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the Multilateral Fund for the
Implementation of the Montreal Protocol

Seventeenth Meeting
Montreal, 26-28 July 1995

PROJECT PROPOSALS: MALAYSIA

This document includes the following project proposals which have been grouped by sector. The agency responsible for the implementation of the project is also indicated. The project proposals are presented in the order indicated below.

Aerosol

- Conversion to Hydrocarbon Technology in the Manufacture of Aerosol Products at Maya Chemical Industries Sdn. Bhd. — UNDP
- Alloychem Malaysia SDN BHD Aerosol Conversion Project — UNDP

Foam

- Elimination of CFCs in the manufacture of cold cured PUF molded products at Urethane Technologies Sdn. Bhd. — UNDP
- Elimination of CFCs in the manufacture of cold cured/integral skin PUF molded products at Muda Murni Sdn. Bhd. — UNDP
- Elimination of ODS in the process of EPE/EPS foam sheet at Star Foam Paper Products Sdn. Bhd. — World Bank

Refrigeration

• Umbrella Project for Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration at Four Small Enterprises (Lim Yew, Exquisite, FMC, Noblelane)	UNDP
• Reduction of the consumption of ODSs in the commercial air-conditioning sector via training, recovery and recycling of CFC-11 and CFC-12 in chillers at MASHRAE	World Bank
• Phase out of CFC-12 MAC System Production Equipment and Conversion to HFC-134a MAC System Manufacturing in Nippodenso Capital SDN BHD	World Bank
• Phase out of CFC-12 MAC System Manufacturing Equipment and Conversion to HFC-134a MAC System Manufacturing Equipment at APM - Air Conditioners Sdn Bhd (APMAC)	World Bank

Solvent

• Conversion of Metal Cleaning Process from 1,1,1 TCA to Hydrocarbons at Eng Teknologi Sdn. Bhd.	World Bank
• Conversion of Metal Cleaning Process from 1,1,1 TAC to non-Ozone Depleting Organic Solvents in Ban Seng Lee Industries Sdn. Bhd	World Bank

PROJECT COVER SHEET

COUNTRY:	Malaysia
PROJECT TITLE:	Conversion to Hydrocarbon Technology in the Manufacture of Aerosol Products at Maya Chemical Industries Sdn. Bhd.
SECTOR COVERED:	Aerosols
ODS USE IN SECTOR:	350 tons CFC (1993)
PROJECT IMPACT:	Phase out of 13 tons of ODP/yr (1993)
PROJECT DURATION:	6 months (for what remains to be done)
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	US$56,613 Incr. Capital Cost
PROPOSED MLF GRANT:	US$56,613
UNIT ABATEMENT COST:	0.71/kg
GRANT EFFECTIVENESS:	US$ 4.35/kg
NATIONAL COORDINATING BODY:	Department of Environment (DOE)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATES:	November 1994, February 1995

PROJECT SUMMARY

This project will complete the ODS phase out and improve the safety conditions at Maya Chemical Industries ("MAYA"), a 100% Malaysian-owned company. Until early 1993, MAYA used about 162 MT of CFC 11/12 as propellant for its aerosol insecticide production line. The company relocated its operations to a new industrial lot in Malacca in 1993 and began a CFC phaseout program. By late 1994, MAYA has eliminated about 90% of its CFC consumption by using hydrocarbon as a substitute propellant. The existing Coaster filling machine has serious leaking problems and does not meet basic safety standards. The project financing will cover the cost of a new Terco filling machine which is now on order, installation of some basic safety equipment and improved exhaust/ventilation system, electrical rewiring, and some modification to the existing gas pipeline. The company will finance from its own funds all the other required additional equipment and works to complete the conversion.

Prepared by: Mr. P. Kurasamy, UNDP Aerosol Consultant, Malaysia
Reviewed by: Dr. H. McCain, UNDP Aerosol Technical Reviewer

PROJECT OF THE GOVERNMENT OF MALAYSIA

Conversion to Hydrocarbon Technology in the Manufacture of Aerosol Products at Maya Chemical Industries Sdn. Bhd.

1. PROJECT OBJECTIVE

The project will eliminate the remaining use of 13 MT of CFC 11/12 annually and upgrade the safety standards at Maya Chemical Industries ("maya") for a Hydrocarbon Aerosol filling.

2. SECTOR BACKGROUND

There are more than 50 aerosol fillers in Malaysia, of which 6 are considered as large fillers, approximately 15 medium-sized fillers, and the rest can be classified as small fillers. The large and the medium fillers are either filling insecticides or spray paints, with the small-sized fillers concentrating mainly on personal care, household, car care and industrial products. Almost all the insecticide fillers have already converted their operations to HCs, while some spray paint fillers have switched to DME. The small fillers still use CFCs mainly.

Total unit sales of aerosols in Malaysia is estimated to be between 38,000,000 units to 40,000,000 units in a year and the CFC consumption was about 300 MT in 1994 as compared to 500 MT recorded in 1990. This reduction is attributed to the fact that most of the major aerosol fillers have converted to non-CFC propellants, particularly to Hydrocarbons.

The current CFC usage, estimated at 300 metric tons per year, is being mainly used in the personal care, industrial, automotive categories and for some usage in air craft insecticides. This project is a direct result of an on-going Technical Assistance Programme encompassing an in-depth industry survey of Small and Medium Industries.

3. ENTERPRISE BACKGROUND

Maya is part of a consortium of small industries and it is 100% Malaysian-owned. The company produces mostly brand insecticide and monthly production output is about 72,000 cans mainly for the local market. Apart from aerosol filling, the company also does production of mosquito coils with the same brand name for the local market. The company traditionally used only CFC 11/12 as a propellant and its annual consumption was about 162 MT until 1993 when it started to gradually switch away to hydrocarbons. In 1994, a residual of 13 MT of CFCs was consumed for some special usage.

Because of safety problems, MAYA relocated its operations to a larger industrial lot at its own cost. Minimum safety measures are in place due to shortage of funds to complete the conversion.

The current factory site at Malacca is a good locale and the tank farm area is strategically placed. However, some modification work is needed to ensure that no concentration of hydrocarbon is formed around the tank farm area, the aerosol filling room and the storage areas. In addition to replacing the existing leaking filling machine, the current molecular sieve columns need to be upgraded with two additional units, and a water bath needs to be installed for leakage detection and quality/pressure control.

4. PROJECT DESCRIPTION

This project will eliminate 13 MT of CFCs and maintain a safe operation at Maya Chemical Industries. Over a period of 18 months, the company has gone through 3 stages to eliminate 162 MT of CFCs and in the process has relocated its filling operations to a different locale which is more suitable for HC filling. However, the existing facilities lack basic safety installations.

Maya Chemical Industries is currently using a semi-automated Coster filling machine that has serious leaking problems in addition to other deficiencies which warranted immediate corrective measures. Pending the approval of this project, and in view of severe safety hazards, in February 1995, the company placed an order for a new filling machine form Terco to solve this problem.

This project will finance the cost of the new filling machine and the related piping works together with the pump, installation of explosion proof electrical system, fire protection equipment and an alarm system. The existing tank farm can be maintained with some minor modification works. To make the filling line effective and safe, the company will install at its own costs, a water bath to conduct leak test, a set of quality control equipment to ensure the products meet high safety standards. The company will also meet the additional cost for the necessary civil works for the hydrocarbon filling operation, an effective exhaust system and effective safety training to its employees.

5. JUSTIFICATION FOR ALTERNATE TECHNOLOGY SELECTION

Hydrocarbon aerosol propellants have been the principal alternatives to CFC 12 employed worldwide. They are approved by the 1991 UNEP Technical Options Report on Aerosols, Sterilants and Miscellaneous Uses and Carbon Tetrachloride.

The substitute propellant, a mixture of butane and propane, does not damage the ozone layer. It does not contribute to acid rain, nor is it carcinogenic, mutagenic, or toxic. This mixture is a volatile organic compound (voc) that contributes somewhat to ground level contamination. This mixture does have a global warming potential, albeit very low.

Hydrocarbons are extremely flammable, and explosive. The storage of the hydrocarbons propellants must be accomplished by strict adherence to the National Fire Protection pamphlet #58 Standard for the Storage and Handling of Liquified Gases.

The controlling concept for the proper handling of the LPG is to minimize the risk of ignition to the vapour. Safety plans must be in place in the aerosol filling plant before beginning operations with this propellant, and extensive safety training must be done.

Hydrocarbon propellants are readily available, although they technically do not qualify as hydrocarbon aerosol propellants (HAPs) because they are not pure enough to be used in all ranges, but for the use in MAYA's insecticide line, the quality of the locally available propellant is adequate after passing through a molecular sieve column for proper purification.

6. PROJECT COST

6.1 INCREMENTAL CAPITAL COSTS

The company is requesting only part of the incremental cost related to the final conversion to hydrocarbons at Maya. The items to be funded under this project amount to a total of US$ 56,613 and include the following:

NO.	DESCRIPTION	COST (US$)
1.	1 unit Terco semi-automatic aerosol filling machine inclusive of crimper and gasser	36,613.00
2.	Fire Protection equipment and alarm system	5,000.00
3.	2 units of Portable gas detectors	2,000.00
4.	Explosion proof electrical equipment and wiring works and gas piping works and explosion proof pump (for new Terco unit)	10,000.00
	Sub-total	53,613.00
	5% Contingency	3,000.00
	GRAND TOTAL	56,613.00

The company will finance from its own funds other equipment necessary for safe aerosol filling, extensive civil works, additional safety equipment and gas detection system, improved exhaust/ventilation system, and staff training (details are provided in Annex 2). These are estimated at about US$ 35,000.

The existing CFC-filling equipment will be destroyed or dismantled upon project completion. It is expected that any residual scrap value will be offset by the costs of transporting, dismantling and destroying the old equipment.

6.2 INCREMENTAL RECURRING COSTS/COST SAVINGS

The project will result in operational savings as the hydrocarbon substitute material is about US$ 1.20 cheaper per kilogram than the CFCs it replaces. However, the increase in higher maintenance and insurance costs when using hydrocarbons, and the additional capital incremental costs that the company will absorb, far exceed the anticipated savings.

6.3 UNIT ABATEMENT COST

The unit abatement cost (A) is calculated as follows:

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

Where C = $56,613.00 OC = 0.00
F = 0.16275 OS = 0.00
W = 13,000

Unit abatement cost = $0.71/kg

6.4 PROJECT COST EFFECTIVENESS

CE = 56,613/13,000 = US$4.35/kg

7. FINANCING PLAN

The company requests a grant of **US$ 56,613** covering the items indicated under 6.1.

8. IMPLEMENTATION

8.1 PROJECT MANAGEMENT

UNDP, through UNOPS and in close consultation with DOE, will oversee the successful completion of this project.

