with HCFC-141b cannot be formed with the existing equipment. Therefore, a new vacuum forming machine estimated to cost $1.0 million might need to be purchased.

Final decisions on all of the equipment purchasing and retrofitting, except for minimal equipment required to build field test models, will be made after Phase I is complete and test results are analyzed.

Equipment items included in this project are based on preliminary test results and experience of Japanese parent companies.

PROJECT COSTS

Total Project Cost

The total project cost of US$2.52 million equals the ODS reduction portion of the overall project (investment costs plus net incremental operating costs). This project will not provide Hitachi Consumer Products (Thailand) with incremental revenues.

Investment Costs of US$2.52 million include costs associated with CFC-free refrigerator product development, technical assistance from Hitachi of Japan, testing, equipment for mass production,and training.

Net Incremental Operating Costs: Because full scale production of refrigerators with HFC-134 and HCFC-141b will not occur until 1996, incremental operating costs have not been included as part of this project. Incremental operating costs will be reexamined at a later date.

Local Ownership Fraction of 51% was considered to determine the amount of eligible OTF grant financing. The total project cost was multiplied by the fraction of local ownership to determine the proposed grant amount.

Other Costs. A 15% contingency (US$193,000) was also included to ensure adequate funding of project costs following project appraisal. An additional US$45,000 (3%) was added to the grant request to cover the fee for services of the financial institution (FI) that will appraise the projects and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Hitachi Consumer Products (Thailand) is US$1,523,000 and was calculated as follows: the total investment cost was added to the present value of the incremental operating cost over the first four years of the project. The resulting total project cost was multiplied by the percentage of Thai ownership (51 percent). This figure was increased by a 15 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee.

PROJECT IMPLEMENTATION

Management: DIW will oversee the successful implementation of this project. The project will be carried out at Hitachi Consumer Products (Thailand). Hitachi Ltd. of Japan will provide technical assistance to its Thai subsidiary during project execution.

Schedule

TASK	1993	1994	1995	1996
Phase I: Model Development, Technical Assistance	xxxx	xxxx		
Testing and Training	x	xxxx	xx	
Phase II: Procurement and Installation of Equipment			xxxx	
Conversion of Production Line to Non-CFC Technology			x	
Full Production of Non-CFC Refrigerators				x

Note: x = one quarter of the year

ESTIMATED DISBURSEMENT: 20% in 1993, 20% in 1994, and 60% in 1995

TECHNICAL ASSESSMENT

This subproject has been reviewed by the OORG technical reviewer, Dr. Michael Jeffs. The project was supported. Suggestions made relative to estimates of equipment costs will be pursued during project appraisal. In addition to Dr. Jeff's review, comments were received from OORG reviewer Dr. L. Kuijpers. A formal review from Mr. Kuijpers will be submitted by May 25.

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5th May, 1993

THAILAND SUB PROJECT PROPOSALS

Dear Don,

Documents were received on 3/5/93.

General comments are :

- Enterprises which are subsidiaries of Japanese refrigerator manufacturers are proposing the use of HCFC 141b foam technology - this is in line with the changes now being implemented in Japan by the parent companies. However, this could be a comparatively short term option in Japan. There is an increasing level of interest in the performance of cyclopentane-based foam which is now being implemented in Europe. Further, at least two Japanese manufacturers are to base part of their production on composites of vacuum insulation panels with CO_2 (water)-blown polyurethane foam.

- HCFC 141b foam technology is now well proven and gives equivalent insulation values to foam based on CFC 11 despite its higher gas thermal conductivity.

- HCFC 22 foam technology is not used unless it is protected by steel panels because of deterioration of thermal insulation with time. The technology proposed by Admiral is not supported for use in refrigerators with plastic liners. The blend HCFC 22 / HCFC 142b overcomes this ageing problem and is in use elsewhere.

- Several projects call for the purchase of new foam injection machines as well as vacuum forming equipment for liners and jigs. Individual comments are given for the enterprises but in general the need for these items should be reviewed at the end of phase 1.

distributor or manufacturer price?

- The HCFC 141b price projection quoted in exhibit 1 of the feasibility study is too high. Current prices are about 50% of the quoted 1994 price level.
- Difficulty of gauging value of technical assistance from parent companies.

Dr. G. M. F. Jaffe - OORQ MD 152
GMFJ/kd/41'

cc : Mr. T. Waltz

ENTERPRISE : HITACHI CONSUMER PRODUCTS

RECOMMENDATION

Approved subject to the comments below.

RELEVANCY AND ADEQUACY OF INFORMATION

Good - all major capital items are included in the project description.

TECHNICAL SOUNDNESS

HCFC 141b technology is well proven and has shown equivalent insulation value to CFC 11-based foam. Hence there should be no need to buy new dies, moulds and jigs as on P 9.4.

LESSON FROM EXPERIENCE

None

ENVIRONMENTAL ISSUES

HCFC 141b is a transitional material which will have to be replaced by a zero ODP blowing agent. Its use will contribute to a saving of 132 ODP te per year.

SAFETY ISSUES

Provision of a ventilation system for HCFC 141b is noted.

COST EFFECTIVENESS

Major impact of decisions at end of Phase 1 on need for dies, moulds, jigs and vacuum forming equipment.

OTHERS

None

Kingdom of Thailand

PRELIMINARY REVIEW OF A NUMBER OF PROJECTS

Conversion of Domestic Manufacturing to HFC-134a and to HCFC-141b in Polyurethane Foams; Conversion of Chillers to HFC-134a

Projects Described by The World Bank, March 1993

1. **Introduction of HCFC-141b for foams and the conversion process to HFC-134a for cooling at THAI TOSHIBA Industries;**
2. **Idem, at ADMIRAL Industries;**
3. **Idem, at HITACHI Industries;**
4. **Idem, at KANG YONG Industries;**
5. **Idem, at AP National Industries;**
6. **Two Chiller Conversion Projects to HFC-134a.**

Kuijpers, LJM (OORG)
Eindhoven, 1993 03 11
RWR-570-LK-93106 -lk

REMARKS REGARDING THE PROPOSALS

1. Foam Blowing

All projects describe a conversion from CFC-11 to HCFC-141b. In a first instance, it is remarkable that there is a large price difference between the conversions proposed for the different industries (take e.g. the difference between AP and Toshiba, 0.25 and 1.79 million). Indeed, HCFC-141b seems to be the preferred route for the Japanese, although, until recently, they have also maintained the HCFC-123 option. It may be that they will stick to the HCFC-141b option, however, in Europe there is a tendency (whether or not realistic) to study cyclopentane, a flammable high boiling refrigerant. About its performance nothing is known so far (conductivity value is worse compared to others, I do not know about long term behaviour).
One should bear in mind that the European manufacturers have been evaluating both 22/142b and 141b for quite some time; they achieved slightly inferior results with 22/142b; however, the long term behavior is not so good, due to diffusion of HCFC-22. Nevertheless, almost all manufacturers switched to HFC-134a (no chlorine anymore, due to environmental group pressure in Germany) shortly before the Domotechnica fair (apart from one). So I do not know whether this could play a role in Japan and in the daughter companies as well.
The best thing is to ask the OORG foam expert as well (Jeffs, ICI), regarding the time involved in optimizing HFC-134a foams. Dependent on this one could solve the question on whether or not to invest in the HCFC-141b route in Thai companies or to postpone a decision to later this year.

2. Refrigeration, general observations

The CFC-12 consumption of the five companies amounts to about 78 tonnes, while a total consumption of 250 tonnes in this sector is mentioned. Is there another large manufacturer involved ?
The above does not hold for CFC-11, 300 tonnes compared to 500 tonnes is used by the firms considered.

Several companies should do something regarding their use of CFC-11, i.e. apply reduction measures (take e.g. Kang Yong and AP which probably use CFC-11 also for cleaning) since the consumption is large compared to the CFC-12 consumption.

3. Refrigeration, specific topics

There is technology support from the mother companies, the costs however vary widely not dependent on the size of the company, e.g. 592,000 for Matsushita supporting the small AP firm. More information (e.g. contracts) on what is specifically covered in each of the cases is absolutely necessary. There is also a question on whether or not the relationship to Kultorn Kirby should not be described more precisely. Description so far (Kirby will provide the companies with compressors for testing) is not at all sufficient. It is often the compressor manufacturer (with its specific lubricant properties and so on) that determines the technology transfer. Design of the appliances and the manufacturing process can be supported by the mother company.
Kirby plays a key role in Thai companies, for this reason more precise information would be extremely useful.
This will also determine whether or not CFC-12 and HFC-134a appliances can be manufactured using the same assembly line.

In particular the technology transfer issue is important; the phased approach presented is in principle OK.

There is also a question regarding test rooms. What is determining the size and the costs for a test room. There is again a remarkable difference between the Admiral company and Hitachi, the smallest and largest in size. The same holds for the differences in costs for refrigerant and oil charging equipment. Maybe this could be explained somewhat more detailed in the proposal. Some firms will invest in leak detectors; does this not hold for all of them ?
A consistent approach and evaluation would be desireable.

Taking the amounts of CFCs involved costs vary from about 18 to 145 USD per kg of CFC (11 and 12) phased out per year. Is this an acceptable figure ?

4. Chillers

As far as the chiller conversion is concerned, there are no significant remarks.
For the HFC-134a conversion, the cost is in the order of USD 30 per kg of CFC-12 not used, which is a high figure, and which should be supported by considerations on the lifetime and economic value of the equipment.
As far as the HCFC-123 conversion, no remarks.

Eindhoven, 11 March 1993

L.J.M. Kuijpers

Thailand

REVIEW OF FIVE PHASE-1 CONVERSION PROJECTS

Conversion of Domestic Appliance Manufacturing to HFC-134a

Project Proposals by The World Bank, April 1993

First Phase of Appliance Manufacture Conversion from CFC-12 to HFC-134a at
Thai-Toshiba
Hitachi Consumer Products
AP National
Admiral Thailand
Kang Yong Electric Industries.

Kuijpers, LJM (OORG) Eindhoven,
1993 05 06
RTU-UNEP-LK-93170 -lk

REVIEW OF THE PHASE 1 PROPOSALS

Recommendation

All project descriptions propose a phase 1 of a two step approach, in agreement with the recommmendations by the OORG group of the Bank. In most cases there is sufficient back up from the developed country appliance manufacturer, where it also applies to additional tests (mainly in Japan).

However, most of the remarks from my earlier review still apply to these latest project proposals:
1. The relationship (and timescale of introduction) with the compressor manufacturers has still many uncertainties since the compressor manufacturers have still to convert their production with the support from others. This implies that the appliance manufacturers will depend on relationships that depend on other relationships where still uncertain parameters are involved.
2. The size of the production of the different manufacturers is quite different, from about 140,000 down to 4,800 (Admiral). Nevertheless, the costs for technical support and for new equipment to be bought do not have any relationship to the production volume.
3. The costs for technical assistance seem to be random, and quite high. As an example, technical assistance for AP National (USD 700,000, production volume 74,000) cannot be compared to others (e.g. Sanyo (USD 454,800, production volume 600,000 pieces). This issue needs to be clarified first.

It is recommended to first establish criteria for the costs for technical assistance -whether or not related to the production volume, e.g. with certain maxima, before that these projects should be approved.
It should also be realized that the conversion will be dependent on the success of the conversion process at compressor manufacturers (projects still to be approved).

Taking these arguments into account, it is difficult to give an overall recommendation for (dis)approval. Costs for Admiral are too high, there is no back up from another manufacturer. Technical assistance costs for AP National are (too) high.

2. Relevance and adequacy of information provided

The project proposals give adequate short descriptions of what is envisaged to be accomplished during a first phase.
The technical assistance agreements are not very well specified (comparable to the Sanyo project), the idea is obtained that a reliable appliance production can be guaranteed (e.g. by additional testing in Japan etc.). However, costs for technical assistance seem to be random:

- Sanyo (separate proposal):	USD 454,800	for a volume of 600,000 pieces.
- TTEI:	USD 510,800	140,000 "
- Kang Yong	USD 320,000	115,000 "
- AP National	USD 700,000	74,000 "
- Hitachi	USD 480,000	142,000 "
- Admiral (estimate)	USD 150,000	4,800 ".

3. Technical soundness

In the conversion to HFC-134a, it is in particular the certainty that a reliable product can be manufactured, which has to do with adapting local manufacturing processes that will cost money.
It will always be difficult to manufacture CFC-12 and HFC-134a appliances at the same moment, unless very special precautions are taken.
The reliability of the appliance will also depend on the quality (and the type) of the compressor. This cannot be estimated at this moment.
Since Kulthorn Kirby is one of the main manufacturers of compressors involved, it should be ascertained whether this company can solve problems which might occur at the manufacturers at the same time.

4. Cost effectiveness

Cost effectiveness cannot be discussed. There are only some questions as already mentioned above:

1. Does "technical assistance" imply a relationship to the production volume ?.
2. Costs for lab equipment (test room) and for charging equipment are quite different. E.g. the costs for charging at Admiral is equal to others with a much bigger production volume.
3. It is difficult to judge upon whether some manufactuers need test rooms, others not.

6/5 1993

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand		
PROJECT TITLE:	Elimination of ODS Used in the Production of Household Refrigerators		
SECTOR COVERED:	Household Refrigerator		
ODS USE IN SECTOR (1992):	1080 MT ODP (430 MT CFC-12 & 650 MT CFC-11)		
PROJECT IMPACT:	Eliminate 448 MT ODP per year (136 MT CFC-12 & 350 MT CFC-11)		
PROJECT DURATION:	Phase I: 2 years Phase II: 1 year		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Cost[1]:	US$ US$	4,950,000 0
PROPOSED OTF FINANCING[2]:	US$ 3,810,000 (@ 65% Thai Ownership)		
COST EFFECTIVENESS:	Not Applicable		
IMPLEMENTING ENTERPRISE:	Sanyo Universal Electric		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This project will phase out chlorofluorocarbons (CFCs) used in household refrigerators manufactured at Sanyo Universal Electric Co., Ltd. (SUE), the largest refrigerator manufacturers in Thailand. The project comprises two phases and will convert two Sanyo refrigerator plants for use of HFC-134a and HCFC-141b as the new refrigerant and foam blowing agent, respectively. The first phase will provide for product development using CFC alternatives and for the purchase of specific equipment for the testing and manufacturing of the new refrigerators. During this phase, Sanyo Universal Electric will obtain engineering assistance and training from its parent company, Sanyo Electric in Japan. The second phase will fully eliminate the use of CFC-12 and CFC-11 at SUE by installing the new equipment necessary for mass production of CFC-free refrigerators. The project will result in the elimination of 136 MT/year of CFC-12 (refrigerant) and 350 MT/year of CFC-11 (foam blowing agent) after the conversion is completed.