8.2 SCHEDULE

The project can be completed within six months as follows:

TASKS	1	2	3	4	5	6
Purchase of Terco filling machine and other equipment	X	X				
Civil works, EX-electrical wiring, exhaust & ventilation system, fire protection system	X	X	X			
Installation of new filling equipment, water bath, safety and gas detection systems			X	X	X	
Safety training						X
Commissioning						X

9. REQUIRED REGULATORY ACTIONS

None

10. PROJECT IMPACT

This project will result in total annual reduction of 13 MT of CFC 11/12 usage at MAYA.

11. ANNEX

Annex 1: Technical Review
Annex 2: Items to be financed by MAYA

ANNEX 2

ITEMS & ACTIVITIES TO BE FINANCED BY MAYA

1. 1 unit water bath	$ 10,335.-
2. 2 units deodorising columns	6,000
3. Additional cost for gas piping works	2,000
4. Additional Explosion proof equipment/pump	2,000
5. Safety training	2,000
5. Additional ventilation/exhaust systems	10,000
6. Installation and commissioning	3,000
TOTAL:	$ 35,000

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June 8, 1995

TO : Geno Nardini FAX: 011-525-780-2356
FAX: 708-268-0862

FROM : Harry McCain

SUBJECT : Conversion to Hydrocarbon Technology in the Manufacture of Aerosol Products at Maya Chemical Industries Sdn. Bhd.

On my report to Ms. Laurence Reno of May 18, 1995, please change **7. Project costs (c)(vii)**. Change **(vii)** to read as follows:

> Because of the fact that old and leaking semi-automatic filling machinery will be replaced with new semi-automatic filling machinery, one may assume that the existing production capacity at Maya Chemical Industries will be increased slightly.

HBMcC/gba

cc: Ms. Laurence Reno
Fax 212-906-6947

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AEROPRES
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May 18, 1995

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TO : Ms. Laurence Reno
Programme Officer
Montreal Protocol Unit BPPS
FAX: 212-906-6947

FROM : Harry B. McCain, Ph.D.
Vice President-Technical Services
Phone: 318-429-6736 / Fax: 318-429-6739

1. **Country of origin:** Malaysia

2. **Project title:** Conversion to Hydrocarbon Technology in the Manufacture of Aerosol Products at Maya Chemical Industries Sdn. Bhd.

3. **Sector/sub-sector:** Aerosols

4. **Relationship to country programme:** N/A

5. **Technology**

(a) Hydrocarbon propellants have long been the preferred substitute for CFCs when used as an aerosol propellant. Hydrocarbon propellants are selected because of their zero ozone depleting potentials. The only environmental shortcoming of the hydrocarbon aerosol propellants (HAPs) is their flammability which can be correctly handled with the appropriate and now well established HAP technology. The U.S.A. has been using HAPs in aerosols instead of CFCs since 1978. In 1994 approximately 3 billion aerosol cans were filled with HAPs.

(b) The technology for the use of HAPs as a substitute for CFCs in aerosol products is well established, permanent, and not transitional. There are no transitional technologies that could be used in the aerosol sector that would be appropriate.

(c) It is totally feasible that the HAP technology required for this project can be transferred from Western Europe and the U.S.A. using the free market system.

(i) No technology transfer agreement is required.
(ii) There is no licensing agreement required.

(iii) The reviewer agrees with the determination to use HAPs as a replacement technology for CFCs used as propellants in aerosol products.
(iv) HAP is the most cost effective technology for this conversion.

6. **Environmental impact**

(a) This project will phase out 13 tons/year of CFC-11/12 (ODS). Global warming potential of hydrocarbons is negligible. **U**nit **A**batement **C**ost is $0.71/Kg U.S.
(b) Costs are appropriate to minimize health and safety and other environmental impacts.

7. **Project costs**

(a) All cost components identified in the project are essential for the conversion from CFCs to hydrocarbon aerosol propellants.
(b) Many cost components are present that will facilitate the conversion to hydrocarbon aerosol propellants.
(c) Cost of equipment
  (i) The cost of existing equipment is addressed in a manner that is consistent with the reviewer's experience.
  (ii) The reviewer agrees with the finding that all of the base line equipment in the report not already purchased should be acquired.
  (iii) No additional equipment requests are essential for the conversion.
  (iv) Much of the base line equipment for this conversion has already been replaced with appropriate conversion equipment.
  (v) The fate of scrapped equipment is not addressed in this report.
  (vi) N/A
  (vii) The new equipment and modifications will increase the existing capacity significantly for filling aerosols at Maya Chemical Industries.
(d) Most of the personnel at Maya are already trained in the use of hydrocarbon aerosol propellants. Some additional training is appropriate.
(e) Operating costs
  (i) The operating costs are appropriate.
  (ii) The project will result in operational savings as the hydrocarbon substitute material is about $1.20 U.S. cheaper per kilogram than the CFCs it replaces. However, the increase in higher maintenance and insurance costs when using hydrocarbons, and the additional capital incremental costs that the company will absorb, far exceed the anticipated savings.
  (iii) N/A

8. **Implementation time frame**

The time frame of six quarters is appropriate.

9. **Recommendations**

(a) This project is approved as proposed.
(b) The report submitted for technical review was concise and informational.

OORG/UNDP Technical Reviewer: Harry B. McCaln

Date Review Completed: May 18, 1995

PROJECT COVER SHEET

COUNTRY:	Malaysia
PROJECT TITLE:	**ALLOYCHEM MALAYSIA SDN BHD Aerosol Conversion Project**
SECTOR COVERED:	Aerosols
ODS USE IN SECTOR:	350 tons CFC (1993); 350 tons ODP
PROJECT IMPACT:	An annual phase out of 29 tons of CFCs (29 tons of ODP)
PROJECT DURATION:	12 months
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	U.S.$ 122,455.00
PROPOSED MLF GRANT:	U.S.$ 122,455.00 (includes 10% contingency)
UNIT ABATEMENT COST:	US$ 0.69/kg
COST EFFECTIVENESS:	US$ 4.22/kg
IMPLEMENTING ENTERPRISE:	Alloychem Malaysia Sdn. Bhd.
COORDINATING NATIONAL BODY:	DEPARTMENT OF ENVIRONMENT, Malaysia.
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATES:	May 1995

PROJECT SUMMARY

This project will complete the ODS phase out at Alloychem and provide a safe working condition. The company is using 29 tons of CFCs per year mainly for its electronic contact cleaners and video head cleaners. In addition to aerosol filling, the company also manufactures some household products and industrial chemicals within the same premises. The company is located at a congested light industrial lot at Sg. Rasah, Klang. In view of this congestion, the location appears unsuitable for aerosol filling.

Currently the company is using two sets of locally fabricated filling machine which are old and will not be suitable for HC filling. These machines are also having leaking problems and will not meet the basic safety standards required in the propellant filling room. The company has done some testing with DME and Hydrocarbon (locally available non aerosol grade LP gas) using the same machine but has not succeded due to varios reasons including damages to the existing machine parts like the seals and gaskets. The company is also facing some problems in the reformulation process for it's contact cleaners.

To complete the conversion, the company needs a filling machine complete with a crimper and a gasser. A water bath and some quality control equipment are needed to ensure the cans do not leak. In addition, the company needs some effective fire prevention equipment, an effective exhaust system and an explosion proof electrical system together with gas piping works and pumps. The company needs to construct a tank farm and the required accessories.

1. PROJECT OBJECTIVES:

The objective of this project is to phase out the annual usage of 29 tons of CFCs in the aerosol production of electronic contact cleaners and video head cleaners at Alloychem (M) Sdn Bhd. This project will also see an improvement to the current poor safety standards and practices at Alloychem.

2. SECTOR BACKGROUND:

There are more than 60 aerosol fillers in Malaysia, of which 6 are considered as large fillers and approximately 15 medium sized fillers. The remaining industries can be classified as small fillers. The large and the medium

fillers are either filling insecticides or spray paints and the small sized fillers concentrate mainly on personal care products, household products, automotive industrial products. Almost all the insecticides have converted their operations to HCs, while some spray paint fillers have switched to DME. The small fillers are mainly using CFCs to do a variety of aerosol products including personal care (hair sprays, hair mousse, perfumes, deodorants and shaving creams), household, automotive and industrial products.

Total unit sales of aerosols in Malaysia could be between 38,000,000 units to 40,000,000 units in a year. The total consumption of CFCs were recorded to be about 500 MT in 1990 and has reduced over the years to an approximate level of 350 MT in 1993 and further reduction has seem to have brought the figures to 300 MT in 1994. This reduction is attributed to the fact that most of the aerosol products have converted to non CFCs particularly to Hydrocarbons.

The current CFC usage, estimated at 300 metric tons per year, is being mainly used in the personal care, industrial, automotive categories and for some usage in air craft insecticides. This project is a direct result of an on-going Technical Assistance Programme encompassing an in-depth industry survey of Small and Medium Industries.

3. ENTERPRISE BACKGROUND:

Alloychem (M) Sdn Bhd is a 100% Malaysian owned company located at a light industrial area in Sg. Rasah, Klang. Alloychem manufactures contact cleaners, video head cleaners and some mould releasing agent for the local market. In addition to it's aerosol filling, the compny also manufactures some household detergent products.

It fills approximately 100,000 cans of contact cleaners, another 8000 cans of video head cleaners and mould releasing agents. Alloychem has an estimated consumption of 29 tons of CFC 11/12 blend as propellant and also uses 113 and 1,1,1 as raw materials for it's production.

Although the existing factory is a semi detached building, it is located in a very congested area and appears totally an inappropriate and unsuitable to aerosol filling. This locale would not become a suitable site for conversion to a non CFC filling process particularly to Hydrocarbons. The local aerosol consultant who made a survey visit to the plant has recommended some immediate safety measures to avoid mishaps to it's employees and to the neighbouring factories, particularly in view of the close proximity of these industries. This interim recommendations were accepted by the company though it will increase some immediate operational cost.

4. PROJECT DESCRIPTION:

This project will eliminate 29 MT of CFCs and maintain a safe operation at Alloychem (M) Sdn Bhd. Over the last one year, the company has made several testings with CO2 and Hydrocarbons, but has not been successful. Due to Technological ignorance and restricted knowledge in formulations, the company has not converted to non CFCs. The other major factor for not considering conversion is the current economic position of the company.

Alloychem is willing to convert it's production facilities to non CFCs if their request for funding assistance is considered by the Multilateral Fund. Since the existing locale is found to be not suitable, the company is prepared to relocate it's operations to a suitable site. The company will meet the cost of the land and building.

The company is requesting for a semi automatic filling machine, a crimper and a gasser together with a water bath, an explosion proof electrical wiring and motors, an effective exhaust ystem, gas leak detector, an effective fire protection system and deodorising columns. The company will relocate the operations to a different locale which will be more suitable for HC filling since the existing facilities lack several basic safety installations. In view of the required volume of gas, there is a neccessity to put up a tank farm with proper safety installations.

5. JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION.

Hydrocarbon carbon aerosol propellants have been the principal alternatives to CFC 12 employed worldwide. They are approved by the 1991 UNEP Technical Options Report on Aerosols, Sterilants and Miscellaneous Uses and Carbon Tetrachloride.