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[1] Net present value of first four years of operating costs/savings.

[2] includes 15% contingency and 3% financial institution fee.

BACKGROUND

The domestic refrigeration industry in Thailand uses CFC-12 to charge new appliances and during servicing, and uses CFC-11 in the production of polyurethane (PU) insulation foam. The demand for household refrigerators and freezers in Thailand is increasing at a rate greater than 10% per year, and most units sold in Thailand are made locally by seven major manufacturers: Sanyo, Toshiba, Hitachi, Sharp Appliances, Mitsubishi, A.P. National, and Admiral. Most of these refrigerators are equipped with compressors manufactured in Thailand by Sanyo and Kulthorn Kirby. In 1992, the sector used a total of 430 MT of CFC-12 (210 MT to charge new appliances and 220 MT for servicing), and about 650 MT of CFC-11.

Sanyo Universal Electric Co., Ltd. (SUE) has two plants producing household refrigerators and freezers, one in Bangkok and the other in Chachoensoa Province. Sixty-five percent of the company is Thai owned, and in 1991 produced approximately 433,000 units of refrigerators comprising twenty-five different models. The Bangkok plant has two production lines with a total capacity of 500,000 sets a year, while the Chachoensoa plant has one production line with a total capacity of 140,000 sets a year. SUE expects to reach its maximum capacity by the end of 1995. SUE also produces its own compressors. In 1992, the company consumed 136 MT of CFC-12 and 350 MT of CFC-11. The average CFC-12 charge size in its refrigerators is 0.2 kg.

PROJECT OBJECTIVE

The objective of this project is to phase out CFC-12 and CFC-11 used in household refrigerators and freezers at Sanyo Universal Electric Co., Ltd.

PROJECT DESCRIPTION

In this project, Sanyo Universal Electric will eliminate the use of CFC-12 and CFC-11 in household refrigerators by converting its manufacturing facilities to those compatible with HFC-134a and HCFC-141b, the new refrigerant and foam blowing agent, respectively. The project will be divided into two phases. The first phase will provide for engineering assistance and training, and acquisition of specific equipment for the testing and manufacturing of the refrigerators. The second phase will allow for the elimination of CFC-12 and CFC-11 by installing the new equipment necessary for mass production of CFC-free refrigerators. In the third phase, not addressed in this project, actual production of CFC-free refrigerators will take place.

The main objective of the project's first phase consists of developing reliable new CFC-free refrigerators at SUE. This task is particularly difficult to accomplish given the considerable engineering design modifications and the necessary testing that have to be done in a relatively short period of time. In order to minimize the risks associated with the conversion process, SUE will acquire technical assistance during Phase I from its parent company, Sanyo Electric of Japan. Sanyo Electric of Japan has developed the new generation of CFC-free refrigerators, and will license this technology to its subsidiaries. To acquire the new technology, SUE will pay US$652,000 and Sanyo Electric of Japan will do the following:

- Design the different refrigerator models
- Conduct approval tests for each refrigerator model
- Conduct approval tests for the compressors made in Thailand
- Provide production drawings for the new models
- Provide training on manufacturing, maintenance, and quality control
- Provide engineering assistance for manufacturing development and operations.

Other related costs such as equipment evaluation, training for operating and maintenance of instruments and equipment for handling new cooling materials and systems, as well as laboratory equipment for testing the refrigerators and making sure that they are manufactured according to design specifications, are also included in the project costs.

Phase I will provide SUE with technology that has been developed by the parent company in Japan, modifying it where necessary to account for differences in the refrigerator models produced in Thailand and manufacturing conditions in that country. The request made for technical assistance covers costs of evaluating the test production and extensive performance tests of 500 refrigerators that will be carried out. It is proposed to have 18 sets of new CFC-free refrigerators produced by SUE tested in Japan and 100 sets are tested at SUE's facility. The remaining 382 sets of CFC-free refrigerators will undergo a field test in Thailand.

Phase II of the project will consist of finalizing the transition to CFC-free technology for mass production. During this transition time, both CFC and non-CFC refrigerators will be produced on the same line. Therefore, SUE will purchase and install an additional set of charging equipment (for HFC-134a and ester oil) as well as a new polyurethane injection foam machine. Because of the flammability of HCFC-141b, additional safety precautions will be taken, such as increasing the ventilation of the room where the machine will be installed. In addition, care will be taken to avoid moisture absorption in ester oil by acquiring a compressor oil processing system. New halogen leak detectors for HFC-134a will also be purchased. Modifications will be made to the mass production test room to increase the cooling test time and improve the ventilation and air-conditioning system. Due to a more stringent requirement on the level of moisture which must be reduced from current specification of 30 ppm to 10 ppm, ovens are needed for drying dehydrators

before they are welded to the systems.

Since some suppliers of refrigerator parts still use 1,1,1-trichloroethane as a cleaning agent, efforts must be made to ensure that there is no chlorine contamination left in the parts. Chlorine contamination tampering with new refrigerant and lubrication oil can cause serious damage to the system. Chlorine checkers will enable SUE to determine the problems and to correct them before parts go to the production lines.

SUE is in a unique position, compared with other household refrigerator manufacturers, in that SUE has an expertise in mixing polyol which enables SUE to have better quality control of insulation foam. To convert to HCFC-141b foam blowing agent, SUE must obtain two new sets of pre-mix equipment: one for each plant. HCFC-141b technology is rather new for SUE; thus, it is vital that the quality control must by conducted constantly. SUE then proposes to acquire a set of K-factor instruments.

Final decisions on all of the equipment purchasing and retrofitting, except for minimal equipment required to build field test models, will be made after Phase I is complete and test results are analyzed. Equipment items included in this project are based on preliminary test results and experience of Japanese parent companies.

PROJECT COSTS

Total Project Cost

The total project cost of US$4.95 million equals the ODS reduction portion of the overall project (investment costs plus net incremental operating costs). This project will not provide Sanyo Universal Electric with incremental revenues.

Investment Costs of US$4.95 million include costs associated with CFC-free refrigerator product development, technical assistance from Sanyo Electric of Japan, testing, new equipment for mass production, and training.

Net Incremental Operating Costs: Because full scale production of refrigerators with HFC-134 and HCFC-141b will not occur until 1996, incremental operating costs have not been included as part of this project.

Local Ownership Fraction of 65% was considered to determine the amount of eligible OTF grant financing. The total project cost was multiplied by the fraction of local ownership to determine the proposed grant amount.

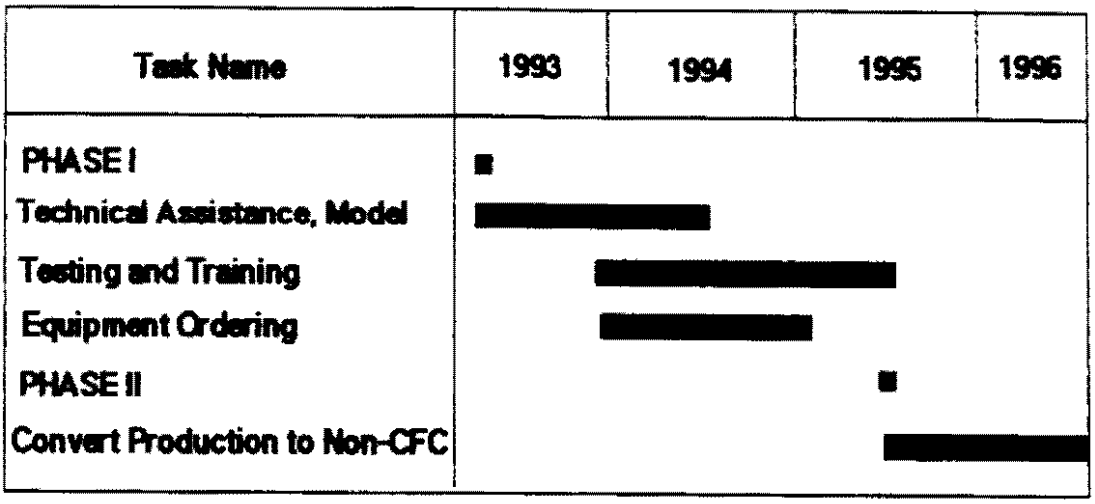
Other Costs. A 15% contingency (US$483,000) was also included to ensure adequate funding of project costs following project appraisal. An additional US$111,000 (3%) was added to the grant request to cover the fee for services of the financial institution (FI) that will appraise the projects and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Sanyo Univeral Electric is US$3,811,000 and was calculated as follows: the total investment cost was added to the present value of the incremental operating cost over the first four years of the project. The resulting total project cost was multiplied by the percentage of Thai ownership (65 percent). This figure was increased by a 15 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee.

PROJECT IMPLEMENTATION

Management: DIW will oversee the successful implementation of this project. The project will be carried out at Sanyo Universal Electric. Sanyo Corporation of Japan will provide technical assistance to SUE during project execution.

Schedule



ESTIMATED DISBURSEMENT: 20% in 1993, 20% in 1994, and 60% in 1995

TECHNICAL ASSESSMENT

This subproject has been reviewed by the OORG technical reviewers, Dr. Michael Jeffs and Dr. L. Kuijpers. The project was supported. Suggestions made relative to estimates of equipment costs will be pursued during project appraisal.

ICI Polyurethanes

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Telex 26151 ICIEVB B
Telefax (02) 759 55 01

5th May, 1993

THAILAND SUB PROJECT PROPOSALS

Dear Don,

Documents were received on 3/5/93.

General comments are :

- Enterprises which are subsidiaries of Japanese refrigerator manufacturers are proposing the use of HCFC 141b foam technology - this is in line with the changes now being implemented in Japan by the parent companies. However, this could be a comparatively short term option in Japan. There is an increasing level of interest in the performance of cyclopentane-based foam which is now being implemented in Europe. Further, at least two Japanese manufacturers are to base part of their production on composites of vacuum insulation panels with CO_2 (water)-blown polyurethane foam.

- HCFC 141b foam technology is now well proven and gives equivalent insulation values to foam based on CFC 11 despite its higher gas thermal conductivity.

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distributor or manufacturer price?

- The HCFC 141b price projection quoted in exhibit 1 of the feasibility study is too high. Current prices are about 50% of the quoted 1994 price level.
- Difficulty of gauging value of technical assistance from parent companies.

Dr. G. M. F. Jaffe - OORG MD 152
GMFJ/kd/41'

cc : Mr. T. Waltz

ENTERPRISE : SANYO UNIVERSAL ELECTRIC

RECOMMENDATION

Approved in principle, but major expenditure noted for Phase 2 needs to be reassessed.

RELEVANCY AND ADEQUACY OF INFORMATION

Study mentions use of reduced CFC 11 foam but no time scale is given.

TECHNICAL SOUNDNESS

HCFC 141b technology is well proven and has been shown to give equivalent insulation performance to CFC 11-based foam.

No reasons given for purchase of total of 3 new polyurethane machines and modifications to 8 others. Additionally, why cannot the existing polyol pre-mix equipment be used. No justification to modification of 2 sheet extruders.

LESSON FROM EXPERIENCE

None

ENVIRONMENTAL ISSUES

HCFC 141b is a transitional substance which must eventually be replaced by a zero ODP blowing agent. Its use will contribute to the saving of 448 ODP te per year.

SAFETY ISSUES

It is noted that provision is made for ventilation systems to use with HCFC 141b.

COST EFFECTIVENESS

Phase 2 expenditure of over $ 2.6 m has no obvious justification.

OTHERS

None

Kingdom of Thailand

PRELIMINARY REVIEW OF A NUMBER OF PROJECTS

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Kuijpers, LJM (OORG)
Eindhoven, 1993 03 11
RWR-570-LK-93106 -lk

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As far as the HCFC-123 conversion, no remarks.

Eindhoven, 11 March 1993

L.J.M. Kuijpers

UNEP Technology and Economics Panel

To The World Bank
c/o
Don Brown, Charles Catanagh
IENIM
Washington DC
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From Dr L. Kuijpers
Technical University
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fax: 31- 40- 46 6627

Date 93-05-10

Pages 1 (including this one)

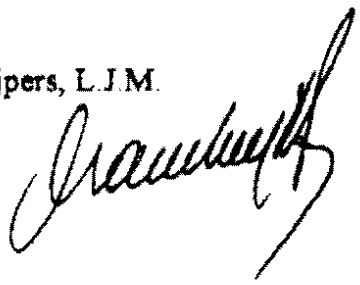
Subject

I have reviewed the slightly modified project proposals, dated 6 May 1993, for projects in0
-India (Shriram, KOI and Bluestar) and
-Thailand (Kulthorn Kirby and Sanyo).

Taking into account that in the "project scope and estimate", "modifications to the manufacturing line" are now budgetted, that license and technical assistance and license agreements are more clearly described,
however, that my reviews of the projects dated 6 May 1993 do still apply (in particular where it concerns the costs for upgrading test facilities, the costs for changing manufacturing processes and technical assistance, or the lack of detailed cost estimates -BlueStar-),

I herewith forward my non-objection to submission of these projects to the Secretariate and to the MPEC meeting June 28/30.

Kuijpers, L.J.M.