The substitute propellant, a mixture of butane and propane, does not damage the ozone layer. It does not contribute to acid rain, nor is it carcinogenic, mutagenic, or toxic. This mixture is a volatile organic compound (voc) that contributes somewhat to ground level contamination. This mixture does have a global warming potential, albeit very low.

Hydrocarbon are extremely flammable, and explosive. The storage of the hydrocarbons propellants must be accomplished by strict adherence to the National Fire Protection pamphlet # 58 Standard for the Storage and Handling of Liquefied Gases.

The controlling concept for the proper handling of LPG is to minimize the risk of ignition to the vapour. Safety plans must be in place in the aerosol filling plant before beginning operations with this propellant, and extensive safety training must be done.

Hydrocarbon propellants are readily available, although they technically do not qualify as hydrocarbon aerosol propellants (HAPs) because they are not pure enough to be used in all ranges, but for the use in Maya Chemicals' mosfly insecticide, the locally available propellant is adequate after passing through a molecular sieve column for proper purification.

6. PROJECT COST

The total project incremental cost is calculated at USD 122,455.00, inclusive of 10% contingency.

6.1 INCREMENTAL CAPITAL COSTS : ALLOYCHEM AEROSOL CONVERSION

NOS	DESCRIPTION	COST IN USD
1.	1 unit Terco semi automatic aerosol filling machine inclusive of crimper and gasser.	36,613.00
2.	1 unit crimp gauge	1,500.00
3.	Fire Protection equipment and alarm system	10,100.00
4.	2 units of Portable gas detectors	3,000.00
5.	Explosion proof electrical equipment and wiring works.	7,500.00
6.	Gas pipes, explosion proof pump (For new Terco unit) and installation	11,210.00
7.	One unit S/S water bath (locally fabricated)	5,000.00
8.	Explosion proof exhaust system	8,000.00
9.	Deodorizing columns and installation	3,000.00
10.	Gas storage tanks and installation	14,400.00
11.	Shipping and transportation	5,000.00
12.	Start up, commissioning and training	6,000.00
	Sub Total	111,323.00
	10 % Contingency	11,132.00
	Grand Total	122,455.00

6.2 INCREMENTAL RECURRING COSTS/COST SAVINGS:

There will be some savings in the propellant cost since HC cost very much lower than CFC. However, in view of the higher investment cost on land and building, couple with the fact that the plant will incur a higher maintenance and insurance cost, the savings are expected to offset the recurring costs.

6.3 PROJECT COST EFFECTIVENESS:

6.3.1 COST EFFECTIVENESS:

Total MLF grant: US$ 122,455.00
ODP phase out: 29,000 kg.
Grant effectiveness: US$ 122,455/29000 = US$ 4.22/kg.

6.3 UNIT ABATEMENT COSTS:

The unit abatement costs for the conversion project at Alloychem (M) Sdn Bhd are calculated as follows:

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

Where C	= $ 122,455.00	OC =	0.00
(C) F	= $ 19,923.00	OS =	0.00
		W =	29,000

Unit abatement cost = $ 0.69/kg

7. FINANCING PLAN

The company is requesting from the MLF an amount of USD 122,455.00 for the incremental capital cost as detailed under 6.1.

8. PROJECT IMPLEMENTATION:

8.1 PROJECT MANAGEMENT:

DOE and UNDP will oversee the successful implementation of this project.

8.2 SCHEDULE:

The project can be completed within twelve months in four phases.

TASK	1ST QUAT	2ND QUAT	3RD QUAT	4TH QUAT
Preparation of site and completion of building	xxxxx	xxxxxx		
Purchase of filling machine and other equipment	xxxxxx			
Installation of machine, complete explosion proof electrical works and installation of explosion proof exhaust system		xxxxxx		
Start up and testing			xxxxxx	
Training and auditing				xxxxxx

9.REQUIRED REGULATORY ACTIONS:

None

10. PROJECT IMPACT:

This project will result in total annual reduction of 29 MT of CFC 11/12 usage at Alloychem (M) Sdn Bhd.

11. ANNEXES:

AEROPRES
CORPORATION

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June 12, 1995

TO : Ms. Laurence Reno FAX: 212-906-6947
Programme Officer
Montreal Protocol Unit BPPS

FROM : Harry B. McCain
Vice President-Technical Services
Phone: 318-429-6736 / Fax: 318-429-6739

1. **Country of origin:** Malaysia

2. **Project title:** ALLOYCHEM MALAYSIA SDN BHD, Aerosol Conversion Project

3. **Sector/sub-sector:** Aerosols

4. **Relationship to country programme**

5. **Technology**

(a) Hydrocarbon propellants have long been the preferred substitute for CFCs when used as an aerosol propellant. Hydrocarbon propellants are selected because of their zero ozone depleting potentials. The only environmental shortcoming of the hydrocarbon aerosol propellants (HAPs) is their flammability which can be correctly handled with the appropriate and now well established HAP technology. The U.S.A. has been using HAPs in aerosols instead of CFCs since 1978. In 1994 approximately 3 billion aerosol cans were filled with HAPs.

(b) The technology for the use of HAPs as a substitute for CFCs in aerosol products is well established, permanent, and not transitional. There are no transitional technologies that could be used in the aerosol sector that would be appropriate.

(c) It is totally feasible that the HAP technology required for this project can be transferred from Western Europe and the U.S.A. using the free market system.

(i) No technology transfer agreement is required.
(ii) There is no licensing agreement required.

(iii) The reviewer agrees with the determination to use HAPs as a replacement technology for CFCs used as propellants in aerosol products.
(iv) HAP is the most cost effective technology for this conversion.

6. **Environmental impact**

(a) This project will result in the phaseout of 29 tons/year of CFC-12 and CFC-11/12 (ODS). Global warming potential is negligible. Unit Abatement Cost is $0.69/Kg U.S.
(b) Costs are appropriate to minimize health and safety and other environmental impacts.

7. **Project costs**

(a) All cost components identified in the project are essential for the conversion from CFCs to hydrocarbon aerosol propellants.
(b) No cost components are present that would facilitate the conversion to hydrocarbon aerosol propellants.
(c) Cost of equipment
  (i) The cost of existing equipment is addressed in a manner that is consistent with the reviewer's experience.
  (ii) The reviewer agrees with the finding that all of the base line equipment in the report should be acquired.
  (iii) No additional equipment requests are essential for the conversion.
  (iv) All of the base line equipment will necessarily have to be replaced.
  (v) The old equipment will be destroyed once the new equipment is installed.
  (vi) There will be no salvage value with the destroyed equipment.
  (vii) With the installation of new equipment and trainine, one may expect a slight increase in the production capacity at Alloychem.
(d) Training costs are appropriate, although the number of persons to be trained per the $6,000.00 U.S. was not given.
(e) Operating costs
  (i) The operating costs are appropriate.
  (ii) Net recurring costs and recurring savings are equal ($0.00) because of a higher investment cost in new land and building; and coupled with an incident higher maintenance and insurance cost, the savings from the purchase of hydrocarbon aerosol propellants as opposed to CFCs are offset.
  (iii) The fact that no savings are realized is reasonable in light of information provided in similar projects.

8. **Implementation time frame**

The time frame of four quarters is optimistic. Six quarters would be more appropriate.

9. **Recommendations**

(a) This project is approved as proposed.

OORG/UNDP Technical Reviewer: Harry B. McCain

Date Review Completed: May 25, 1995

PROJECT COVER SHEET

COUNTRY :	Malaysia
PROJECT TITLE:	Elimination of CFCs in the manufacture of cold cured PUF molded products at Urethane Technologies Sdn. Bhd.
SECTOR COVERED :	Foamed Plastics/Refrigeration
ODS USE IN SECTOR :	600 t CFCs (=ODP) in 1991
PROJECT IMPACT :	35 t of CFC-11 (1994 consumption)
PROJECT DURATION :	One year
PROJECT USEFUL LIFE :	10 years
TOTAL PROJECT COSTS :	USD 204,000
PROPOSED MLF GRANT:	USD 204,000
COST EFFECTIVENESS :	Grant Effectiveness - USD 5.83/kg/y Unit Abatement Cost - USD 0.95/kg/y
NATIONAL COORDINATING Agency:	Government Of Malaysia Department Of Environment (DOE)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	February 1995

PROJECT SUMMARY

Under this project, Urethane Technologies Sdn. Bhd. will eliminate the use of CFC-11 in the production of PUR cold cured molded products, such as cushion, pillows and furniture items by switching to all water blown system. The two existing low pressure foam dispensers will be replaced by a high pressure foaming unit with two mixing heads, a mold heating oven, trials and technical assistance in formulation development and training.

Prepared by: Bert Veenendaal
Reviewed by: Dr Hubert Creyf

PROJECT OF THE GOVERNMENT OF MALAYSIA

URETHANE TECHNOLOGIES- CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF COLD-CURED PUF MOLDINGS

1. PROJECT OBJECTIVE

The objective of this project is to phase out the use of CFC-11 in the manufacture of cold cured PUF moldings at Urethane Technologies Sdn. Bhd. in Sarawak, Malaysia.

2. SECTOR BACKGROUND

The total CFC consumption in Malaysia in 1991 was about 600 t in the foam sector. The predominant consumption was of CFC-11 and to a lesser extent CFC-12, and smaller quantities of Methyl Chloroform, CFC-113 etc. The refrigeration industry consumed about 1500 t of CFCs.

3. ENTERPRISE BACKGROUND

Urethane Technologies Sdn. Bhd. was established in 1987 and is a 100% Malaysian owned enterprise. It employs 19 persons. The enterprise manufactures cold cured PUF molded products such as furniture cushions, pillows, mattresses. The products are sold in the domestic as well as export markets. Urethane Technologies has two Cannon low pressure foam dispensers (Model C60 and C300) and its 1994 CFC consumption was about 35 tons.

4. PROJECT DESCRIPTION

Urethane Technologies currently uses CFC-11 as a blowing agent in the manufacture of cold-cured furniture foam products. Under this project, the enterprise will switch to all-water blown system to replace CFC-11. To cater to the increased viscosity of the new formulation and to improve production efficiency, one high pressure foam dispenser with two mixing heads is recommended to replace the existing two low pressure foaming units. In addition, a mold oven, trials and technical assistance for formulation development will also be provided.

5. TECHNOLOGY

There are numerous technologies to replace the use of CFCs in flexible molded PUF. Available replacements fall into the following categories:

- Alternative blowing agents
- Alternative chemistry
- Alternative manufacturing technologies

The enterprise has selected the alternative chemistry option comprising of all-water blown high resilience foam. This requires lower investment than for alternative manufacturing, avoids potential quality discrepancies (as in alternative blowing agents) and allows maintenance of the foam properties.

6. PROJECT COSTS

6.1 INCREMENTAL COSTS

The following are the expected incremental capital costs:

One High Pressure Foam dispenser (with two mixing heads)	US$ 150,000
One Mold Oven:	US$ 10,000
Trials and Start-up:	US$ 10,000
Technology assistance:	US$ 10,000
Training:	US$ 5,000
Contingencies:	US$ 19,000
TOTAL:	**US$ 204,000**

The switch away from CFC-11 to all-water blown system will lead to an increase in material costs; however, the enterprise is not requesting any payment for the incremental operating cost.