Thailand

REVIEW OF A PHASE-1 CONVERSION PROJECT

Conversion of Domestic Appliance Manufacturing to HFC-134a

Project Proposal by The World Bank, April 1993

The conversion of **Appliances** Manufacturing from CFC-12 to HFC-134a
at **Sanyo Universal Electric Co. (SUE) Industries;**

Kuijpers, LJM (OORG) Eindhoven,
1993 05 06
RTU-UNEP-LK-93150 -lk

REVIEW OF THE PROPOSAL

Recommendation

The project description proposes two phases of a three step approach, in agreement with the recommmendations by the OORG group of the Bank. Sufficient back up from the developed country manufacturer (Sanyo Japan) can be assumed.

It will concern a substantial technical assistance agreement; this seems to be in place, although it cannot be judged upon whether this should be USD 454,800 and whether it should be based upon the principle that the R&D investments by the mother company (3.72 million) have to be distributed among all subsidiaries. A logical approach would be that the larger part is being covered by the mother company and the rest is distributed among the subsidiaries.

What is very important:
There can only be discussed a technology transfer at a certain specified cost, when there is commercial production at the mother company (implying guaranteed reliability). This aspect is not very well described in the proposal.

There will be an influence of the production processes involved in the manufacture of the refrigerators and freezers used in the field test; this may interfere with phenomena caused by the compressor. For this aspect consultancy with the license -mother- company and with the compressor manufacturer will provide the most rapid solution. Since this also applies to Sanyo, no major problems are expected. It should be assumed that assistance from the compressor manufacturer next to assistance from the mother company is contained in the technical assistance agreement.

The costs/ or the number of vacuum pumps and leak detectors -to be used in the manufacturing process- seem to be high. This should be carefully investigated.

Provided that commercial production is being undertaken by the mother company (guaranteeing reliable products after technology transfer), provided that cost estimates for some of the equipment are carefully analyzed, and provided that it is acceptable that all the R&D investments done by the mother company, can be "reimbursed' via a technical assistance agreement (USD 454,800), the project should be eligible for funding under the Multilateral Fund.

2. Relevance and adequacy of information provided

The project proposal gives an adequate short description of what is envisaged to be accomplished during two phases.

The proposal for a technical assistance agreement is a good one. Whether all costs invested in R&D by the mother company have to be distributed among all subsidiaries is not clear; it would be logical that the mother company (Sanyo Japan) carries the larger part, the rest being distributed among the subsidiaries.

Although the technical assistance agreement is not very well specified, the idea is obtained that reliable production can be guaranteed (i.e. e.g. additional testing in Japan etc.).
However, the remark should be made here that it is not described whether Sanyo has a commercial production, or is planning commercial production at very short notice, i.e. commercial production of appliances in Japan. This is considered a "conditio sine qua non" for the specification of a technical assistance agreement. ✓

3. Technical soundness

In the conversion to HFC-134a, it is in particular the certainty that a reliable product can be manufactured, which has to do with adapting local manufacturing processes that will cost money. This seems to be covered by the estimates fiven in the proposal.

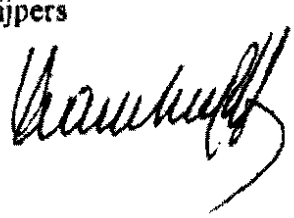
4. Cost effectiveness

By carrying out this project, an annual amount of 136 tonnes of CFC-12 is being phased out, which is in the order of 15 USD per kg, if the total project cost of 2.18 million is taken into account. This figure seems reasonable.

The major uncertainty whether the total amount should be as described, lies in the amount for the technical assistance assumed. This has already been discussed above.
Considering the total cost estimate, a reduction could also be possible since the estimate for the investment in vacuum pumps and leak detectors seem to be rather high. There is still substantial development taking place where it concerns leak detectors. This needs careful analysis.

Eindhoven, 6 May 1993

L.J.M. Kuijpers



The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand		
PROJECT TITLE:	Conversion of Compressor Manufacture from CFC-12 to HFC-134a Designs		
SECTOR COVERED:	Refrigeration		
ODS USE IN SECTOR (1992):	1080 MT ODP (430 MT CFC-12 & 650 MT CFC-11)		
PROJECT IMPACT:	Indirect		
PROJECT DURATION:	2 years		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Costs[1]:	US$ US$	1,285,000 0
PROPOSED OTF FINANCING[2]:	US$989,000 (@ 65% Thai Ownership)		
COST EFFECTIVENESS:	Not Applicable		
IMPLEMENTING ENTERPRISE:	Sanyo Universal Electric Co., Ltd. (SUE)		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This OTF request is for phase 1 funding of a project will lead to conversion of an existing CFC-12 compressor manufacturing facility at Sanyo Universal Electric Co. Ltd. (SUE) to a facility which manufactures compressors operating with the non-ozone depleting refrigerant HFC-134a. In Phase 1, 1300 compressors will be produced for test purposes. The full project when completed will provide a major indigenous source of HFC-134a compressors for use in the production of non-CFC domestic refrigerators in Thailand. Technology for HFC-134a compressor manufacture has been transferred by Sanyo-Japan to SUE under the terms of a newly approved technical assistance agreement. This project is one of a series of similar projects under the Global Refrigeration Project as approved by the Executive Committee of the Multilateral Fund in September 1992. Several refrigerator manufacturers in Thailand have based their scheduled transition to non-CFC refrigerators on the successful completion of this project.

[1] Net present value of first four years of operating costs/savings.

[2] Includes 15% contingency and 3% financial institution fee.

BACKGROUND

All refrigerators manufactured in Thailand currently use CFC-12 as the refrigerant working fluid. Technology for manufacturing these compressors has been imported. Technologies for application of the new non-ODS refrigerant (HFC-134a) to replace CFC-12 must also be imported.

Sanyo Universal Electric Co., Ltd. (SUE), a 65% Thai owned company, is a major manufacturer of hermetic compressors in Thailand with about 50% market share. SUE manufactures compressors suitable for domestic refrigeration applications as well as for replacement of failed units in the field. All refrigerator compressors made by SUE are designed for use of CFC-12 refrigerant. During 1992, SUE produced 780,000 CFC-12 compressors, of which 70% were used in Sanyo refrigerators, 10% were sold for use by other manufacturers in Thailand, and 20% were exported.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of CFC-12 in compressor manufacturing through conversion to compressors operating with HFC-134a.

PROJECT DESCRIPTION

Phase I of this activity involves assembly of 100 compressors using imported parts, followed by test manufacturing of 1200 compressors (12 models) in existing manufacturing facilities. Test manufacturing is necessary to assure the quality of the units to be produced when full scale production is initiated. Laboratory equipment with which to develop and test manufactured units is included in the Phase I project scope. Additional tests will be conducted in Japan as defined in the Sanyo technical service agreement. Sanyo-Japan will also provide on-site support for the transition to HFC-134a compressors by SUE.

The Phase I Project plan is as follows:

a. Obtain the full technology package for HFC-134 compressors from Sanyo-Japan including bill of materials, specifications, detail drawings, and testing standards.
b. Purchase and install testing facilities for compressor evaluation.
c. Procure necessary materials and components and modify plant for production of 1300 HFC-134a units.
d. Conduct life and reliability tests on 12 compressor models.
e. Field test HFC-134a compressors in domestic refrigerators, freezers, and coolers.
f. Prepare a feasibility study and cost estimate for the full conversion of compressor manufacturing facilities to HFC-134a compressors in Phase II.

The full cost of Phase I is eligible for OTF funding as defined in Item 2b of the Indicative List of Categories of Incremental Costs. However, no operational costs are included at this time. The fee for the Technical Assistance Agreement with Sanyo-Japan is included in the Phase I cost estimate.

SUE is preparing to move quickly to implement the proposed project and has already started to purchase some of the long-delivery equipment needed for Phase I. Pilot assembly of 100 compressors for initial testing will commence in September 1993. Trial manufacturing will occur in March 1994 and full scale production capability is to be in place by the end of 1994 with a complete phaseout of CFC-12 compressors by the end of 1995.. The schedule is designed to accomplish a variety of life, reliability and field tests in preparation for a full conversion of the CFC-12 compressor manufacturing facilities to HFC-134a compressors under a Phase II project. A preliminary estimate indicates that Phase II incremental costs will be about $3,000,000.

There is no direct measure of the cost effectiveness or impact of this project, as it focuses on test manufacture of new compressor designs for non-ODS refrigerators.

PROJECT COSTS

The total project cost of US$1,285,000 equals the ODS reduction portion of the overall project (investment costs plus net incremental operating costs).

Investment Costs of US$1,285,000 include capital investment costs for test manufacture components, test facilities, and materials, as well as production line modifications.

Net Incremental Operating Costs. There are no incremental costs associated with this Phase I project, as it focuses on test manufacture of new compressor designs.

Local Ownership Fraction of 65% was considered to determine the amount of eligible OTF grant financing. The total project cost was multiplied by the fraction of local ownership to determine the proposed grant amount.

Other Costs. A 15% contingency (US$125,000) was also included to ensure adequate funding of project costs following project appraisal. An additional US$29,000(3%) was added to the grant request to cover the fee for services of the financial institution (FI) that will appraise the projects and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for SUE is US$989,000 and was calculated as follows: the total investment cost was added to the present value of the incremental operating cost over the first four years of the project. The resulting total project cost was multiplied by the percentage of Thai ownership (65 percent). This figure was increased by a 15 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee.

PROJECT IMPLEMENTATION

Management: DIW will oversee the successful implementation of this project. The project will be carried out at SUE.

Schedule

	Start	Complete
Obtain full bill of materials, specs and drawings from Sanyo-Japan	Apr 93	Aug 93
Upgrade test facilities	Apr 93	Aug 93
Calorimeter		
Dynamometer		
Noise and Vibration		
Computer		
Refrigeration Test Lab		
Life Test Facilities		
Field Test Hardware		
Component and Material Procurement	Apr 93	Aug 93
Upgrade assembly and finishing facilities		Sep 93
Assembly and finishing	Sep 93	Sep 93
Calorimeter and sound test	Sep 93	Oct 93
Life and field test	Nov 93	Nov 94

ESTIMATED DISBURSEMENT: 80% in 1993, and 20% in 1994

TECHNICAL ASSESSMENT

This subproject has been reviewed by the OORG technical reviewer, Dr. L. Kuijpers. The project was supported.

UNEP Technology and Economics Panel

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Date 93-05-10

Pages 1 (including this one)

Subject

I have reviewed the slightly modified project proposals, dated 6 May 1993, for projects in0
-India (Shriram, KOI and Bluestar) and
-Thailand (Kulthorn Kirby and Sanyo).

Taking into account that in the "project scope and estimate", "modifications to the manufacturing line" are now budgetted, that license and technical assistance and license agreements are more clearly described,
however, that my reviews of the projects dated 6 May 1993 do still apply (in particular where it concerns the costs for upgrading test facilities, the costs for changing manufacturing processes and technical assistance, or the lack of detailed cost estimates -BlueStar-),

I herewith forward my non-objection to submission of these projects to the Secretariate and to the MPEC meeting June 28/30.

Kuijpers, L.J.M.

Thailand

REVIEW OF A PHASE-1 CONVERSION PROJECT

Conversion of Domestic Appliance Manufacturing to HFC-134a

Project Proposal by The World Bank, April 1993

First Phase of Compressor Manufacture Conversion from CFC-12 to HFC-134a
at **Sanyo Universal Electric Co. (SUE) Industries;**

Kuijpers, LJM (OORG) Eindhoven,
1993 05 06
RTU-UNEP-LK-93147 -lk

REVIEW OF THE PHASE 1 PROPOSAL

Recommendation

The project description proposes phase 1 of a two step approach, in agreement with the recommmendations by the OORG group of the Bank. Sufficient back up from the developed country manufacturer (Sanyo Japan) can be assumed, where it also applies to additional tests in Japan.

However, the conversion process will not only deal with the modification of compressor and lubricant for the operation of HFC-134a; it will also deal with specific phenomena in the manufacturing process. It will therefore concern a substantial technical assistance agreement; this seems to be in place, although it cannot be judged upon whether this should be USD 320,000. now 4.5% +

There will also be an influence of the production processes involved in the manufacture of the refrigerators and freezers used in the field test; this may interfere with phenomena caused by the compressor. For this aspect consultancy with the license company may also provide the most rapid solution, it may also concern here Sanyo appliances.

The costs for upgrading the test facilities seem to be high, i.e. more than USD 800,000. It should be investigated whether the investments in the calorimeter and the life test facility should be of this size.

Provided that cost estimates for the test facilities are once more carefully analyzed -and probably reduced-, the project should be eligible for funding under the Multilateral Fund. √

2. Relevance and adequacy of information provided

The project proposal gives an adequate short description of what is envisaged to be accomplished during a first phase. However, it is not clear (part c of phase 1) whether a separate small production line will be set up for the test-manufacture of HFC-134a compressors (in the cost overview only "components for test manufacture of 1300 units" are mentioned).

Although the technical assistance agreement is not very well specified, the idea is obtained that reliable production can be guaranteed (i.e. e.g. additional testing in Japan etc.)

3. Technical soundness

In the conversion to HFC-134a, it is in particular the certainty that a reliable product can be manufactured, which has to do with adapting local manufacturing processes that will cost money. This seems to be covered by the estimate "modifications to production line".

In the proposal, it is being mentioned that field tests of the compressors should be carried out on refrigerators, freezers and coolers. Of course, it is needed to test the compressors on appliances. However, this part of the program will not give all the necessary insight into the reliability of the compressor itself, due to the fact that the field test results will be affected by the specs for the components and the manufacturing process of the appliances. It is difficult to say how problems can be avoided. At least one has to discuss with the component manufacturer all the issues and specifications involved. Cooperation with Sanyo Japan and Sanyo Appliance Manufacturing will work out positive.

Manufacturing of appliances on HFC-134a implies that they have to be manufactured at a site where special evacuation and charging equipment will be available. This is not mentioned in the project proposal, but it is less relevant at this stage..

4. Cost effectiveness

Cost effectiveness cannot be discussed. There are only some questions as already mentioned above:

1. Does "components for test manufacture" imply that a separate test production line is set up, which would be advantageous in order to study the manufacturing process.
2. Taking into account the production for domestic use and export to other developing countries (interesting figures are all given), i.e. 780,000 pieces, this relates to an annual reduction of about 190 tonnes of CFC-12, which is a reasonable amount.
3. It is not clear whether the investment in the test facilities has to be as high as proposed
4. The technical assistance agreement seems to be of the right order of magnitude but it is difficult to judge upon.
5. Field tests of the compressors on appliances means that the appliance has to be manufactured for HFC-134a (following certain specs) and that, when mounting the compressor on the appliance, special evacuating and charging equipment will be needed. It is not clear whether this would imply extra costs compared to what is given in the proposal.

Considering the total cost estimate, a reduction could be possible since the estimate for the investment in the test facilities seems to be rather high. This needs careful analysis.

Eindhoven, 6 May 1993

L.J.M. Kuijpers

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand		
PROJECT TITLE:	Conversion of Compressor Manufacture from CFC-12 to HFC-134a Designs		
SECTOR COVERED:	Refrigeration		
ODS USE IN SECTOR (1992):	1080 MT ODP (430 MT CFC-12 & 650 MT CFC-11)		
PROJECT IMPACT:	Indirect		
PROJECT DURATION:	2 years		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Costs[1]:	US$ US$	832,000 0
PROPOSED OTF FINANCING[2]:	US$686,000 (@ 70% Thai Ownership)		
COST EFFECTIVENESS:	Not Applicable		
IMPLEMENTING ENTERPRISE:	Kulthorn Kirby Co. Ltd.		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This OTF request is for phase 1 funding of a project will lead to conversion of an existing CFC-12 refrigeration compressor manufacturing facility at Kulthorn Kirby Co. Ltd. (KKC) to a facility which manufactures compressors operating with the non-ozone depleting refrigerant HFC-134a. In Phase 1, 1600 compressors will be produced for test purposes.The full project when completed will provide a major indigenous source of HFC-134a compressors for use in the production of non-CFC domestic refrigerators. Technology for HFC-134a compressor manufacture has been transferred by Tecumseh and the motor technology from Kirby to KKC under the terms of an existing license agreement. This project is one of the first of a series of similiar projects under the Global Refrigeration Project as approved by the Executive Commmittee of the Multilateral Fund in September 1992. Several Thai refrigerator manufacturers have based their scheduled transition to non-CFC refrigerators on the successful completion of this project.

[1] Net present value of first four years of operating costs/savings.

[2] Includes 15% contingency and 3% financial institution fee.

BACKGROUND

All refrigeration and air conditioning devices manufactured in Thailand use CFCs or HCFC-22 and the refrigerant working fluid. CFC-12 is mainly used for domestic refrigerators and freezers, and water coolers employing hermetic compressors. Technology for manufacturing these compressors has been imported. Technologies for application of the new non-ODS refrigerant (HFC-134a) to replace CFC-12 must also be imported.

Kulthorn Kirby Co. Ltd. (KKC) is a 70% Thai owned major manufacturer of hermetic compressors in Thailand with a 54% market share. It manufactures compressors suitable for both air conditioning and refrigeration applications as well as for replacement of failed units in the field. All air conditioning applications use HCFC-22 refrigerant, whereas all refrigeration compressors (suitable for water coolers, freezers and domestic refrigerators) use CFC-12 refrigerant. During 1992, KKC produced 716,000 CFC-12 hermetic compressors plus 185,000 CFC-12 compressor kits which were exported to Tecumseh in Canada. In 1993, all exports of CFC-12 compressors will be to the United States.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of CFC-12 in compressor manufacturing through conversion to compressors operating with HFC-134a.

PROJECT DESCRIPTION

Phase I of this activity involves test manufacturing of 9 compressor models in existing facilities. Test manufacturing is necessary as the designs transferred to KKC under their license agreement must be adapted to local conditions. In particular, the compressor motor must be modified to tolerate electrical power conditions in Thailand. The technology KKC will receive from Tecumseh is specific to designs of established Tecumseh compressors which have been modified for optimum use of HFC-134a refrigerant. Kirby technology is specific to designs of motors specific to tropical conditions and 220V electrical power. Laboratory equipment with which to develop and test the necessary design modifications is included in the Phase I project scope. Existing laboratory test facilities and test equipment will be used to the extent feasible to minimize incremental project costs. Tecumseh and Kirby, plus qualified outside consultants will support KKC in their development activities.

The Phase I Project plan is as follows:

a. Obtain a complete technology package for HFC-134 compressors from Tecumseh and the motor technology from Kirby, including bill of materials, specifications and detail drawings. Modify designs as required.
b. Modify testing facilities for compressor evaluation.
c. Procure necessary materials, tools, dies and components for 1600 HFC-134a units.
d. Conduct life and reliability tests on 9 compressor models.
e. Provide compressors sufficient for developmental testing of KKC compressors in customer refrigerators.
f. Field test a full range of HFC-134a compressor models in domestic refrigerators, freezers, and coolers.
g. Prepare a feasibility study, cost estimate, and schedule for a Phase II project to completely convert the plant to HFC-134a compressor manufacture.

The Kulthorn Kirby project differs from other similar projects included in the Global Refrigeration Projects in that there are separate technology agreements covering the compressor (Tecumseh) and motor (Kirby) designs. Kuthorn Kirby must adapt both designs to their local requirements and make appropriate models for testing by their technology suppliers.

The full cost of Phase I is eligible for OTF funding as defined in Item 2b of the Indicative List of Categories of Incremental Costs. However, no operational costs are included at this time Also, there are no technology transfer fees for compressors included as these are already incorporated into the existing KKC-Tecumseh license agreement. A fee for transfer of the necessary motor technology from Kirby is included.

KKC is moving quickly to implement the proposed project and has started Phase I in late 1992 at their own expense. KKC must produce initial models for testing by refrigerator manufacturers in June 1993. The schedule is designed to accomplish a variety of life, reliability and field tests in preparation for a full conversion of KKC CFC-12 compressor manufacturing facilities to HFC-134a compressors under a Phase II project to be completed in 1994. A preliminary estimate indicates that Phase II incremental costs will be about $3,000,000.

PROJECT COSTS

The total project cost of US$832,000 equals the ODS reduction portion of the overall project (investment costs plus net incremental operating costs).

Investment Costs of US$832,000 include capital investment and transportation costs for test manufacture components, and test facilities.

Net Incremental Operating Costs. There are no incremental costs associated with this Phase I project, as it focuses on test manufacture of new compressor designs.

Local Ownership Fraction of 70% was considered to determine the amount of eligible OTF grant financing. The total project cost was multiplied by the fraction of local ownership to determine the proposed grant amount.

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

Requested Funding. The proposed OTF grant for KKC is US$686,000 and was calculated as follows: the total investment cost was added to the present value of the incremental operating cost over the first four years of the project. The resulting total project cost was multiplied by the percentage of Thai ownership (70 percent). This figure was increased by a 15 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee.

PROJECT IMPLEMENTATION

Management: DIW will oversee the successful implementation of this project. The project will be carried out at KKC.

Schedule

	Start	Complete
Obtain full bill of materials, specs and drawings from Tecumseh	Nov 92	Jun 93
Obtain designs, drawings and specifications for motors from Kirby	Jun 93	Jun 93
Upgrade test facilities	Mar 93	Sep 93
Calorimeter		Sep 93
Dynamometer		Sep 93
Noise and Vibration		Jan 94
CAD/CAM Computer		Mar 93
Lock Rotor Test Rig		May 93
Life Test Facilities		May 93
Field Test Hardware		Oct 93
Upgrade assembly and finishing facilities	Apr 93	Jun 93
Component procurement	Apr 93	May 93
Procurement of HFC-134a and polyolester oil	Apr 93	Jun 93
Motor design, relay and OLP selection	Nov 92	Jun 94
Assembly and finishing	Jun 93	Jul 94
Calorimeter and sound test	May 93	Oct 94
Life and field test	Sep 93	Jul 94

ESTIMATED DISBURSEMENT: 80% in 1993, and 20% in 1994

TECHNICAL ASSESSMENT

This subproject has been reviewed by the OORG technical reviewer, Dr. L. Kuijpers. The project was supported.

UNEP Technology and Economics Panel

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Pages 1 (including this one)

Subject

I have reviewed the slightly modified project proposals, dated 6 May 1993, for projects in0
-India (Shriram, KOI and Bluestar) and
-Thailand (Kulthorn Kirby and Sanyo).

Taking into account that in the "project scope and estimate", "modifications to the manufacturing line" are now budgetted, that license and technical assistance and license agreements are more clearly described,
however, that my reviews of the projects dated 6 May 1993 do still apply (in particular where it concerns the costs for upgrading test facilities, the costs for changing manufacturing processes and technical assistance, or the lack of detailed cost estimates -BlueStar-),

I herewith forward my non-objection to submission of these projects to the Secretariate and to the MPEC meeting June 28/30.

Kuijpers, L.J.M.

Compressor

Thailand

REVIEW OF A PHASE-1 CONVERSION PROJECT

Conversion of Domestic Appliance Manufacturing to HFC-134a

Project Proposal by The World Bank, April 1993

First Phase of Compressor Manufacture Conversion from CFC-12 to HFC-134a
at **Kulthorn Kirby Co. Ltd (KOI) Industries;**

Kuijpers, LJM (OORG) Eindhoven,
1993 05 06
RTU-UNEP-LK-93145 -lk

REVIEW OF THE PHASE 1 PROPOSAL

Recommendation

The project description proposes phase 1 of a two step approach, in agreement with the recommmendations by the OORG group of the Bank. Sufficient back up from the developed country manufacturers (Kirby and Tecumseh) can be assumed.

However, the conversion process will not only deal with the modification of compressor and lubricant for the operation of HFC-134a; it will also deal with specific phenomena in the manufacturing process. It may therefore be that a much more extended consultancy (than the one proposed) agreement with Tecumseh (not with Kirby) should be agreed upon in a preliminary way. This in order to discuss phenomena occurring during testing and field testing which will be caused by local compressor manufacturing conditions.
There will also be an influence of the production processes involved in the manufacture of the refrigerators and freezers used in the field test; this may interfere with phenomena caused by the compressor. For this aspect consultancy with the license company may also provide the most rapid solution.

It is not logical, under normal conditions, to assume that tooling costs for new compressor parts are of a substantial magnitude. This conversion proposal assumes high costs involved; it will certainly be possible to reduce these costs whilst, on the other hand, consulting services should be increased (assuming an amount needed of USD 10,000 is not much).
Provided that cost estimates are once more carefully analyzed (which will certainly lead to a reduction, i.e. lower tooling and and higher consultancy costs) and provided that a preliminary "extended consultancy agreement" can be worked out, the project should be eligible for funding under the Multilateral Fund.

2. Relevance and adequacy of information provided

The project proposal gives an adequate short description of what is envisaged to be accomplished during a first phase. However, it is not clear (part c of phase 1) whether a separate small production line will be set up for the test-manufacture of HFC-134a compressors (in the cost overview only

"components for test manufacture of 1600 units" are mentioned).

Consultancy with Tecumseh is mentioned. Since reliable production of HFC-134a compressors may be influenced by local manufacturing conditions, consultancy during the whole duration of the project is recommendable (July 1993 to July 1994) and should be taken into consideration.
This will increase the cost estmate for consultancy.

3. Technical soundness

The proposal mentions that designs must be adapted to local conditions, and that, in particular, the compressor motor must be modified. However, modification of electric motors is a normal part of the compressor design under license (which has also been the case with Kirby for all CFC-12 compressor electric motors).
The principle design of the compressor will not be different from the CFC-12 one; tooling costs for new compressor parts cannot be assumed to be high, at least not as high as mentioned in the proposal. It is much more the certainty that a reliable product can be manufactured, which has to do with adapting local manufacturing processes that will cost money, since it involves costs for test analysis and consultancy with the mother company.

In the proposal, it is being mentioned that field tests of the compressors should be carried out on refrigerators, freezers and coolers. Of course, it is needed to test the compressors on appliances. However, this part of the program will not give all the necessary insight into the reliability of the compressor itself, due to the fact that the field test results will be affected by the specs for the components and the manufacturing process of the appliances. It is difficult to say how problems can be avoided. At least one has to discuss with the component manufacturer all the issues and specifications involved. Advice from the mother company (Tecumseh) will also be helpful (see under consultancy).
Maybe input from Tecumseh to this proposal can be asked for; this in particular since the project has already started with the help of the Tecumseh mother company.

Manufacturing of appliances on HFC-134a implies that they have to be manufactured at a site where special evacuation and charging equipment will be available. This is not mentioned in the project proposal. Nevertheless, at this stage this aspect should not be prohibitive for a possible approval of the project.

4. Cost effectiveness

Cost effectiveness cannot be discussed. There are only some questions as already mentioned above:

1. Does "components for test manufacture" imply that a separate test production line is set up, which would be advantageous in order to study the manufacturing process.
2. Taking into account the production for domestic use and export to other developing countries (no figures given), i.e. 716,000 pieces, this relates to an annual reduction of about 175 tonnes of CFC-12, which is a reasonable amount.
3. Consultancy over more than a year will be needed. It may be that costs can be covered by the USD 10,000 mentioned in the proposal, but it is unlikely.
4. It is not clear what "technology fees for test unit motors" ad USD 150,000 means.
5. Tooling costs for new compressor parts cannot be assumed to be high in the case of the

conversion from CFC-12 to HFC-134a. The cost estimate given in the proposal seems to be high.

6. Field tests of the compressors on appliances means that the appliance has to be manufactured for HFC-134a (following certain specs) and that, when mounting the compressor on the appliance, special evacuating and charging equipment will be needed. It is not clear whether this would imply extra costs compared to what is given in the proposal.

Considering the total cost estimate, a reduction is likely, since tooling costs (and maybe the costs for tech fees for test unit motors) seem to be high. However, it will be offset for a small part due to higher consultancy costs.