6.2 COST EFFECTIVENESS

Grant Effectiveness

a. MLF Grant:	US$ 204,000
b. ODS phase out:	kg 35,000
Grant Effectiveness (a/b):	**US$ 5.83/kg/y**

Unit Abatement Costs

a. ODS Reduction Capital Costs:	US$ 204,000
b. Annual incremental Costs:	-
c. Capital Recovery Factor (10%):	0.16275
d. ODS Reduction/year:	kg 35,000
Unit Abatement Costs (axc+b/d):	**US$ 0.95/kg/y**

7. FINANCING PLAN

The enterprise requests a great covering the total incremental capital cost as listed under 6.1 amounting to **US$ 204,000.**

8. PROJECT IMPLEMENTATION

8.1 Management

UNDP will oversee the successful implementation of this project and will provide technical assistance during project execution.

8.2 Schedule

TASK	TIME FOR COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. MLF Approval	x					
Procurement Preparation		x				
Vendor Selection		x				
2. Transportation, arrival and customs clearance			x			
Installation and plant modification.				x		
				x		
3. Machine Start-up					x	
Trials/Training					x	
Certification						

9. PROJECT IMPACT

This project will eliminate the use of 35 t of CFC-11 in the first year after implementation. The project employs commercially and environmentally acceptable technology.

10. ANNEX

Annex-A: Technical Review

TECHNICAL REVIEW.

1.Country:

Malaysia.

2.Project Title:

Elimination of CFCs in the manufacture of cold cured PUF molded products at Urethane Technologies Sdn. Bhd.

3.(Sub)Sector:

Foamed Plastics.

4.CP-Relationship:

The national coordinating agency is the Government of Malaysia and the Department of Environment.
No other data are available to the reviewer.

5.Technology:

For cold cured moldings, the company will switch over from CFC 11 usage to all-water blown formulations. This technology can be accepted, but requires the use of high pressure foam dispensors, as mentioned in the project. The necessity of a mold heating oven is, in view of the technology change, unclear.

6.Environmental Impact:

The zero ODP solution envisaged in the cold cured molding technology is, from an environmental point of view, an excellent choice.

7.Project Costs:

All costs as presented are acceptable, with exception of the mold oven, which is not justified in the project.
The enterprise does not ask for payment of the incremental operating costs.
Supposing no mold oven is counted, the cost for elimination of 1 kg of ODP is USD (194,000 / 35,000) or USD 5.54.

8.Implementation:

UNDP will oversee the implementation of this project and will provide technical assistance during project execution.
The proposed time schedule is acceptable.

9.Recommendation:

It is recommended to accept the project, only inclusive the USD 10,000 if the company can give a valid reason for the mold oven.

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date: 060595

PROJECT COVER SHEET

COUNTRY:	Malaysia
PROJECT TITLE:	Elimination of CFCs in the manufacture of cold cured/Integral skin PUF molded products at Muda Murni Sdn. Bhd.
SECTOR COVERED:	Foamed Plastics/Refrigeration
ODS USE IN SECTOR:	600 t (=ODP) in 1991
PROJECT IMPACT:	21 t of CFC-11 (1994 consumption)
PROJECT DURATION:	One year
PROJECT USEFUL LIFE:	10 years
TOTAL PROJECT COSTS:	USD 302,000
PROPOSED MLF GRANT:	USD 302,000
COST EFFECTIVENESS:	Grant Effectiveness - USD 14.38/kg/y Unit Abatement Cost - USD 2.34/kg/y
NATIONAL COORDINATING AGENCY:	Government of Malaysia Department Of Environment (DOE)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	February 1995

PROJECT SUMMARY

Under this project, Muda Murni Sdn. Bhd. will eliminate the use of CFC-11 in the production of cold cured molded PUF products, such as automotive seat cushions, and integral skin PUF products such as arm and head rests etc.. All water blown system will be used in place of CFC-11 for the cold-cured molded foaming, and HCFC-141b for the integral skin products. This will involve replacement of the two existing low pressure foam dispensers by equivalent high pressure dispensers. In addition, a mold heating oven, production trials and technical assistance for formulation development and training will be provided.

Prepared by : Bert Veenendaal
Reviewed by : Dr Hubert Creyf

PROJECT OF THE GOVERNMENT OF MALAYSIA

MUDA-MURNI - CONVERSION TO CFC-FREE TECHNOLOGY IN THE MANUFACTURE OF COLD CURED MOLDED PUF AND INTEGRAL SKIN PUF

1. PROJECT OBJECTIVE

The objective of this project is to phase out the use of CFC-11 in the manufacture of cold cured and integral skin PUF moldings at Muda Murni Sdn. Bhd. at Selangor, Malaysia.

2. SECTOR BACKGROUND

The total CFC consumption in Malaysia in 1991 was about 600 t in the Foam Sector. The predominant consumption was of CFC-11 and to a lesser extent CFC-12, and smaller quantities of Methyl Chloroform, CFC-113 etc. The refrigeration industry consumed about 1500 t of CFCs.

3. ENTERPRISE BACKGROUND

Muda Murni Sdn. Bhd. was established in 1988 and is a 100% Malaysian owned enterprise. It employs 15 persons for the manufacturing of cold cured molded PUF automotive seat cushions as well as integral skin PUF products such as head and arm rests etc. The products are sold in the domestic as well as export markets. Within Malaysia, its main customers are the automotive industry. In 1994, Muda Murni consumed about 21 tons of CFC-11, of which about 14 tons was for cold cured products and 7 tons for the integral skin products.

4. PROJECT DESCRIPTION

Under this project, Muda Murni will switch to all-water blown system in place of CFC-11 formulation for the cold cured moldings. To cater to the increased viscosity of the new formulation, a high pressure foam dispenser will be required to replace the existing low pressure unit (Cannon C300). In addition, provision for a mold heating oven, trials and technical assistance for formulation development will be made. Increased operating costs are expected due to the higher material costs of the water-based formulation; however, the company is not requesting any incremental operating cost.

5. TECHNOLOGY

There are numerous technologies to replace the use of CFCs in flexible molded PUF. Available replacements fall into the following categories :

- Alternative blowing agents.
- Alternative chemistry
- Alternative manufacturing technologies

The enterprise has selected alternative chemistry option, comprising of all-water blown high resilience foam. This requires lower investment than for alternative manufacturing, avoids potential quality discrepancies (as in alternative blowing agents) and maintains the foam properties.

Integral Skin polyurethane foams are characterized by a high density outer skin and a low density core. In addition to blowing the foam, blowing agents are required to perform auxiliary functions such as skin formation and decrease of viscosity.

HCFCs satisfy the market requirements on aesthetics and performance and are considered the most acceptable interim replacements. HCFCs such as -22,-141b and -123 have all been tested mostly with positive results. However, HCFC-22 has been seen to cause fronting in some applications. HCFC-141b appears to be the most viable interim substitute, and HCFC-141b based formulations are available at competitive prices locally.

Possible replacement scenarios for the future comprises of Hydrocarbons (Pentanes). HFCs (152a, 134a, 125, 245, 356) either independently or as a supplement to water based formulations and fully water blown systems.

For this integral skin foam production, the enterprise has decided to switch to HCFC-141b as the interim CFC-11 replacement.

6. PROJECT COSTS

6.1 CAPITAL COST

The following are the expected incremental capital costs:

Two High Pressure foam dispensers:	US$ 230,000
One Mold Oven:	US$ 10,000
Trials and Start-up (2 lines):	US$ 20,000
Technology transfer/training:	US$ 15,000
Contingencies:	US$ 27,000
TOTAL:	**US$ 302,000**

The use of alternative blowing agents would lead to an increase in material costs. However, the customer is not requesting payment of any incremental operating costs associated with the technology changes.

6.2 COST EFFECTIVENESS

6.2.1 Grant Effectiveness

a. MLF Grant:	US$	302,000
b. ODS phase out:	kg	21,000
Grant Effectiveness (a/b):	**US$**	**14.38/kg/y**

6.2.2 Unit Abatement Costs

a. ODS Reduction Capital Costs:	US$	302,000
b. Annual incremental Costs:	US$	-
c. Capital Recovery Factor (10y/10%)		0.16275
d. ODS Reduction/year	kg	21,000
Unit Abatement Costs (axc+b/d):	**US$**	**2.34/kg/y**

7. FINANCING PLAN

The enterprise requests a grant covering the total incremental capital cost only as calculated under 6.1 and amounting to
US$ 302,000

8. PROJECT IMPLEMENTATION

8.1 Management

UNDP will oversee the successful implementation of this project and will provide technical assistance during project execution.

8.2 Schedule

TASK	TIME FOR COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. MLF Approval	x					
Procurement Preparation	xx					
Vendor Selection		x				
2. Shipment and customs clearance			xx			
Installation and plant modification.				xx		
3. Machine Start-up				x		
Trials/Training						
Certification				xxx		

9. PROJECT IMPACT

This project will eliminate the use of 21 t of CFC-11 in the first year after implementation. The project employs commercially and environmentally acceptable technology.

Annex: Technical Assessment

TECHNICAL REVIEW.

1.Country:

Malaysia.

2.Project Title:

Elimination of CFCs in the manufacture of cold cured/integral skin PUF molded products at MUDA MURNI Sdn. Bhd.

3.(Sub)Sector:

Foamed Plastics.

4.CP-Relationship:

The national coordinating agency is the Government of Malaysia and the Department of Environment.

No other data are available to the reviewer.

5.Technology:

For cold cured moldings, the company will switch over from CFC 11 usage to all-water blown formulations. This technology can be accepted, but requires the use of high pressure foam dispensors, as mentioned in the project. The necessity of a mold heating oven is, in view of the technology change, unclear.

The IS production will abandon the use of CFC 11, and replace it with low ODS HCFC 141b. In this case the use of a high pressure dispensor will provide a better mixture of the chemicals.

6.Environmental Impact:

The zero ODP solution envisaged in the cold cured molding technology is, from an environmental point of view, an excellent choice.

The HCFC 141b solution must be an intermediate one. The GWP for HFCF 141b is 10% of the GWP of CFC 11. However the smog potential of HCFC 141b is ± 10 times higher than for CFC 11.

7.Project Costs:

The incremental capital costs refer to one mold oven ; the reason for this cost item seems not linked to the change of technology, it is hence proposed not to allow it.
All other items can be accepted.
The company does not request payment for incremental operating costs.
Supposing no mold oven provided, the cost for elimination of 1 kg of ODS is USD (292,000/21,000) or USD 13.90.

8.Implementation:

UNDP will oversee the implementation of this project and will provide technical assistance during project execution.
The proposed time schedule is acceptable.

9.Recommendation:

It is recommended to accept the project, only inclusive the USD 10,000 if the company can give a valid reason for the mold oven.