Eindhoven, 6 May 1993

L.J.M. Kuijpers

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand
PROJECT TITLE:	Demonstration of Low Cost HFC-134a Retrofit of Existing CFC-12 MAC's
SECTOR COVERED:	Mobile Air-Conditioning (MAC)
ODS USE IN SECTOR (1991):	1,640 MT CFC-12 (320 MT new equipment; 1,320 MT servicing)
PROJECT IMPACT:	Not Applicable
PROJECT DURATION:	7 months
TOTAL PROJECT COST:	US$60,000
PROPOSED OTF FINANCING[1]:	US$71,000 (@ 100% Thai Ownership)
COST EFFECTIVENESS:	Not Applicable
IMPLEMENTING ENTERPRISE:	Karnawat Co.Ltd.
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY

This project will demonstrate retrofitting mobile air conditioners (MACs) which use CFC-12 as the working fluid to HFC-134a. Some 2.3 million vehicles in Thailand have air conditioning units installed, all of which use CFC-12 as the refrigerant. To charge, service and repair these MACs 1,640 MT of CFC-12 are consumed annually in service stations spread out across the country. To phase out the use of CFC-12 in the MAC sector, two concurrent efforts must be carried out. One is to eliminate the current production of CFC-12 MACs; another is to minimize the demand of CFC-12 in the MACs' service sector. A cost-effective way to minimize such demand in the service sector is to retrofit existing MACs for HFC-134a. Retrofitting will ensure the continued utility of installed equipment with many years of remaining serviceable life. The project will comprise three phases. The first phase will involve the selection and acquisition of retrofit components. The second phase will involve the retrofitting of 50 mobile air-conditioning units, 25 of which will be installed in private cars and 25 installed in taxis. The third phase will involve close and regular monitoring of the conditions of the retrofitted MACs. Karnawat is 100% Thai owned, which was taken into account in calculating the proposed OTF financing.

[1] Includes 15% contingency and 3% financial institution fee.

SIMONE MANAGEMENT INC.

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(215) 352-4600

May 11, 1993

TO: CHARLES B. CATANACH / JESSICA POPPELE - WORLD BANK
FAX: 202-477-6619

FROM: SIMON OULOUHOJIAN - OORG REVIEWER - MOBILE AC
FAX 215-352-1345

THAILAND - REVIEW OF PROJECT #1 PROPOSAL - MOBILE AIR CONDITIONING

COUNTRY:	Kingdom of Thailand
PROJECT TITLE:	Demonstration of Low Cost HFC-134a Retrofit of Existing CFC-12 MAC's
SECTOR COVERED:	Mobile Air-Conditioning (MAC)
ODS USE IN SECTOR:	320 MT of CFC-12 for new equipment in 1991 and 1,320 MT of CFC-12 for servicing in 1991
PROJECT IMPACT:	N/A
PROJECT DURATION:	7 months
PROJECT ECONOMIC LIFE:	N/A
TOTAL PROJECT COST:	US$ 65,000
PROPOSED GTF FUNDING:	US$ 65,000
IMPLEMENTING ENTERPRISE:	Kernewat Co. Ltd
COORDINATING MINISTRY:	Department of Industrial Works Ministry of Industry Kingdom of Thailand

Based on information contained in the proposal and analysis, I support this project.

This proposal, especially with accelerated phase out December 31, 1995, would reduce CFC usage, short term as well as long term.

This project certainly would step up awareness within the air conditioning industry as well as public awareness.

This project will seed the Mobile Air Conditioning Service Industry for the new training of retrofit technology as well as safe handling of the new non-ozone depleting refrigerant R134a and synthetic lubricants (PAGS ESTERS).

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand	
PROJECT TITLE:	Replacement of CFC-11 with HCFC-141b as a Foam Blowing Agent	
SECTOR COVERED:	Foam Blowing	
ODS USE IN SECTOR (1991):	1500 MT ODP (1300 MT CFC-11 & 200 MT CFC-12)	
PROJECT IMPACT:	Eliminate 50 MT ODP per year (50 MT CFC-11)	
PROJECT DURATION:	6 months	
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Cost[1]:	US$ 26,000 US$ 121,000
PROPOSED OTF FINANCING[2]:	US$174,000 (@ 100% Thai Ownership)	
COST EFFECTIVENESS:	US$2.83/kg ODP/year	
IMPLEMENTING ENTERPRISE:	Technic Foam, Ltd.	
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand	
IMPLEMENTING AGENCY:	The World Bank	
APPRAISAL DATE:	August, 1993	

PROJECT SUMMARY

This project will eliminate the use of CFC-11 for producing rigid polyurethane insulating foam at Technic Foam, Ltd. The phaseout will be accomplished by replacing CFC-11 with HCFC-141b as the foam blowing agent. This will require modifying existing equipment and chemical formulations, and providing technical assistance to Technic Foam's managers and workers. The project will eliminate an estimated 50 MT of CFC-11 per year.

Technic Foam, Ltd. is the largest of three firms that apply PU spray insulation in Thailand, and estimates that it has 60 to 65 percent of this particular market. Technic is 100 percent Thai owned, which was taken into account in calculating the proposed OTF financing. Incremental operating costs result primarily from differences between costs for required quantities of HCFC-141b and CFC-11. Preliminary HCFC-141b price information used for cost calculations was based on invoices reviewed in Thailand. During appraisal, this data will be cross-checked with information from chemical suppliers and local distributors.

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[1] Net present value of first four years of operating costs/savings.

[2] Includes 15% contingency and 3% financial institution fee.

ICI Polyurethanes

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5th May, 1993

THAILAND SUB PROJECT PROPOSALS

Dear Don,

Documents were received on 3/5/93.

General comments are :

- Enterprises which are subsidiaries of Japanese refrigerator manufacturers are proposing the use of HCFC 141b foam technology - this is in line with the changes now being implemented in Japan by the parent companies. However, this could be a comparatively short term option in Japan. There is an increasing level of interest in the performance of cyclopentane-based foam which is now being implemented in Europe. Further, at least two Japanese manufacturers are to base part of their production on composites of vacuum insulation panels with CO_2 (water)-blown polyurethane foam.

- HCFC 141b foam technology is now well proven and gives equivalent insulation values to foam based on CFC 11 despite its higher gas thermal conductivity.

- HCFC 22 foam technology is not used unless it is protected by steel panels because of deterioration of thermal insulation with time. The technology proposed by Admiral is not supported for use in refrigerators with plastic liners. The blend HCFC 22 / HCFC 142b overcomes this ageing problem and is in use elsewhere.

- Several projects call for the purchase of new foam injection machines as well as vacuum forming equipment for liners and jigs. Individual comments are given for the enterprises but in general the need for these items should be reviewed at the end of phase 1.

distributor or manufacturer price?

- The HCFC 141b price projection quoted in exhibit 1 of the feasibility study is too high. Current prices are about 50% of the quoted 1994 price level.
- Difficulty of gauging value of technical assistance from parent companies.

Dr. G. M. F. Jaffe - OORG MD 152
GMFJ/kd/41'

cc : Mr. T. Waltz

ENTERPRISE : TECHNIC FOAM

RECOMMENDATION

Supported subject to comments below.

RELEVANCY AND ADEQUACY OF INFORMATION

Good.

TECHNICAL SOUNDNESS

The use of HCFC 141b foam technology is proven in slabstock and spray applications and is supportable where energy saving by replacing CFC 11-based foam with equivalent technology is a requirement - as in the cold store and pipe insulation applications.

Use of CO_2 would have increased foam costs by 50% (minimum) and required equipment modifications.

LESSON FROM EXPERIENCE

None

ENVIRONMENTAL ISSUES

HCFC 141b is a transitional material and will eventually have to be replaced by a zero ODP blowing agent. Its use will save about 45 ODP te per year (not 50 ODP te).

SAFETY ISSUES

Adequate attention to new equipment to deal with flammable nature of HCFC 141b. Query that sufficient time is devoted to operator training.

COST EFFECTIVENESS

Annex 2 lists incremental cost for year one. This is queried on basis of high price for HCFC 141b - see general comments.

OTHERS

None

Kingdom of Thailand

PRELIMINARY REVIEW OF A NUMBER OF PROJECTS

Conversion of Domestic Manufacturing to HFC-134a and to HCFC-141b in Polyurethane Foams; Conversion of Chillers to HFC-134a

Projects Described by The World Bank, March 1993

1. **Introduction of HCFC-141b for foams and the conversion process to HFC-134a for cooling at THAI TOSHIBA Industries;**
2. **Idem, at ADMIRAL Industries;**
3. **Idem, at HITACHI Industries;**
4. **Idem, at KANG YONG Industries;**
5. **Idem, at AP National Industries;**
6. **Two Chiller Conversion Projects to HFC-134a.**

Kuijpers, LJM (OORG)
Eindhoven, 1993 03 11
RWR-570-LK-93106 -lk

REMARKS REGARDING THE PROPOSALS

1. Foam Blowing

All projects describe a conversion from CFC-11 to HCFC-141b. In a first instance, it is remarkable that there is a large price difference between the conversions proposed for the different industries (take e.g. the difference between AP and Toshiba, 0.25 and 1.79 million). Indeed, HCFC-141b seems to be the preferred route for the Japanese, although, until recently, they have also maintained the HCFC-123 option. It may be that they will stick to the HCFC-141b option, however, in Europe there is a tendency (whether or not realistic) to study cyclopentane, a flammable high boiling refrigerant. About its performance nothing is known so far (conductivity value is worse compared to others, I do not know about long term behaviour).
One should bear in mind that the European manufacturers have been evaluating both 22/142b and 141b for quite some time; they achieved slightly inferior results with 22/142b; however, the long term behavior is not so good, due to diffusion of HCFC-22. Nevertheless, almost all manufacturers switched to HFC-134a (no chlorine anymore, due to environmental group pressure in Germany) shortly before the Domotechnica fair (apart from one). So I do not know whether this could play a role in Japan and in the daughter companies as well.
The best thing is to ask the OORG foam expert as well (Jeffs, ICI), regarding the time involved in optimizing HFC-134a foams. Dependent on this one could solve the question on whether or not to invest in the HCFC-141b route in Thai companies or to postpone a decision to later this year.

2. Refrigeration, general observations

The CFC-12 consumption of the five companies amounts to about 78 tonnes, while a total consumption of 250 tonnes in this sector is mentioned. Is there another large manufacturer involved ?
The above does not hold for CFC-11, 300 tonnes compared to 500 tonnes is used by the firms considered.

Several companies should do something regarding their use of CFC-11, i.e. apply reduction measures (take e.g. Kang Yong and AP which probably use CFC-11 also for cleaning) since the consumption is large compared to the CFC-12 consumption.

3. Refrigeration, specific topics

There is technology support from the mother companies, the costs however vary widely not dependent on the size of the company, e.g. 592,000 for Matsushita supporting the small AP firm. More information (e.g. contracts) on what is specifically covered in each of the cases is absolutely necessary. There is also a question on whether or not the relationship to Kultorn Kirby should not be described more precisely. Description so far (Kirby will provide the companies with compressors for testing) is not at all sufficient. It is often the compressor manufacturer (with its specific lubricant properties and so on) that determines the technology transfer. Design of the appliances and the manufacturing process can be supported by the mother company.
Kirby plays a key role in Thai companies, for this reason more precise information would be extremely useful.
This will also determine whether or not CFC-12 and HFC-134a appliances can be manufactured using the same assembly line.

In particular the technology transfer issue is important; the phased approach presented is in principle OK.

There is also a question regarding test rooms. What is determining the size and the costs for a test room. There is again a remarkable difference between the Admiral company and Hitachi, the smallest and largest in size. The same holds for the differences in costs for refrigerant and oil charging equipment. Maybe this could be explained somewehat more detailed in the proposal. Some firms will invest in leak detectors; does this not hold for all of them ?
A consistent approach and evaluation would be desireable.

Taking the amounts of CFCs involved costs vary from about 18 to 145 USD per kg of CFC (11 and 12) phased out per year. Is this an acceptable figure ?

4. Chillers

As far as the chiller conversion is concerned, there are no significant remarks.
For the HFC-134a conversion, the cost is in the order of USD 30 per kg of CFC-12 not used, which is a high figure, and which should be supported by considerations on the lifetime and economic value of the equipment.
As far as the HCFC-123 conversion, no remarks.

Eindhoven, 11 March 1993

L.J.M. Kuijpers

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand
PROJECT TITLE:	Elimination of ODS Used in the Production of Household Refrigerators, Structural Foams, and the Cleaning of Heat Exchangers
SECTOR COVERED:	Household Refrigerator
PROJECT IMPACT:	Eliminate 9 MT ODP per year (3 MT CFC-12, 6 MT CFC-11 & 8 MT TCA)
PROJECT DURATION:	Phase I: 2 years Phase II: 1 year
TOTAL PROJECT COST:	ODS Reduction Investment Cost: US$ 1,210,000 Incremental Operating Cost[1]: US$ 15,000
PROPOSED OTF FINANCING[2]:	This request is for **permission to proceed**; no funding is requested at this time. This project will be submitted to the EC following pre-appraisal for funding approval of about US$1,634,000 (@ 100% Thai Ownership)
COST EFFECTIVENESS:	**Part a** (Household Refrigerators and A/C): Not Applicable **Part b** (Heat Exchangers): US$30.49/kg ODP/year
IMPLEMENTING ENTERPRISE:	Admiral Thailand Co., Ltd.
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand
IMPLEMENTING AGENCY:	The World Bank

[1] Net present value of first four years of operating costs/savings.

[2] Includes 30% contingency and 3% financial institution fee.

PROJECT SUMMARY

This OTF request is for permission to proceed on final preparation of a project proposal to phase out chlorofluorocarbons (CFCs) used in household refrigerators and air conditioners manufactured at Admiral Thailand Co., Ltd. The project will also eliminate 1,1,1-trichloroethane (TCA) used to clean the heat exchangers of the air conditioners. The phaseout will be accomplished by converting the production line to refrigerators using HFC-134a and HCFC-22 as the new refrigerant and foam blowing agent respectively. The air conditioner production line will be converted by replacing CFC-11 used in the structural foam with a fully blended polyol containing water. The use of 1,1,1-Trichloroethane will be eliminated by replacing the existing metal cleaning process with semi-batch aqueous cleaning equipment. The project will consist of two phases. The first phase will provide for product development using CFC alternatives and will identify all equipment and process changes needed to implement the alternative technology. During this phase, Admiral will obtain engineering assistance and training from its compressor and chemical suppliers. The aqueous cleaning equipment for the heat exchangers will be installed during Phase I of the project.

During Phase II, Admiral will purchase and install the new equipment necessary for mass production of CFC-free refrigerators as well as for the manufacturing of the structural foam used in the air conditioners. The project will result in the elimination of 3 MT/year of CFC-12 (refrigerant), 6 MT/year of CFC-11 (foam blowing agent) and 8 MT/year of 1,1,1-trichloroethane after the conversion is completed.

BACKGROUND

The domestic refrigeration industry in Thailand uses CFC-12 as the refrigerant in new refrigerators and also to replace lost refrigerant during servicing. CFC-11 is used as the blowing agent for polyurethane (PU) insulation foam in refrigerators and in structural foam production. The demand for household refrigerators and freezers in Thailand is increasing at a rate greater than 10% per year, and most units sold in Thailand are made locally by seven major manufacturers: Sanyo, Toshiba, Hitachi, Sharp Appliances, Mitsubishi, A.P. National, and Admiral. Most refrigerators are equipped with compressors manufactured in Thailand by Sanyo and Kulthorn Kirby. In 1992, the sector used a total of 430 MT of CFC-12 (210 MT to charge new appliances and 220 MT for servicing), and about 650 MT of CFC-11.

Admiral Thailand Co., Ltd. (Admiral), which is 100 percent Thai owned, is the smallest refrigerator manufacturer in Thailand and has a trademark agreement with Admiral. Annual production is approximately 4,800 refrigerators and freezers, comprising three different models. The plant also produced 24,000 air conditioner units in 1991. Admiral also manufactures the heat exchangers used in their air conditioners. In 1992, the company consumed 3 MT of CFC-12, six MT of CFC-11 and eight MT of TCA. The average CFC-12 charge size in its refrigerators is 0.52 kg. Admiral is still using full CFC-11 formulation for its foam and uses about 0.93 kg of CFC-11 per refrigerator.

Admiral Thailand is typical of a small refrigerator with a core staff of experienced personnel in key positions but without outside technical support. Since the future of Admiral's licensing agreement with Domicor Inc. U.S.A. is uncertain after 1993, Admiral must rely on its own designs, developments, and testing of the non-CFC refrigerator designs. However, Admiral first must secure technical assistance from its compressor and chemical suppliers to ensure that the risks associated with the conversion process are minimized. The purpose of this assistance is to provide Admiral with the technical information and support necessary to guarantee a successful conversion to ODS-free technology. Such agreements are to be in place before the project can be considered as pre-appraised

PROJECT OBJECTIVES

This project has two main objectives:

a) to phase out CFC-12 and CFC-11 used in refrigerators/freezers, and CFC-11 used in air conditioner structural foam.

b) to eliminate the use of 1,1,1-trichloroethane in the cleaning operation of heat exchangers through the use of an aqueous cleaning technology.

PROJECT DESCRIPTION

This project will be divided into two separate components. Component A concerns the phaseout of CFCs used in household refrigerators/freezers and in the structural foam for air conditioners. Component B concerns the phaseout of 1,1,1-trichloroethane used in cleaning the heat exchangers.

Component A (Household Refrigerators and A/C)

The use of CFC-12 and CFC-11 in household refrigerators will be eliminated by converting the manufacturing facility to one compatible with HFC-134a refrigerant and an alternative foam blowing agent (HCFC-22,HCFC-22/142b, or HCFC-141b). It will also phase out CFC-11 used to make the structural foam of the air conditioners by replacing it with a fully blended polyol. Component A will be subdivided into two phases. The first phase will provide for engineering assistance, training, and acquisition of specific equipment for testing the new refrigerators. The second phase will allow for the elimination of CFC-12 and CFC-11 through the purchase and installation of the new equipment necessary for mass production of CFC-free refrigerators. Equipment required for the production of the structural foam of the A/C will also be purchased.

Phase I of the project will ensure that Admiral has the necessary equipment to conduct adequate testing. A controlled ambient test room with an accompanying data acquisition system will be purchased. This room will be used to test the refrigerators and help determine the optimum refrigerant charge and length of the capillary tube. Additional tests will be performed to select the most suitable filter drier for HFC-134a and ester oil. Pull-down tests will be conducted to make sure that the food and freezer compartment temperatures reach their design values.

Training will also be an integral part of Phase I. Technical experts from Kulthorn Kirby, the compressor supplier, will train Admiral's employees on the proper fabrication of HFC-134a refrigeration circuits. Emphasis will be on quality control due to the higher sensitivity of the new system to contaminants. Additional training on handling the new foam blowing agent will be provided by ICI Polyurethanes and Cannon Urethane Technology. Final decisions on all of the equipment purchasing and retrofitting, except for minimal equipment required to build field test models, will be made after Phase I is complete and test results are analyzed.

Phase II of the project will consist of finalizing the transition to non-CFC technology. During this transition time, both CFC and non-CFC refrigerators will be produced on the same line. Therefore, Admiral will purchase and install an additional set of charging equipment (for HFC-134a and ester oil) as well as a new high pressure polyurethane injection foam machine. An identical high pressure injection machine for the structural foam will also be installed. If a high-pressure fluid such as HCFC-22 is used, Admiral must purchase pressurized storage tanks for the polyol/blowing agent blend. Care will be taken during this period to avoid cross contamination of refrigerants and compressor oils. New halogen leak detectors for HFC-134a will also be purchased.

Component B (Heat Exchangers)

Admiral will eliminate the use of TCA in the heat exchanger manufacturing process by installing a semi-batch aqueous cleaning process. Admiral currently uses a batch dip process to remove oils left over from the manufacturing process. The new cleaning equipment will be used to replace the TCA cleaning process. The switch from a relatively inert cleaning process to one where water is utilized as a solvent will require aqueous cleaner evaluation and process development to ensure that cleaning times and drying times are sufficient to remove the dirt and oil from the product. The project activites for elimination of TCA use consist of the following elements:

- Process development and material compatibility testing
- One medium volume semi-batch aqueous cleaning system
- One wastewater recycling system
- Installation and training costs
- Costs of environmental permitting.

Each of these project elements is explained in detail below:

Process development and material compatibility testing will be performed by Admiral to determine the best cleaning agents and rinse water additives required to ensure adequate cleaning.

The aqueous cleaning equipment will include one aqueous washing tank, two or three cascading clean water rinse tanks, a separate hot air drying section or oven, and an overhead hoist to move the equipment between each stage of the cleaning process.

Wastewater will be captured, cleaned, and reused within the Admiral facility. The use of aqueous cleaning processes requires that wastewater be treated to remove hydrocarbon oil and detergent prior to discharge. Water treatment equipment is provided as an integral part of this project. The installed equipment must include wastewater treatment to be accepted for funding.

The project includes funding to prepare the sites for the equipment. Costs are included for electrical supply and plumbing modifications to ensure safe installation of the equipment. Some modifications are necessary to the cleaning rooms so that the process flow is uninterrupted in times of high volume cleaning.

Employees will be trained in the proper operation and maintenance of the new equipment. Incremental costs associated with the differences in cost of electricity, solvents, and labor are included, as is the cost of acquiring the necessary environmental permits.

PROJECT COSTS

Total Project Cost

The total project cost of US$1.22 million equals the ODS reduction portion of the overall project (investment costs plus net incremental operating costs). This project will not provide Admiral with incremental revenues.

Investment Costs of US$1.22 million include costs associated with CFC-free refrigerator product development, technical assistance, testing, equipment for mass production, and training, as well as costs associated with the acquisition of an aqueous cleaning system for the heat exchangers.

Net Incremental Operating Costs:

Component A (Household Refrigerators and A/C): Because full scale production of non-CFC refrigerators will not occur until 1995, incremental operating costs have not been included as part of this project.

Component B (Heat Exchangers): The net incremental operating costs of US$15,000 are equal to the net present value of the first four years of incremental operating costs. These costs are due primarily to the increased electricity requirements and the costs of wastewater treatment.

Local Ownership Fraction of 100% was considered to determine the amount of eligible OTF grant financing. The total project cost was multiplied by the fraction of local ownership to determine the proposed grant amount.

Other Costs. A 30% contingency (US$366,000) was also included to ensure adequate funding of project costs following project appraisal. An additional US$48,000 (3%) was added to the grant request to cover the fee for services of the financial institution (FI) that will appraise the projects and oversee procurement, disbursement and audits.

Requested Funding. The proposed OTF grant for Kang Yong Electric Co., Ltd. is US$1,634,000 and was calculated as follows: the total investment cost was added to the present value of the incremental operating cost over the first four years of the project. The resulting total project cost was multiplied by the percentage of Thai ownership (100 percent). This figure was increased by a 30 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee.

PROJECT IMPLEMENTATION

Management: DIW will oversee the successful implementation of this project. The project will be carried out at Admiral.

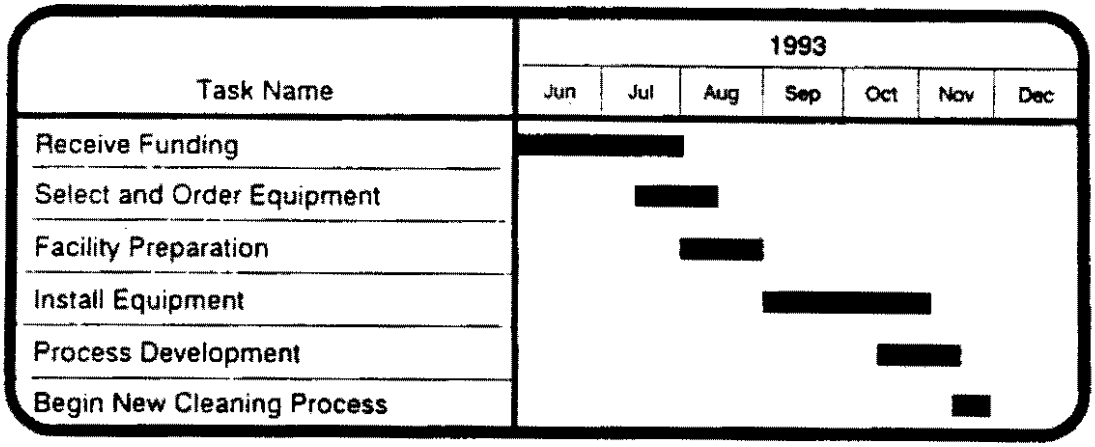
Schedule

Part a (Household Refrigerators and A/C)

TASK	1993	1994	1995	1996
Phase I: Model Development, Technical Assistance	xxxx	xxxx		
Testing and Training	x	xxxx	xx	
Phase II: Procurement and Installation of Equipment			xxxx	
Conversion of Production Line to Non-CFC Technology			x	
Full Production of Non-CFC Refrigerators				x

Note: x = one quarter of the year

Part b (Heat Exchangers)



ESTIMATED DISBURSEMENT: To be determined upon pre-appraisal.

TECHNICAL ASSESSMENT

This subproject has been reviewed by the OORG technical reviewer, Dr. Michael Jeffs. The project is not supported at this time because of inadequate definition of the proposed foam technology. Firm technology agreements also need to be developed. In addition to Dr. Jeff's review, comments were received from OORG reviewer Dr. L. Kuijpers. A formal review from Mr. Kuijpers will be submitted by May 25.

ICI Polyurethanes

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5th May, 1993

THAILAND SUB PROJECT PROPOSALS

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distributor or manufacturer price?

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- Difficulty of gauging value of technical assistance from parent companies.

Dr. G. M. F. Jaffe - OORG MD 152
GMFJ/kd/41'

cc : Mr. T. Waltz

ENTERPRISE : ADMIRAL

RECOMMENDATION

Before support is given the choice of HCFC 22 foam technology should be re-examined. Additionally, major capital items need justification.

RELEVANCY AND ADEQUACY OF INFORMATION

No justification noted for purchase of items in Phase 2.

TECHNICAL SOUNDNESS

The use of HCFC 22 for insulating foam is unproven for applications such as refrigerators where gas interchange can occur through the plastic liner, leading to deterioration of insulating value.

Structural foam based on CO_2 (water) is adequately proven.

LESSON FROM EXPERIENCE

None

ENVIRONMENTAL ISSUES

HCFC 22 is a transitional material and will eventually have to be replaced by a zero ODP blowing agent - such as HFC 134a as noted in the study. The use of CO_2 (water) for the non-insulating structural foam application is sound. Project leads to saving of 9.3 ODP te per year.

SAFETY ISSUES

None.

COST EFFECTIVENESS

Major impact of capital items in Phase 2 such as 2 foam machines. CO_2 (water) process certainly does not need a premix station for blowing agent (item 5). This section needs to be queried.

OTHERS

None

Kingdom of Thailand

PRELIMINARY REVIEW OF A NUMBER OF PROJECTS

Conversion of Domestic Manufacturing to HFC-134a and to HCFC-141b in Polyurethane Foams; Conversion of Chillers to HFC-134a

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6. **Two Chiller Conversion Projects to HFC-134a.**

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REMARKS REGARDING THE PROPOSALS

1. Foam Blowing

All projects describe a conversion from CFC-11 to HCFC-141b. In a first instance, it is remarkable that there is a large price difference between the conversions proposed for the different industries (take e.g. the difference between AP and Toshiba, 0.25 and 1.79 million). Indeed, HCFC-141b seems to be the preferred route for the Japanese, although, until recently, they have also maintained the HCFC-123 option. It may be that they will stick to the HCFC-141b option, however, in Europe there is a tendency (whether or not realistic) to study cyclopentane, a flammable high boiling refrigerant. About its performance nothing is known so far (conductivity value is worse compared to others, I do not know about long term behaviour).
One should bear in mind that the European manufacturers have been evaluating both 22/142b and 141b for quite some time; they achieved slightly inferior results with 22/142b; however, the long term behavior is not so good, due to diffusion of HCFC-22. Nevertheless, almost all manufacturers switched to HFC-134a (no chlorine anymore, due to environmental group pressure in Germany) shortly before the Domotechnica fair (apart from one). So I do not know whether this could play a role in Japan and in the daughter companies as well.
The best thing is to ask the OORG foam expert as well (Jeffs, ICI), regarding the time involved in optimizing HFC-134a foams. Dependent on this one could solve the question on whether or not to invest in the HCFC-141b route in Thai companies or to postpone a decision to later this year.