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date: 060495

COUNTRY:	Malaysia	
PROJECT TITLE:	Elimination of ODS in the process of EPE/EPS foam sheet	
SECTOR COVERED:	Non-Insulating Foam	
ODS USE IN SECTOR:	722 ODP-Weighted MT	
PROJECT IMPACT:	Phaseout of 66 ODP-weighted MT of CFC-12	
PROJECT DURATION:	1 year	
PROJECT ECONOMIC LIFE:	10 years	
TOTAL PROJECT COST:	ODS Reduction Investment Costs: Incremental Operating Cost/(Savings): Total Project Costs:	US$ 578,000 US$(115,800) US$ 462,200
GRANT EFFECTIVENESS:	US$ 5.15/ODP-weighted kg of ODS phased out	
REQUESTED OTF FINANCING:[1]	US$ 350,400 as grant	
IMPLEMENTING ENTERPRISE:	Star Foam Paper Products Sdn. Bhd.	
COORDINATING MINISTRY:	Malaysian Department of the Environment (DOE)	

PROJECT SUMMARY

This project will phase out 66 MT of CFC-12 consumption in the production of extruded polystyrene (EPS) and polyethylene (EPE) foam sheet at Star Foam Paper Products Sdn. Bhd. by converting the production line to the use of butane/carbon dioxide for EPS and EPE. The company has identified a pump manufacturer that has successfully designed a high pressure injection pump able to provide butane/CO_2 blowing technology. Star Foam will, however, have to undertake various safety modifications at its plant.

TECHNICAL ASSESSMENT

This project proposal was approved by the OORG technical reviewer on March 17, 1995. Preliminary quotations have been sought for equipment being requested through the project proposal in order to provide cost estimates. During procurement, the LFI will again verify that competitive quotations have been sought before equipment is purchased.

[1] Includes 15 percent contingency and 3 percent financial agent fee.

PROJECT OBJECTIVE

The objective of this project is to phaseout the use of CFCs in the manufacture of extruded polyethylene/polystyrene foam sheet at Star Foam Paper Products Sdn. Bhd. ("Star Foam").

SECTOR BACKGROUND

The ODS consumption in the foam industries in Malaysia is estimated to have reached 600 MT in 1991. It is about 8 percent of the total ODS and 7 percent of total ODP-weighted consumption. Polyurethane foams and EPS/EPE foam sheets are the dominant foam products manufactured in Malaysia. Star Foam is one of four Malaysian manufacturers of EPS/EPE foam sheets. These products are being supplied to food, furniture, and electronic sectors.

ENTERPRISE BACKGROUND

Star Foam was incorporated in 1988 and has its production plant in Gelang Patah, Johor Bahru in the south of peninsular Malaysia. The total built-in area of the factory is 36,000 square feet. The company is a joint venture with 80 percent local ownership. The remaining 20 percent is Singapore owned. Foam sheet production is the main activity. Apart from foam sheets, the company also produces rigid plastic sheet production for the automobile industry. The company's total workforce is about 25 full-time employees.

For EPS/EPE foam sheet production, the company has a Seikisui extruder supplied by the Uniplas corporation in Japan. The capacity of the machine is 900 MT per year. Fully 70 percent of the company's product is for the local market with 30 percent being exported to Singapore. EPS is being used in the food packaging industries, while EPE is being used in the furniture and electronics industries. Star Foam currently uses approximately 66 MT of CFC-12 per year. At present, about 70 percent of the company's product is EPS while 30 percent is EPE.

PROJECT DESCRIPTION

Star Foam proposes to completely phase out its use of CFC-12 in EPS and EPE foam production and shift to CO2 as its primary blowing agent. Star Foam has identified a pump manufacturer that has recently designed a high pressure injection pump able to inject CO_2. Supplemental use of butane will, however, be required.

For EPS, based on Star Foam's product range, the average proportion of CO_2 to butane will be about 85:15 for EPS. For EPE production, CO2 usage is still in a development stages. The estimated achievement is 50% CO2 blended with 50% butane.

Star Foam requires new equipment and modification to its process. Equipment needs include:

Storage

- bulk storage for CO_2

Extrusion System

- modification of mixing portion of screw
- new seals
- modification of die and air ring
- new air compressor

Blowing System

- new high pressure metering pump
- extra additives feeding system
- insulated piping, fittings, safety valves, and devices

Safety Equipment

- safety equipments such as combustible gas detection system, anti-static blower, extinguishers are required to install to prevent risks of fire
- technical assistance for installation, commissioning, and testing the new equipment

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

Based on its own testing using a pilot scale pump, Star Foam has selected carbon dioxide as its primary non-ODS technology. A complete shift from CFC-12 to CO_2 is possible but so far is still in development stages. Star Foam will supplement its use of CO_2 with butane both in EPS and EPS production. The CO_2 used in this process does not present a global warming risk (i.e., does not add net emissions to the atmosphere) because the gas is extracted from carbon dioxide present in normal air rather than produced as a by-product. In addition, carbon dioxide is:

- Non-toxic
- Non-flammable
- Low in cost
- Environmentally friendly, and
- Soluble in polystyrene

The reason CO2 cannot completely replace CFC-12 in the production of EPE foam sheet is because it is not very soluble in LDPE. Butane will therefore supplement CO_2 in this application for about four to six years. Star Foam recognizes that butane is an extremely flammable substance and has already taken some safely precautions anticipating conversion to butane foam blowing. Full safety precautions will be taken by Star Foam to ensure that flammability and explosion risks will be minimized at its plant.

PROJECT COSTS

The total project cost of US$ 462,216 covers the investment costs plus net incremental operating costs (in this case net incremental savings) over the first four years. This project will not provide the enterprise with any incremental revenues.

Investment Costs of US$ 578,000 are detailed in Annex A.

Net Incremental Operating Savings. Given a ten percent discount rate, the net present value of the incremental operating costs minus the offsetting savings over the first four years of the project results in a net incremental operating savings of US$ 115,784. Star Foam expects to achieve savings in blowing agent in converting from CFC-12 to CO_2 and butane (both because of cost and because of a reduction in amount of blowing agent required). Because, however, the secondary foaming capability of CO_2 blown products is inferior to that of CFC-12, Star Foam will be producing thicker and higher density sheets. In order to maintain the same daily output as at present, they will switch from producing 150 rolls with a density of 16.5 kg/roll to 115 rolls with a 21.5 kg/roll density. In doing so, they will consume approximately 150 MT of raw material general purpose polystyrene (900 MT instead of 750 MT) per year which will offset some of the operating savings achieved by converting blowing agents. A more detailed breakdown of the operating costs and the assumptions used for each year of the project are provided in Annex B.

Local Ownership Fraction of 80% and exports of 30 percent to non-Artilce 5 country markets were considered to determine the amount of eligible OTF grant financing. The total project cost was therefore multiplied by 80% and by 80% again to determine the proposed grant amount.

Other Costs. A 15% contingency (US$ 44,400) was also included to ensure adequate funding of project costs following project appraisal. An additional US$ 10,200 (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 requested OTF grant for Star Foam is US$ 350,400. This amount was calculated as follows: the present value of the net incremental operating savings over the first four years of the project were subtracted from the total investment costs. The resulting total project cost was multiplied by the percentage of Malaysian ownership (80%) and by the eligible amount based on exports (80%). 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.

UNIT ABATEMENT COST (UAC)

As derived in Annex C, the UAC calculated over the ten year life of the project is US$ 0.87 per ODP-weighted kg of ODS phased out. This number is derived from the incremental annualized capital costs of US$ 94,067, the net annualized incremental operating savings of US$ 115,784 and average annual savings of approximately 66 ODP-weighted MT. The UAC is slightly negative because the capital costs are annualized over a ten year period while the operating savings are annualized over a four year period.

SCHEDULE

TASK	Q1	Q2	Q3	Q4
Equipment installations and modifications	XXXX	XX		
Training on safety		XX		
Trials using CO_2 and butane			XX	
Start Up				XXXX

REQUIRED REGULATORY ACTIONS

At present, the Government of Malaysia levies varying duties on imported equipment. Because duties and taxes are considered transfer payments between organizations rather than true economic costs, the Multilateral Fund does not consider such costs as incremental. Hence, in order to reduce the total costs incurred by Star Foam, it is recommended that the Malaysian government waive the import duty for all equipment supplied for this project.

RESULTS

This project will eliminate the use of at least 66 ODP-weighted tons of ODS in the first year of implementation. Market and company growth indicates that this may increase in subsequent years.

ANNEX A
Capital Costs (US$)

Butane Technology		
Technical assistance for butane system		20,000
Training for butane including safe handling of flammable materials	20,000	
Carbon dioxide technology		
New CO_2 pump		136,000
Pilot CO_2 pump for testing	30,000	
New CO_2/butane high pressure metering system		110,000
Modifications to air compressor		6,000
Modifications to screw	5,000	
Modifications to die and air ring		12,000
Modifications to seals	1,000	
CO_2 storage, structure, and installation	65,000	
Piping, fitting, and insulation	35,000	
Technical assistance for CO_2 start up	40,000	
Fire Safety and Alarm System/Building modifications		
Ventilation and exhaust ducting		30,000
Gas sensing and detection system	40,000	
Portable gas detection system	4,000	
Fire extinguishers (trolley and hand held)	18,000	
Static eliminator	6,000	
TOTAL COSTS	**578,000**	

ANNEX B
Net Incremental Operating Costs

COST ITEM	1995	1996	1997	19978
Baseline				
EPS	138,600	138,600	138,600	138,600
EPE	59,400	59,400	59,400	59,400
GPPS raw material	637,500	637,500	637,500	637,500
Post-Project				
EPS	21,599	21,599	21,599	21,599
EPE	12,375	12,375	12,375	12,375
GPPS raw material	765,000	765,000	765,000	765,000
Net Incremental Operating Costs/(Savings)	(36,527)	(36,527)	(36,527)	(36,527)
NPV @ 10 percent (4 years)	(115,784)			

Assumptions:

EPS:EPE 70:30
EPS: converts from 100% CFC-12 to 85% CO_2/15% butane
EPE: converts from 100% CFC-12 to 50% CO_2/50% butane
Price of CFC-12: US$3.00/kg
Price of CO_2: US$0.50/kg
Price of butane: US$0.85/kg
Price of GPSS: US$0.85/kg

ANNEX C
Unit Abatement Cost

A.	**ODS Savings**	
	ODP of CFC-12	1.0
	Use of CFC-12 in 1994	66 MT
	Economic Life of Project	10 years
	Average Annual ODS Phased Out	66 ODP-weighted MT
B.	**Incremental Capital Costs**	
	Total investment costs	578,000
	Annualized incremental capital costs	94,067
C.	**Net Annualized Incremental Operating Savings**	(36,527)
	UAC ($/kg ODP phase out)	0.87

STAR FOAM PAPER PRODUCTS - MALAYSIA

TECHNOLOGY

The enterprise uses about 66 te pa of CFC 12 to manufacture extruded polystyrene (EPS) and polyethylene (EPE) foam sheets for packaging applications.