2. Refrigeration, general observations

The CFC-12 consumption of the five companies amounts to about 78 tonnes, while a total consumption of 250 tonnes in this sector is mentioned. Is there another large manufacturer involved ?
The above does not hold for CFC-11, 300 tonnes compared to 500 tonnes is used by the firms considered.

Several companies should do something regarding their use of CFC-11, i.e. apply reduction measures (take e.g. Kang Yong and AP which probably use CFC-11 also for cleaning) since the consumption is large compared to the CFC-12 consumption.

3. Refrigeration, specific topics

There is technology support from the mother companies, the costs however vary widely not dependent on the size of the company, e.g. 592,000 for Matsushita supporting the small AP firm. More information (e.g. contracts) on what is specifically covered in each of the cases is absolutely necessary. There is also a question on whether or not the relationship to Kultorn Kirby should not be described more precisely. Description so far (Kirby will provide the companies with compressors for testing) is not at all sufficient. It is often the compressor manufacturer (with its specific lubricant properties and so on) that determines the technology transfer. Design of the appliances and the manufacturing process can be supported by the mother company.
Kirby plays a key role in Thai companies, for this reason more precise information would be extremely useful.
This will also determine whether or not CFC-12 and HFC-134a appliances can be manufactured using the same assembly line.

In particular the technology transfer issue is important; the phased approach presented is in principle OK.

There is also a question regarding test rooms. What is determining the size and the costs for a test room. There is again a remarkable difference between the Admiral company and Hitachi, the smallest and largest in size. The same holds for the differences in costs for refrigerant and oil charging equipment. Maybe this could be explained somewehat more detailed in the proposal. Some firms will invest in leak detectors; does this not hold for all of them ?
A consistent approach and evaluation would be desireable.

Taking the amounts of CFCs involved costs vary from about 18 to 145 USD per kg of CFC (11 and 12) phased out per year. Is this an acceptable figure ?

4. Chillers

As far as the chiller conversion is concerned, there are no significant remarks.
For the HFC-134a conversion, the cost is in the order of USD 30 per kg of CFC-12 not used, which is a high figure, and which should be supported by considerations on the lifetime and economic value of the equipment.
As far as the HCFC-123 conversion, no remarks.

Eindhoven, 11 March 1993

L.J.M. Kuijpers

Thailand

REVIEW OF FIVE PHASE-1 CONVERSION PROJECTS

Conversion of Domestic Appliance Manufacturing to HFC-134a

Project Proposals by The World Bank, April 1993

First Phase of Appliance Manufacture Conversion from CFC-12 to HFC-134a at
Thai-Toshiba
Hitachi Consumer Products
AP National
Admiral Thailand
Kang Yong Electric Industries.

Kuijpers, LJM (OORG) Eindhoven,
1993 05 06
RTU-UNEP-LK-93170 -lk

REVIEW OF THE PHASE 1 PROPOSALS

Recommendation

All project descriptions propose a phase 1 of a two step approach, in agreement with the recommmendations by the OORG group of the Bank. In most cases there is sufficient back up from the developed country appliance manufacturer, where it also applies to additional tests (mainly in Japan).

However, most of the remarks from my earlier review still apply to these latest project proposals:
1. The relationship (and timescale of introduction) with the compressor manufacturers has still many uncertainties since the compressor manufacturers have still to convert their production with the support from others. This implies that the appliance manufacturers will depend on relationships that depend on other relationships where still uncertain parameters are involved.
2. The size of the production of the different manufacturers is quite different, from about 140,000 down to 4,800 (Admiral). Nevertheless, the costs for technical support and for new equipment to be bought do not have any relationship to the production volume.
3. The costs for technical assistance seem to be random, and quite high. As an example, technical assistance for AP National (USD 700,000, production volume 74,000) cannot be compared to others (e.g. Sanyo (USD 454,800, production volume 600,000 pieces). This issue needs to be clarified first.

It is recommended to first establish criteria for the costs for technical assistance -whether or not related to the production volume, e.g. with certain maxima, before that these projects should be approved.
It should also be realized that the conversion will be dependent on the success of the conversion process at compressor manufacturers (projects still to be approved).

Taking these arguments into account, it is difficult to give an overall recommendation for (dis)approval. Costs for Admiral are too high, there is no back up from another manufacturer. Technical assistance costs for AP National are (too) high.

2. Relevance and adequacy of information provided

The project proposals give adequate short descriptions of what is envisaged to be accomplished during a first phase.
The technical assistance agreements are not very well specified (comparable to the Sanyo project), the idea is obtained that a reliable appliance production can be guaranteed (e.g. by additional testing in Japan etc.). However, costs for technical assistance seem to be random:

- Sanyo (separate proposal):	USD 454,800	for a volume of 600,000 places.	
- TTEI:	USD 510,800	140,000	"
- Kang Yong	USD 320,000	115,000	"
- AP National	USD 700,000	74,000	"
- Hitachi	USD 480,000	142,000	"
- Admiral (estimate)	USD 150,000	4,800	".

3. Technical soundness

In the conversion to HFC-134a, it is in particular the certainty that a reliable product can be manufactured, which has to do with adapting local manufacturing processes that will cost money.
It will always be difficult to manufacture CFC-12 and HFC-134a appliances at the same moment, unless very special precautions are taken.
The reliability of the appliance will also depend on the quality (and the type) of the compressor. This cannot be estimated at this moment.
Since Kulthorn Kirby is one of the main manufacturers of compressors involved, it should be ascertained whether this company can solve problems which might occur at the manufacturers at the same time.

4. Cost effectiveness

Cost effectiveness cannot be discussed. There are only some questions as already mentioned above:

1. Does "technical assistance" imply a relationship to the production volume ?.
2. Costs for lab equipment (test room) and for charging equipment are quite different. E.g. the costs for charging at Admiral is equal to others with a much bigger production volume.
3. It is difficult to judge upon whether some manufacturers need test rooms, others not.

6/5 1993

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand
PROJECT TITLE:	Phaseout of CFC-12 in Mobile Air Conditioners
SECTOR COVERED:	Mobile Air-Conditioning (MAC)
PROJECT IMPACT:	Reduce consumption of CFC-12 by 125 MT/year
PROJECT DURATION:	1 year
TOTAL PROJECT COST:	US$618,000
PROPOSED OTF FINANCING[1]:	This request is for permission to proceed; no funding is requested at this time. This project will be submitted to the EC following pre-appraisal for funding approval of about US$463,000 (@ 56% Thai Ownership)
COST EFFECTIVENESS:	Not Applicable
IMPLEMENTING ENTERPRISE:	Nippondenso Thailand Sales
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand
IMPLEMENTING AGENCY:	The World Bank

PROJECT SUMMARY

This request is for permission to proceed on final preparation of a project proposal to convert Nippondenso's network of 150 mobile air-conditioning service shops from CFC-12 to shops for servicing new HFC-134a mobile air conditioners which will be installed in new cars starting in 1992. This project will prepare Nippondenso's network of 150 mobile air-conditioning service shops to provide services for new HFC-134a mobile air conditioners (MACs) which will be installed in new cars in 1993. Under this project, Nippondenso will set up a demonstration center which will be used to train technicians from its own service network as well as technicians from other interested service shops. Tools and equipment required for servicing HFC-134a MACs will then be distributed free of charge to Nippondenso-authorized service shops. This project is a necessary complement to the automobile manufacturer's decision to produce cars with air conditioning units using HFC-134a as the working fluid. MACs require regular servicing. To ensure that product quality and utility is retained for the HFC-134a MAC systems, service shops will have to be equipped to service these systems, and service engineers will have to receive proper training. The auto maker's decision to install 134a units will result in annual CFC savings of 625 MT.

[1] Includes 30% contingency and 3% financial institution fee.

May 11, 1993

TO: CHARLES B. CATANACH / JESSICA POPPELE - WORLD BANK
FAX: 202-477-6619

FROM: SIMON OULOUHOJIAN- OORG REVIEWER - MOBILE AC
FAX: 215-352-1345

THAILAND - REVIEW OF PROJECT PROPOSAL - MOBILE AIR CONDITIONING

COUNTRY:	Thailand
PROJECT TITLE:	Phaseout of CFC-12 in Mobile Air Conditioners
SECTOR COVERED:	Mobile Air-Conditioning (MAC)
ODS USE IN SECTOR:	320 MT of CFC-12 for new equipment in 1991 1,320 MT of CFC-12 for servicing in 1991
PROJECT IMPACT:	Reducing the consumption of CFC-12 by 126 MT per year
PROJECT DURATION:	1 year
PROJECT ECONOMIC LIFE:	5 years
TOTAL PROJECT COST:	US$ 810,000
PROPOSED OTF FINANCING:	US$ 455,000
IMPLEMENTING ENTERPRISES:	Nippondenso Thailand Sales
COORDINATING MINISTRY:	Department of Industrial Works Ministry of Industry

PROJECT #2 RE: NEW TOOLS - TRAINING FOR HFC 134a - FIVE YEAR PROJECT

I support this project with accelerated phase out and the introduction of the non ozone depleting HFC 134a to mobile air conditioning systems.
The air conditioning industry needs training to support this alternative refrigerant.

This project will provide and prepare the 150 Nippendenso service shops with the tools and training necessary as well as serve as training centers for the entire mobile air conditioning service industry in the Kingdom of Thailand.

HFC 134a refrigerant and synthetic lubricant (PAGS ESTERS) requires a strong retraining effort of the service industry with emphasis on proper repairs before charging air conditioning systems to break the "Gas and Go" mindset of working with CFCs that precluded fixing the leak because of the low cost of CFC12.

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand		
PROJECT TITLE:	Conversion of Electronic Cleaning Process from CFC-113 to High-Purity Water Cleaning		
SECTOR COVERED:	Solvent Cleaning		
PROJECT IMPACT:	Phase out annual consumption of 15 MT CFC-113 (weighted) per year		
PROJECT DURATION:	6 months		
TOTAL PROJECT COST:	ODS Reduction Investment Cost: Incremental Operating Costs[1]:	US$ US$	228,000 10,000
PROPOSED OTF FINANCING[2]:	This request is for permission to proceed; no funding is requested at this time. This project will be submitted to the EC following pre-appraisal for funding approval of about US$319,000 (@ 100% Thai Ownership).		
COST EFFECTIVENESS:	US$2.56/kg ODP/year		
IMPLEMENTING ENTERPRISE:	TeamTronics Co., Ltd.		
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand		
IMPLEMENTING AGENCY:	The World Bank		
APPRAISAL DATE:	August, 1993		

PROJECT SUMMARY

This request is for permission to proceed on final preparation of a project proposal to eliminate the use of CFC-113 solvent in the cleaning of flexible circuit card assemblies at TeamTronics. TeamTronics is a contract manufacturing facility producing high technology circuit assemblies for use in electronic equipment such as computers. At TeamTronics, the phaseout of ozone depleting substances (ODS) will be accomplished by replacing the current CFC-113 batch cleaner with one in-line aqueous cleaner. The aqueous cleaners will be used to remove flux residues and light ionic contamination from the circuit cards. The project also includes the purchase and installation of a water recycling system. The project will result in the elimination of 15 MT per year of CFC-113 after the conversion is completed. TeamTronics is 100 percent Thai owned, which was taken into account in calculating the proposed OTF financing.

[1] Net present value of first four years of operating costs/savings.

[2] Includes 30% contingency and 3% financial institution fee.

northern telecom

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Mississauga, Ontario
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VIA TELECOPIER

May 28, 1993

Mr. Don Brown
The World Bank
1818 H Street, NW
Washington, D.C. 20433
U.S.A.

Dear Don:

Re: **Comments on Thailand Project**

I have reviewed the Thailand solvent projects for Hana Semiconductor, GSS Array, SAHA Union, THECO, CI Group, and TeamTronics, and have provided verbal comments to you. I have summarized these comments as follows:

- Was the no clean option considered for GSS Array, Hana Semiconductor, and TeamTronics? It appears that the type of products manufactured are candidates for the no-clean process, which would thus have avoided the need for waste water treatment facilities at these locations.

- In the case of SAHA Union, I ask if IBM's experts in San Jose, California were contacted with regard to the proposed process. If not, I recommend that Dr. Ming Ko, or other staff at San Jose, be brought into the project as it goes forward. IBM at San Jose has developed aqueous cleaning for the disc drives at that location and they would presumably have good information to share with SAHA which has IBM involvement.

- I'm not familiar with the plastic media cleaning process suggested for Hana Semiconductor and time constraints precluded any opportunity to familiarize myself with this concept. I am, therefore, unable to offer comments.

- The proposed technologies for cleaning of heat exchangers at CI Group and at THECO should work well and are considered appropriate alternates. Costs appear to be in the expected range for these technologies.

Generally speaking, my concerns rest with the selection of aqueous cleaning processes, especially in the case of manufacturing of consumer products, rather than promoting the concept of no clean as the preferred technology.

It has been shown by many companies that no clean is gaining acceptance as a preferred manufacturing technology -- for high tech/high reliability products such as in the telecommunications switching equipment, as well as for consumer products. The benefits include: removal of a manufacturing step; the avoidance of purchasing cleaning supplies; the avoidance of waste treatment and disposal; and, in many cases, improved product quality. I believe the industry trend towards no clean will continue which may, at some point in the future, make obsolete alternative cleaning systems such as aqueous.