It proposes to use CO_2 / butane mixtures, in the ratio of 85:15 for EPE. The proposals will involve the purchase of new equipment and the modification of existing equipment.

This technology mix represents the preferred options for this sector.

ENVIRONMENTAL ISSUES

The main issue relates to safe operation with highly flammable butane. There is adequate provision including training involved in the project.

The enterprise should ensure that any emissions of butane do not transgress any local VOC regulations.

PROJECT COSTS

The equipment proposed is justified. There are no quotations, competitive or otherwise, to view - have these been sought ?

The operating costs are well displayed and represent a saving.

TIMEFRAME

This is acceptable.

RECOMMENDATION

Approval subject to elucidation of the points mentioned under "Project Costs".

GMFJ/kd/14/3/95

PROJECT COVER SHEET

COUNTRY:	**MALAYSIA**
PROJECT TITLE:	Umbrella Project for Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at Four Small Enterprises
SECTOR COVERED:	COMMERCIAL REFRIGERATION
ODS USE IN SECTOR:	150 - 200 tons ODS (1994 estimate)
PROJECT IMPACT:	44.8 tons of CFCs (CFC11: t); CFC12 : t)
TOTAL PROJECT COST:	USD 694,500 Incr. Capital Cost
PROPOSED MLF GRANT:	USD 694,500
COST EFFECTIVENESS:	2.52 US$/kg (Unit Abatement Cost) 15.5 US$/Kg (Grant Effectiveness)
PROJECT DURATION:	1.5 years.
ECONOMIC LIFE:	10 years.
NATIONAL COORDINATING BODY:	Department of Environment (DoE)
IMPLEMENTING AGENCY:	UNDP
APPRAISAL DATE:	April 1995

PROJECT SUMMARY

This project covers four small enterprises manufacturing commercial refrigeration equipment such as bottle coolers, commercial chest freezers, etc. in Malaysia. These companies presently all use CFC 11 in the production of rigid PU insulation foam and CFC 12 as the refrigerant. Their individual annual CFC consumption is under 15 tons. Under the project, all five companies will eliminate a total of about tons of CFCs, by replacing CFC 11 with HCFC 141b, and CFC 12 with HFC 134a. Funds requested will be used to change the existing production lines, and for prototyping, trialling, testing, and training, etc.

Prepared by: Stuart Kelly, in collaboration with the Department of Environment.

Reviewed by: L.J.M. Kuijpers/M.J.P.Janssen (Refrigeration) and H. Creyf (Foam). Their comments are attached.

PROJECT OF THE GOVERNMENT OF MALAYSIA

ELIMINATION OF CFCs IN THE MANUFACTURE OF COMMERCIAL REFRIGERATION EQUIPMENT AT FIVE SMALL ENTERPRISES

1. PROJECT OBJECTIVE

The objective of this project is to eliminate the consumption of CFCs at five small commercial refrigeration equipment manufacturing enterprises in Malaysia.

2. SECTOR BACKGROUND

The Malaysia Country Programme (CP) for the Phase-out of Ozone Depleting Substances (ODS) under the Montreal Protocol was approved at the 5th meeting of the Executive Committee of the Multilateral Fund (MLF) in November 1991.

The CP estimates that CFC consumption in the foam sector in Malaysia in 1991 was approximately 600 tons in 1991. CFC 11 for polyurethane foams, and CFC 12 for polystyrene and polyethylene foam sheet are the dominant substances in this sector, with much smaller usage of methyl chloroform, CFC 114, and CFC 115. According to the CP, the largest CFC consuming sector is refrigeration and air-conditioning which totalled 1,500 tons in 1991. CFC 12 is the major refrigerant used, principally in automotive air-conditioning, and in the manufacture of domestic and commercial refrigeration equipment.

Malaysia has enjoyed very strong economic growth over the past several years and ODS consumption in some sectors may be expected to have grown considerably from the estimates in the CP. It is estimated that in the Commercial Refrigeration sector real growth rates over the past four years have been 10% per annum.

The CP does not specifically identify any enterprises manufacturing commercial refrigeration equipment but this sector in Malaysia is typical of many other Developing Countries in that it comprises a substantial number of small enterprises. Whilst ODS consumption at individual enterprises may often be small, the total sector consumption is significant and this, coupled with the high growth rates, makes the Commercial Refrigeration sector a current priority in Malaysia's ODS phase-out strategy.

While it is difficult to estimate the current total CFC consumption in the sector, it might be anticipated as being of the order of 150 tons per annum. Data collected from visits to 6 manufacturers so far amounted to about 130 tons of CFCs.

During 1994, projects for two medium-size commercial refrigeration enterprises were approved by the MLF. The present project is the first of two groups of projects targeting small commercial refrigeration enterprises (defined as those whose annual ODS consumption is less than 15 tons). Approval of this project by the MLF in July 1995 will provide stimulus towards ODS elimination in the sector, and will also eliminate any possible market distortion.

Several other small enterprises have been identified as being engaged in the manufacture and/or installation of commercial refrigeration equipment. Data on their ODS consumptions will be obtained to assess the potential and eligibility for MLF project funding. It is expected that a second and last umbrella project for this sub-sector will be submitted to the next ExCom, grouping all remaining small enterprises and thus completing the ODS phaseout in this sub-sector.

3. ENTERPRISES

The four enterprises covered under this project are the following:

ENTERPRISE	LOCAL OWNERSHIP	ODS TONS 1994	PRODUCTION VOLUME (1994)
		CFC11/ CFC12/total	
LIM YEW REF.	100%	11 + 4 = 15	14,939
EXQUISITE	100%	12.4 + 2.0 = 14.4	5,360
FMC	100%	4 + 2 = 6	1,296
NOBLELANE	100%	7.1 + 2.3 = 9.4	9,009
TOTAL ODS: 44.8			

More detailed information on the individual enterprises are given in the Annexes under the respective sub-project.

4. PROJECT DESCRIPTION

Under this umbrella project, a total of about 45 tons of ODS will be phased out. All the four enterprises will switch from the use of CFC 11 as blowing agent to HCFC-141b for the production of rigid insulating foams needed for their refrigeration equipment, and from CFC-12 as refrigerant to HFC-134a. The enterprises recognize the interim nature of the use of HCFC-141b towards a zero-ODP system.

The project will cover the costs of new replacement foam dispensing equipment, new refrigerant charging and leak detection equipment, re-design of the refrigeration systems and protyping, testing, production trials, technology transfer and training.

5. TECHNOLOGY

5.1. REPLACEMENT OF CFC 11.

5.1.1 OVERVIEW

The phaseout technologies for rigid insulation foams are as under:

Low ODS technologies (interim) > Reduced CFC
> HCFCs (22, 141b, 22=142b)

Non-ODS technologies (permanent)> Pentanes
> All Water Blown
> HFCs (134a, 245, 356)

The selection of an alternative technology has been made following the following considerations:

- Maturity
- Cost-effectiveness - investment
  - operation
- Commercial availability
- Technical support
- Product properties
- Operational safety
- Environmentally/legally acceptable

All four companies, considering these issues, have selected HCFC-141b as their CFC-11 replacement technology.

5.1.2. SELECTION

The selection of HCFC 141b technology as the immediate replacement for CFC 11 is a realistic and cost-effective choice for the enterprises, given the physical constraints of the existing plants' layout for use of cyclopentane. Relatively modest funding is requested to achieve the conversion and the technology choice is supported by the Malaysia Department of Environment. The enterprises understand that HCFC 141b is an interim solution which may require a change to an appropriate zero-ODP technology at some future date. The provision of replacement high pressure PU foam dispensing machines will facilitate this.

5.1.3 IMPACT ON THE PRODUCTION PROCESS

The high pressure PU foam dispensing machine and the use of pre-blended HCFC-141b/polyol will enable the new technology to be introduced efficiently and safely. HCFC-141b is moderately flammable in the gaseous state, but the liquid is not flammable. In the intended application, a HCFC-141b/polyol pre-mix should not

pose any risk, but a monitoring check at commissioning will be performed to ensure safe worker exposure levels. Ventilation is to be installed where needed to ensure exposure levels are maintained below the recommended occupational exposure limit.

The majority of the chest freezers use metal cabinet liners, and glass sliding lid closures. The change to HCFC-141b technology does not impact on these materials. A small number of chest freezers have conventional lids with a HIPS plastic lid liner. This liner material should be modified to be resistant to HCFC-141b.

Foam density adjustments will be necessary to obtain equivalent insulation values.

5.2. REPLACEMENT OF CFC 12.

HFC 134a is universally accepted as a replacement for CFC 12 in the manufacture of unitary commercial refrigeration equipment such as bottle coolers and freezers. HFC 134a is widely available and the technology is mature, having already been introduced commercially in many of the Developed Countries. Replacement of CFC 12 with HFC 134a requires relatively modest changes to existing production facilities.

Whilst hydrocarbon refrigerant (iso-butane) is being increasingly used in the manufacture of domestic refrigerators in several Developed Countries, the transfer of this technology to Developing Countries is not always cost effective. It also raises questions about safety issues and remains conditional on the support of a technology partner experienced in the production of comparable refrigerators and freezers on a commercial scale. It is further dependent on the technology partner providing assurances in writing on safety issues, and, of course, the availability of adequate supplies of both compressors and hydrocarbon refrigerant of the required quality.

HFC 152a might be considered as another candidate for CFC 12 replacement in domestic refrigerators. However, HFC 152a is also flammable, the technology has not been developed commercially, and there are some questions around its stability in refrigerator systems. Furthermore, compressors for use with HFC 152a are not commercially available.

5.2.2. SELECTION

All four enterprises have selected HFC 134a to replace the CFC-12 system. Based on economic and environmental considerations, cyclo-pentane appears to be the best choice for commercial refrigerator and freezer applications. It combines an attractive price with zero-ODP, and near-zero GWP properties. The enterprises considered

cyclo-pentane technology, but whilst recognising both the environmental and economic benefits of cyclo-pentane versus HCFC 141b, they selected HCFC 141b as a first stage, interim, replacement for CFC 11.

Several important considerations influenced the enterprises decision in favour of HCFC 141b technology as a first step in ODS elimination:

- HCFC 141b was selected in 1994 after trials conducted by the PU foam chemicals supplier demonstrated that the existing equipment at the enterprises could handle the proposed HCFC 141b formulation.

- HCFC 141b technology can be introduced quickly, utilising the existing equipment, with minimal investment cost and plant downtime, and in time to meet client deadlines for "CFC-free" bottle coolers and freezers.

- whilst cyclo-pentane technology could be introduced by the provision of the necessary safety equipment, cyclo-pentane storage and blending facilities, and a new "cyclo-pentane ready" high pressure PU foam dispensing machine, this would involve a major, and unacceptable, disruption of plant operations and loss of production. It could also not be accomplished within the CFC elimination target dates imposed on the enterprises by their clients.