There continue to be objectives to no clean by some manufacturers, often based on anticipated customer demand or reluctance to believe that high reliability electronic products can be manufactured without cleaning. A guide to selection of appropriate alternatives to CFC-113 and methyl chloroform cleaning in the electronics industry which would be based on industry experience gained over the past five years would be a useful document that could be used by the Bank, its consultants, and industry in developing countries. This concept was discussed at the OORG meeting and will be brought to the attention of the executive of the Industry Cooperative for Ozone Layer Protection (ICOLP) for consideration as something that experts from ICOLP member companies might develop.

Regards,

Art FitzGerald

Arthur D. FitzGerald
Director
Environmental Projects

ADF/jm
fl16

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand
PROJECT TITLE:	Demonstration of Low Pressure Chiller Conversion and Refrigerant Recovery Technology
SECTOR COVERED:	Building Air Conditioning
PROJECT IMPACT:	Demonstration of chiller conversion and refrigerant recovery technologies. 5 MT CFC-11 consumption avoided (2 MT at Kian Gwan; 3 MT at Imperial)
PROJECT DURATION:	One month for engineering changes
TOTAL PROJECT COSTS:	Kian Gwan Building ODS Reduction Invesment cost: US$ 78,000 Incremental Operating Costs[1]: US$ 100,000 Imperial Queen's Park Hotel ODS Reduction Investment Cost: US$ 63,000 Incremental Operating Costs[1]: US$ 90,000
PROPOSED OTF FINANCING[2]:	This request is for **permission to proceed**; no funding is requested at this time. This project will be submitted to the EC following pre-appraisal for funding approval of about US$238,000 for Kian Gwan Building and US$205,000 for Imperial Queen's Park Hotel (both @ 100% Thai Ownership)
COST EFFECTIVENESS:	Kian Gwan Building: US$22.27/kg ODP/year Imperial Queen's Park Hotel: US$15.27/kg ODP/year
IMPLEMENTING ENTERPRISES:	Kian Gwan Company is the owner of the chillers on which York Air Conditioning and Refrigeration (Thailand) will perform the conversion. The Imperial Family of Hotels is the owner of the chillers on which Jardine Trane Air Conditioning will perform the conversion.
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand
IMPLEMENTING AGENCY:	The World Bank

[1] Net present value of first four years of operating costs/savings.

[2] Includes 30% contingency and 3% financial institution fee.

PROJECT SUMMARY

This OTF request is for permission to proceed on final preparation of a project to develop the ability of Thai engineers and technicians to convert low pressure CFC-11 chillers to HCFC-123, and to recover and recycle CFC-11 refrigerant during service operations. The project would involve two of the largest refrigeration service companies in Thailand: York Air Conditioning and Refrigeration (Thailand) and Jardine Trane Air Conditioning. York would convert two 500 ton CFC-11 centrifugal chillers at the Kian Gwan Company's main office complex, and Trane would convert one 1,215 ton CFC-11 centrifugal chiller at the Imperial Family of Hotels's Queen's Park Hotel. Both York and Trane would undertake the conversions with the help of engineers from their parent companies. Recovery/recycling equipment would be purchased to remove the CFC-11 refrigerant and purify it for reuse in other chillers, reducing Thai consumption and imports of CFC-11. York and Trane would assume ownership of the recycling machines after the completion of the project so that they could use them at other sites to reduce ODS servicing related emissions. Finally, the project would reimburse the chiller owners (Kian Gwan and the Imperial Family of Hotels) for increased energy and refrigerant costs that they would incur as a result of the conversions. Both buildings are assumed to be 100% Thai owned, which has been taken into account in calculating the proposed OTF financing. It is expected that this project will eliminate the consumption of 5 MT of CFC-11.

Kingdom of Thailand

PRELIMINARY REVIEW OF A NUMBER OF PROJECTS

Conversion of Domestic Manufacturing to HFC-134a and to HCFC-141b in Polyurethane Foams; Conversion of Chillers to HFC-134a

Projects Described by The World Bank, March 1993

1. **Introduction of HCFC-141b for foams and the conversion process to HFC-134a for cooling at THAI TOSHIBA Industries;**
2. **Idem, at ADMIRAL Industries;**
3. **Idem, at HITACHI Industries;**
4. **Idem, at KANG YONG Industries;**
5. **Idem, at AP National Industries;**
6. **Two Chiller Conversion Projects to HFC-134a.**

Kuijpers, LJM (OORG)
Eindhoven, 1993 03 11
RWR-570-LK-93106 -lk

REMARKS REGARDING THE PROPOSALS

1. Foam Blowing

All projects describe a conversion from CFC-11 to HCFC-141b. In a first instance, it is remarkable that there is a large price difference between the conversions proposed for the different industries (take e.g. the difference between AP and Toshiba, 0.25 and 1.79 million). Indeed, HCFC-141b seems to be the preferred route for the Japanese, although, until recently, they have also maintained the HCFC-123 option. It may be that they will stick to the HCFC-141b option, however, in Europe there is a tendency (whether or not realistic) to study cyclopentane, a flammable high boiling refrigerant. About its performance nothing is known so far (conductivity value is worse compared to others, I do not know about long term behaviour).
One should bear in mind that the European manufacturers have been evaluating both 22/142b and 141b for quite some time; they achieved slightly inferior results with 22/142b; however, the long term behavior is not so good, due to diffusion of HCFC-22. Nevertheless, almost all manufacturers switched to HFC-134a (no chlorine anymore, due to environmental group pressure in Germany) shortly before the Domotechnica fair (apart from one). So I do not know whether this could play a role in Japan and in the daughter companies as well.
The best thing is to ask the OORG foam expert as well (Jeffs, ICI), regarding the time involved in optimizing HFC-134a foams. Dependent on this one could solve the question on whether or not to invest in the HCFC-141b route in Thai companies or to postpone a decision to later this year.

2. Refrigeration, general observations

The CFC-12 consumption of the five companies amounts to about 78 tonnes, while a total consumption of 250 tonnes in this sector is mentioned. Is there another large manufacturer involved ?
The above does not hold for CFC-11, 300 tonnes compared to 500 tonnes is used by the firms considered.

Several companies should do something regarding their use of CFC-11, i.e. apply reduction measures (take e.g. Kang Yong and AP which probably use CFC-11 also for cleaning) since the consumption is large compared to the CFC-12 consumption.

3. Refrigeration, specific topics

There is technology support from the mother companies, the costs however vary widely not dependent on the size of the company, e.g. 592,000 for Matsushita supporting the small AP firm. More information (e.g. contracts) on what is specifically covered in each of the cases is absolutely necessary. There is also a question on whether or not the relationship to Kultorn Kirby should not be described more precisely. Description so far (Kirby will provide the companies with compressors for testing) is not at all sufficient. It is often the compressor manufacturer (with its specific lubricant properties and so on) that determines the technology transfer. Design of the appliances and the manufacturing process can be supported by the mother company.
Kirby plays a key role in Thai companies, for this reason more precise information would be extremely useful.
This will also determine whether or not CFC-12 and HFC-134a appliances can be manufactured using the same assembly line.

In particular the technology transfer issue is important; the phased approach presented is in principle OK.

There is also a question regarding test rooms. What is determining the size and the costs for a test room. There is again a remarkable difference between the Admiral company and Hitachi, the smallest and largest in size. The same holds for the differences in costs for refrigerant and oil charging equipment. Maybe this could be explained somewehat more detailed in the proposal. Some firms will invest in leak detectors; does this not hold for all of them ?
A consistent approach and evaluation would be desireable.

Taking the amounts of CFCs involved costs vary from about 18 to 145 USD per kg of CFC (11 and 12) phased out per year. Is this an acceptable figure ?

4. Chillers

As far as the chiller conversion is concerned, there are no significant remarks.
For the HFC-134a conversion, the cost is in the order of USD 30 per kg of CFC-12 not used, which is a high figure, and which should be supported by considerations on the lifetime and economic value of the equipment.
As far as the HCFC-123 conversion, no remarks.

Eindhoven, 11 March 1993

L.J.M. Kuijpers

Conversion of Chillers to HFC-134a and HCFC-123

Project Proposals by The World Bank, April 1993

Conversion from CFC-12 to HFC-134a at the Post Building and from CFC-11 to HCFC-123 at Klan Gwan and Imperial.

Recommendation

Since the project description contains guarantees for the conversion (back up by developed country manufacturers), there is no technical reason to not recommend approval.

However, it should be born in mind that costs for conversion are very high, i.e. USD 35 per kg of CFC-12 and USD 85 and 53 for the conversion to HCFC-123 (even compared to domestic appliance conversion projects).

It emphasizes the need for setting up good economic criteria for chiller conversions.

Eindhoven, 6 May 1993

L.J.M. Kuijpers

The Montreal Protocol on Substances that Deplete the Ozone Layer

Thailand ODS Multicomponent Investment Project

Project Cover Sheet

COUNTRY:	Kingdom of Thailand
PROJECT TITLE:	Demonstration of Conversion of CFC-12 Chillers to HFC-134a
SECTOR COVERED:	Building Air Conditioning
PROJECT IMPACT:	Demonstrate chiller conversion and refrigerant recovery technologies; Avoid consumption of 6 MT of CFC-12
PROJECT DURATION:	One month
TOTAL PROJECT COST:	ODS Reduction Investment Cost: US$ 176,000 Incremental Operating Costs[1]: US$ 14,000
PROPOSED OTF FINANCING[2]:	This request is for permission to proceed; no funding is requested at this time. This project will be submitted to the EC following pre-appraisal for funding approval of about US$ 254,000 (@100 % Thai Ownership)
COST EFFECTIVENESS:	US$10.12/kg ODP/year
IMPLEMENTING ENTERPRISES:	The Post Publishing Company is the owner of the chillers. Pido International Company will perform the conversion at the Bangkok Post Building.
COORDINATING MINISTRY:	Department of Industrial Works (DIW), Ministry of Industry, Kingdom of Thailand
IMPLEMENTING AGENCY:	The World Bank

[1] Net present value of first four years of operating costs/savings.

[2] Includes 30% contingency and 3% financial institution fee.

PROJECT SUMMARY

This OTF request is for permission to proceed on final preparation of a project proposal to convert three 400-ton CFC-12 centrifugal chillers at the Bangkok Post Building to operate using HFC-134a as the refrigerant. In addition to eliminating the use of ODSs at the facility, the project would serve as an example to building owners who use McQuay chillers throughout Thailand of the process of converting to alternative refrigerants and provide experience in retrofitting CFC-12 centrifugal chillers. Pido International, the representative of McQuay Air Conditioning in Thailand, would perform the conversion with help of engineering consultants from McQuay. The project would also include the purchase of a recovery machine that would be used to remove the CFC-12 refrigerant and purify it for reuse in existing chillers elsewhere, reducing Thai consumption and imports of CFC-12. The recycling technology would be used by the chiller service companies at other sites to reduce ODS servicing related emissions. Finally, the project would reimburse the chiller owner for increased energy and refrigerant costs that they would incur as a result of the conversions. The Post Publishing Company is assumed to be 100% Thai owned, which has been taken into account in caculating the proposed OTF financing. This project is expected to eliminate the consumption of 6 MT of CFC-12.

Kingdom of Thailand

PRELIMINARY REVIEW OF A NUMBER OF PROJECTS

Conversion of Domestic Manufacturing to HFC-134a and to HCFC-141b in Polyurethane Foams; Conversion of Chillers to HFC-134a

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Kuijpers, LJM (OORG)
Eindhoven, 1993 03 11
RWR-570-LK-93106 -lk

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There is technology support from the mother companies, the costs however vary widely not dependent on the size of the company, e.g. 592,000 for Matsushita supporting the small AP firm. More information (e.g. contracts) on what is specifically covered in each of the cases is absolutely necessary. There is also a question on whether or not the relationship to Kultorn Kirby should not be described more precisely. Description so far (Kirby will provide the companies with compressors for testing) is not at all sufficient. It is often the compressor manufacturer (with its specific lubricant properties and so on) that determines the technology transfer. Design of the appliances and the manufacturing process can be supported by the mother company.
Kirby plays a key role in Thai companies, for this reason more precise information would be extremely useful.
This will also determine whether or not CFC-12 and HFC-134a appliances can be manufactured using the same assembly line.

In particular the technology transfer issue is important; the phased approach presented is in principle OK.

There is also a question regarding test rooms. What is determining the size and the costs for a test room. There is again a remarkable difference between the Admiral company and Hitachi, the smallest and largest in size. The same holds for the differences in costs for refrigerant and oil charging equipment. Maybe this could be explained somewehat more detailed in the proposal. Some firms will invest in leak detectors; does this not hold for all of them ?
A consistent approach and evaluation would be desireable.

Taking the amounts of CFCs involved costs vary from about 18 to 145 USD per kg of CFC (11 and 12) phased out per year. Is this an acceptable figure ?

4. Chillers

As far as the chiller conversion is concerned, there are no significant remarks.
For the HFC-134a conversion, the cost is in the order of USD 30 per kg of CFC-12 not used, which is a high figure, and which should be supported by considerations on the lifetime and economic value of the equipment.
As far as the HCFC-123 conversion, no remarks.

Eindhoven, 11 March 1993

L.J.M. Kuijpers

Conversion of Chillers to HFC-134a and HCFC-123

Project Proposals by The World Bank, April 1993

Conversion from CFC-12 to HFC-134a at the Post Building and from CFC-11 to HCFC-123 at Kian Gwan and Imperial.

Recommendation

Since the project description contains guarantees for the conversion (back up by developed country manufacturers), there is no technical reason to not recommend approval.

However, it should be born in mind that costs for conversion are very high, i.e. USD 35 per kg of CFC-12 and USD 85 and 53 for the conversion to HCFC-123 (even compared to domestic appliance conversion projects).

It emphasizes the need for setting up good economic criteria for chiller conversions.

Eindhoven, 6 May 1993

L.J.M. Kuijpers