- at a yet undetermined future time, the enterprises plan to replace the HCFC 141b technology with cyclo-pentane, or a commercially developed and acceptable alternative zero-ODP technology. The choice will be dependent on the technology options available at that time. To facilitate this final change to a non-ODS technology, the enterprises require a high pressure PU foam dispensing machine and this is included in the project proposal. With the provision of a replacement high pressure PU foam dispensing machine, the enterprises accept that they will bear all the additional costs associated with the change from HCFC 141b to a non-ODS PU insulation foam technology.

- the purchase, installation, and commissioning of new cyclo-pentane based equipment in parallel to the existing equipment, in order to minimise production downtime, would be an attractive option if financed by the MLF. However, space constraints at the Alor Star factory preclude this option.

The selection of HCFC 141b technology as the immediate replacement for CFC 11 by the enterprises is a realistic and sensible choice under the prevailing circumstances. Relatively modest funding is requested to achieve this and the technology choice is supported by the Malaysia Department of Environment. The enterprises understand

that HCFC 141b is an interim solution which will require a change to an appropriate zero-ODP technology at some future date. The provision of a replacement high pressure PU foam dispensing machine will facilitate this.

5.2.3. IMPACT ON THE PRODUCTION PROCESS

HFC 134a, like CFC 12, is non-flammable. HFC 134a has also been the subject of extensive toxicological testing and is considered safe in use in industrial applications provided the suppliers recommended occupational exposure levels are not exceeded. At the present time this means ensuring that exposure levels do not exceed 1000 parts per million on an 8-hour time-weighted average basis. This is the same as the Occupational Exposure Limit (OEL)/Threshold Limit Value (TLV) for CFC 12 and thus no changes from current practices are required.

There will be an approximately 10% reduction in the mass charge of HFC 134a compared with CFC 12 for a refrigerator system of the same capacity. This is taken into account in the calculation of the incremental operational costs.

It is well understood that the chemical stability of HFC 134a/synthetic lubricant systems in unitary commercial and domestic refrigeration systems, and hence the long term performance of the appliances, is sensitive to moisture content and certain chlorinated impurities. This requires that CFC 12 and HFC 134a handling equipment be carefully segregated, and it also calls for better evacuation of the system prior to refrigerant charging.

Because system cleanliness and moisture content is paramount to the successful manufacture of HFC 134a refrigerators, the enterprises will need to carefully re-assess production procedures and re-train production personnel as appropriate.

The conversion from CFC 12 to HFC 134a will take place on a model by model basis, so there is a requirement for new system evacuation equipment and refrigerant charging equipment. Leak detection of the refrigeration system is an integral part of the manufacturing process and the use of HFC 134a requires that new leak detection equipment be employed and provision for this has been made in the budgets.

6. PROJECT COSTS

6.1. INCREMENTAL CAPITAL COSTS

6.1.1 CAPITAL COST FOR CFC 11 PHASE-OUT

4 x HIGH PRESSURE PU FOAM DISPENSING MACHINES	380,000
TRAINING, TEST TRIALS & TECHNOLOGY TRANSFER	34,000
CONTINGENCIES	37,000
Subtotal (US$)	451,000

CAPITAL COST FOR CFC 12 PHASE-OUT

4 x REFRIGERANT CHARGING EQUIPMENT	108,000
4 x NEW VACUUM PUMPS	22,000
4 X R134a LEAK DETECTION EQUIPMENT	10,500
RE-DESIGN, PROTOTYPING, TESTING, PILOT SCALE PRODUCTION & RELIABILITY TEST TRIALS	40,000
TRAINING/TECHNOLOGY TRANSFER/TECHNICAL ASSISTANCE	41,000
CONTINGENCIES (10%)	22,000
Subtotal (US$)	**243,500**

TOTAL INCREMENTAL CAPITAL COST: US$ 694,500

6.2 INCREMENTAL OPERATING COSTS & BENEFITS

As mentioned under section 4.1, the enterprises will incur higher operating costs as a result of the technology change to phase out both CFC-11 and CFC-12. However, the enterprises are not requesting any associated incremental operating costs.

6.3. TOTAL PROJECT INCREMENTAL COSTS

TOTAL COST (Capital Only) (US$)	694,500
% Article 5.1 Country Ownership	100%
FUNDING REQUESTED FROM MLF (US$)	694,500

6.4 COST EFFECTIVENESS

6.4.1 UNIT ABATEMENT COST (US$/Kg)

a. Capital Investment Costs:	694,500
b. Capital Recovery Factor (10% p.a.):	0.16275
c. Incremental Operating Costs:	n/a
d. ODP Reduction (1994):	44,800 kgs
e. Unit Abatement Cost (US$/Kg): [(a x b) + c] /d	2.52

6.4.2 GRANT EFFECTIVENESS (US$/Kg)

TOTAL PROJECT COST:	694,500 US$
TOTAL ODP PHASEOUT:	44,800 ODS/Kgs
GRANT EFFECTIVENESS:	15.50 US$/Kg

7. FINANCING PLAN

A grant total of **US$ 694,500** is requested for the four enterprises, covering only the incremental capital costs related to the technology conversion.

8. PROJECT IMPLEMENTATION

8.1 MANAGEMENT

UNDP will oversee the successful implementation of this project, and will provide technical assistance during project execution.

8.2 SCHEDULE

TASK	TIME TO COMPLETION					
	Q1	Q2	Q3	Q4	Q5	Q6
1. Preparation						
MLF Approval	X					
Procurement Preparation	XX	X				
Vendor Selection		XX				
2. Installation						
Arrival of Equipment		XX				
Customs Clearance		X				
Machine Installation		X	X			
3. Start-Up						
Machine Start-up			X			
Trials & Training			XXX	XXX	XX	
Mass Production Change					X	XX
Certification						X

9. PROJECT IMPACT

This project will eliminate the use of about 48 ODP tons of CFCs per year based on the 1994 production figures.

10. ANNEXES

Country of origin: MALAYSIA

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at EXQUISITE PRODUCTS MANUFACTURING Sdn. Bhd.

Sector/sub-sector Commercial refrigeration
Relationship to country program (UNDP)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

- In this project, HFC-134a is selected as the alternative refrigerant for the replacement of CFC-12. In commercial refrigeration HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.
- EXQUISITE does not have a formal technology transfer agreement. However, the technology will be developed in house with assistance from the compressor supplier (MATSUSHITA) and the refrigerant supplier. Furthermore, external assistance will be present; provisions are included for this support. Taking these facts into consideration, a successful project implementation can be expected.
- Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of the state of development, safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

Environmental impact

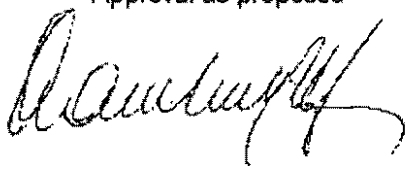
HFC-134a has an ODP of zero and a GWP of 1300 compared to carbon dioxide (100 year time horizon). For commercial refrigeration, unitary equipment, a GWP of this magnitude is acceptable.

Project costs

- The equipment requested is essential for the conversion process.
- The costs of equipment, training, prototyping, testing, trials and technical assistance are reasonable.
- Incremental operational costs are claimed for half a year.
- The calculation of the operational costs include the correct items and associated costs are reasonable.
- When the UAC value is calculated for the refrigerant conversion part separately, a value of 13.1 USD/kg/year is obtained, which is in line compared to other, similar, projects.

Implementation timeframe Reasonable
Relevance and adequacy of information provided Reasonable
Recommendations Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands, 8-June-1995



Kuijpers L.J.M.,
Technical University Eindhoven, NL

Country of origin: MALAYSIA

Project title: Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at FMC REFRIGERATION HOLDINGS Sdn. Bhd.

Sector/sub-sector Commercial refrigeration
Relationship to country program (UNDP)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

- In this project, HFC-134a is selected as the alternative refrigerant for the replacement of CFC-12. In commercial refrigeration HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.
- FMC does not have a formal technology transfer agreement. However, the technology will be developed in house with assistance from the compressor suppliers and the refrigerant supplier. Furthermore, provisions are included for external assistance. Taking these facts into consideration, a successful project implementation can be expected.
- Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of the state of development, safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

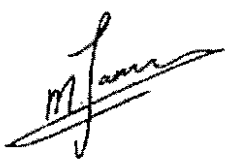
Environmental impact

HFC-134a has an ODP of zero and a GWP of 1300 compared to carbon dioxide (100 year time horizon). For commercial refrigeration a GWP of this magnitude is acceptable.

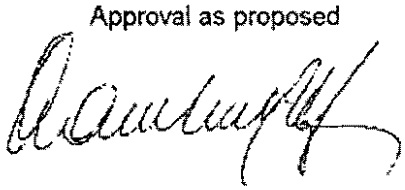
Project costs

- The equipment requested is essential for the conversion process.
- The costs of equipment, training, prototyping, testing, trials and technical assistance are reasonable.
- No incremental operational costs are claimed. (The calculation of the operational costs added, include the correct items and associated costs are reasonable).
- When the UAC value is calculated for the refrigerant conversion part separately, a value of 6 USD/kg/year is obtained (excluding operational costs), which is in line compared to other, similar, projects.

Implementation timeframe Reasonable
Relevance and adequacy of information provided Reasonable
Recommendations Approval as proposed



Janssen M.J.P.,
Eindhoven, The Netherlands, 8-June-1995



Kuijpers L.J.M.,
Technical University Eindhoven, NL

Country of origin:	MALAYSIA
Project title:	Elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at LIM YEW REFRIGERATION Co.

Sector/sub-sector	Commercial refrigeration
Relationship to country program	(UNDP)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

- In this project, HFC-134a is selected as the alternative refrigerant for the replacement of CFC-12. In commercial refrigeration HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.
- LIM YEW does not have a formal technology transfer agreement. However, the technology will be developed in house with assistance from the compressor (MATSUSHITA) and the refrigerant supplier. Due to high pressure of the clients of this company to produce CFC-free products, LIM YEW has already build prototypes which were accepted by a customer. Next to the experience already gained (and shared with the NOBLELANE company discussed in the previous review), provisions are included for additional external assistance. Taking all these facts into consideration, a successful project implementation can be expected.
- Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of the state of development, safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

Environmental impact

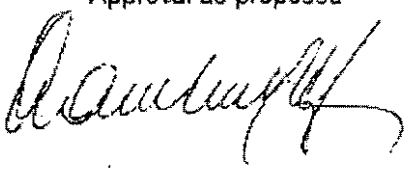
HFC-134a has an ODP of zero and a GWP of 1300 compared to carbon dioxide (100 year time horizon). For commercial refrigeration a GWP of this magnitude is acceptable.

Project costs

- The equipment requested is essential for the conversion process and associated costs are reasonable.
- The costs of training, prototyping, testing, trials and technical assistance are reasonable.
- No incremental operational costs are claimed. (The calculation of the operational costs added, include the correct items and associated costs are reasonable).
- When the UAC value is calculated for the refrigerant conversion part separately, a value of 3.6 USD/kg/year is obtained (excluding operational costs), which is low compared to other, similar, projects.
- As stated before, there is considerable pressure on the company by its clients to produce CFC-free units as soon as possible. This means that by the time of approval of this project, some investments are likely to have been made, and hence, retroactive financing of a part of the project will be necessary.

Implementation timeframe	Reasonable
Relevance and adequacy of information provided	Reasonable
Recommendations	Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands, 8-June-1995



Kuijpers L.J.M.,
Technical University Eindhoven, NL

Country of origin: MALAYSIA
Project title: Elimination of CFCs 11 and 12 in the Manufacture of Commercial Freezers at NOBLELANE INDUSTRIES Sdn. Bhd.

Sector/sub-sector Commercial refrigeration
Relationship to country program (UNDP)

Note *This review addresses only the refrigerant conversion part of the project, it does not address the part related to the foam blowing agent conversion.*

Technology

- In this project, HFC-134a is selected as the alternative refrigerant for the replacement of CFC-12. In commercial refrigeration HFC-134a technology is a proven and acceptable (nontransitional) technology to reduce CFC-12 consumption.
- NOBLELANE does not have a formal technology transfer agreement. However, the technology will be developed in house with assistance from the compressor supplier (MATSUSHITA) and the refrigerant supplier. Moreover, a co-operation with LIM YEW REFRIGERATION Co. exists (see review hereafter) which reduces the necessary development efforts. Next to this, provisions are included for additional external assistance. Taking these facts into consideration, a successful project implementation can be expected.
- Other technologies than HFC-134a were considered (hydrocarbons, HFC-152a) but were not selected because of the state of development, safety issues and the lack of commercially available compressors. From the zero ODP technologies HFC-134a is one of the most cost effective solutions.

Environmental impact

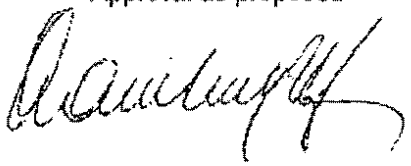
HFC-134a has an ODP of zero and a GWP of 1300 compared to carbon dioxide (100 year time horizon). For commercial refrigeration a GWP of this magnitude is acceptable.

Project costs

- The equipment requested is essential for the conversion process and associated costs are reasonable.
- The costs of training, prototyping, testing, trials and technical assistance are low.
- Incremental operational costs are not claimed. (The calculation of the operational costs added, include the correct items and associated costs are reasonable).
- When the UAC value is calculated for the refrigerant conversion part separately, a value of 3.2 USD/kg/year is obtained (excluding operational costs), which is low compared to other, similar, projects.
- There is considerable pressure on the company by its clients to produce CFC-free units as soon as possible. This means that by the time of approval of this project, some investments may have been made already, and hence, retroactive financing of a part of the project might be necessary.

Implementation timeframe Reasonable
Relevance and adequacy of information provided Reasonable
Recommendations Approval as proposed

Janssen M.J.P.,
Eindhoven, The Netherlands, 8-June-1995



Kuijpers L.J.M.,
Technical University Eindhoven, NL

(12)

TECHNICAL REVIEW.

1.Country:

Malaysia.

2.Project Title:

Umbrella project for the elimination of CFCs 11 and 12 in the Manufacture of Commercial Refrigeration Equipment at Four Small Enterprises.

The following 4 companies are involved:

- Exquisite Products Manufacturing (malaysia) Sdn. Bhd.
- FMC REFRIGERATION HOLDINGS Sdn. Bhd.
- LIM YEW REFRIGERATION Co.
- NOBLELANE INDUSTRIES Sdn. Bhd.

3.(Sub)Sector:

Commercial Refrigeration.

This review covers only the foam part.

4.CP-Relationship:

The Malaysian CP for phaseout of ODS under the Montreal Protocol was approved at the 5th meeting of the Executive Committee of the MLF in November 1991.

Due to the presence of several small enterprises, and high growth rates, the Commercial Refrigeration sector constitutes a priority in Malaysia's ODS phaseout strategy.

5.Technology:

The four enterprises will replace CFC 11 in the production of insulating PU with HCFC 141b,which is considered to be an interim step to totally ODS free solutions.

The cyclopentane solution can in some cases not be used, due to lack of the space necessary for safety in the operation. Those firms will perhaps have to change to all-water blown foam.

Under those circumstances, the change to HCFC 141b can be accepted for an interim period.

All companies request a high pressure dispensing machine, which will

facilitate the transition to ODS free foams.

6.Environmental Impact:

The ODP of HCFC 141b is 0.11; the ODP of CFC 11 being 1.0. THe GWP of HCFC 141b is 10% of the GWP of CFC 11.

7.Project Costs:

The next table summarizes the capital costs related to the change in technology for the PUF production:

Company	Capital costs USD	ODP weighted ODS- kg	Unit elimination price USD
EXQUISITE	121,000	11,040	10.96
FMC	121,000	3,420	35.38
LIM YEW	121,000	9,790	12.36
NOBLELANE	88,000	6,350	13.86
ALL	451,000	30,600	14.74

All costs can be accepted as presented.
Incrementeal operating costs are taken by the companies.

8.Implementation:

Management and time schedule can be accepted as presented.

9.Recommendation:

It is recommended to accept the project(s).

Prepared by Hubert Creyf, UNDP Foam Sector Reviewer.
Date: 061195

COUNTRY:	Malaysia	
PROJECT TITLE:	Reduction of the consumption of ozone depleting substances in the commercial air-conditioning sector via training, recovery and recycling of CFC-11 and CFC-12 in chillers.	
SECTOR COVERED:	Commercial building air conditioning	
ODS USE IN SECTOR:	Approximately 200 MT of CFC-11 and CFC-12 in 1990	
PROJECT IMPACT:	Phaseout of 105 ODP-weighted MT of CFC-11 and CFC-12	
PROJECT DURATION:	1 year	
PROJECT ECONOMIC LIFE:	10 years	
TOTAL PROJECT COST:	ODS Reduction Investment Costs:	US$ 637,800
	Incremental Operating Costs:	US$ 197,800
	Total Project Costs:	US$ 835,600
GRANT EFFECTIVENESS:	US$ 9.15/ODP-weighted kg of ODS phased out	
REQUESTED OTF FINANCING:[1]	US$ 990,000 as grant	
IMPLEMENTING ENTERPRISE:	Malaysian Chapter of American Society of Heating, Refrigerating and Air-conditioning Engineers (MASHRAE)	
COORDINATING MINISTRY:	Malaysian Department of the Environment (DOE)	

PROJECT SUMMARY

The project aims to reduce emissions of CFC's from chillers during operation, maintenance & servicing by operators. Chiller systems use principally CFC-11 & CFC-12 as refrigerants. The project will reduce CFC consumption by training air-conditioning technicians in better operation and maintenance procedures, better changing & vacuuming processes and the elimination of venting during repairs. Equipment necessary to reduce chiller servicing emissions will be leased to Malaysian chiller service companies when routine maintenance is carried out.

The UNEP/IEPAC has agreed to provide the training that is to be undertaken at the national level, while the Malaysia Chapter of ASHRAE (MASHRAE) will be responsible for all subsequent local training activities. UNEP/IEPAC will therefore administer and provide services for US$60,000 out of the total budget.

TECHNICAL ASSESSMENT

This project proposal has been approved by Lambert Kuijpers (OORG refrigeration reviewer) on February 17, 1995). Previous review of the proposal requested further consideration of the quantities recoverable through the project and further discussion about operating costs. Both issues have been addressed to the reviewer's satisfaction .

[1] Includes 15 percent contingency and 3 percent financial agent fee.

PROJECT OBJECTIVE

The object of this project is to reduce the annual consumption of ODS in the commercial air-conditioning chiller sector. In this context, the two major goals of the project are to:

- reduce CFC emissions from existing chillers by training technicians about the ODS phaseout and the need to service chillers following the best codes of practice, and providing them with the equipment to follow these practices and
- reduce the likelihood that Malaysia will experience excessive costs for retrofitting or retiring chillers because refrigerants are not available.

SECTOR BACKGROUND

The annual consumption CFC-11 and CFC-12 by large central chiller plants in the commercial building air-conditioning sector in Malaysia is estimated to be 192 MT. This represents approximately 25% of a total of 766 MT of ODS which exists in 1,470 central chiller units within Malaysia.

Approximately a quarter of these are CFC-12 chillers which have a leakage rate of 15% per year, and the remainder are CFC-11 chillers which have a leakage rate of 5% per year. It is assumed therefore that the average annual leakage rate is approximately 8% per year. Based on these assumptions, 61 MT is leaked and presumed irretrievable. The remaining 131 MT of CFC is lost as a result of poor maintenance and other operator practices. It is this 131 MT of CFC that the project seeks to address through a program of CFC recycling and service operator training.

It is assumed that this project would be able to reach 90% of all chillers, and thus a total potential of 118 MT would be eliminated. The service operator training will seek to address general refrigerant maintenance issues that will result in approximately 35 MT in emissions reductions. Given a recovery efficiency rate of 85%, approximately 70 MT could be captured through recovery during servicing. In total, therefore, an annual consumption of 105 MT could be eliminated through this project.

The 1,470 chiller units are presently distributed among 4 major regions within the country. The distribution of chillers are as follows:

Northern Region:	147 units
Southern Region:	147 units
Central Region:	882 units
East Malaysia:	294 units
Total	**1,470 units**

Since 1990 CFC 11 & CFC 12 machines have been gradually phased out and with effect from 1992 non-ODS based chillers have been introduced into the market. Malaysia is a net importer of ODS and does not produce any ODS for chiller operations. As such Malaysian chiller operations are highly dependent on the availability of CFCs supplied by manufacturers overseas.

The existing bank of chillers in the market is projected to have an average remaining working life between 10 and 15 years. Hence a gradual phaseout of the use of CFC chillers is envisaged without substantial destabilisation of the economy. Owners of chillers have a choice of either to retrofit chillers to run on non-ODS refrigerants or to write-off the chillers at the end of their useful life, the bottom line being how much is the cost.

ENTERPRISE BACKGROUND

The Malaysian Chapter of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (MASHRAE) is a society registered with the Registrar of Society, Malaysia. Its members are also members of the parent society (ASHRAE) based in United States of America. A majority of its members are from the air-conditioning and refrigerating industry working either as manufacturers, researchers, contractors, engineers, educators, or specialist consultants.

Formed in 1986, the society presently has a membership of 300 local Chapter members and is managed by a Board of Governors (BOG) elected annually. The BOG consists of a President, President Elect, Vice-President, Hon. Secretary, Hon. Treasurer and three other Board members. MASHRAE's main function is to disseminate information to its members and the industry in general via seminars, workshops and industrial visits organized from time to time. It also publishes newsletters, receives overseas visitors and speakers, makes representations to the government on issues related to the air-conditioning and refrigeration industry and provides advice on the choice and use of standards and practices. MASHRAE is a non-profit organization with board members actively participating in government working groups on the environment. Presently, a representative from MASHRAE chairs the working group WG-2B which deals with CFC use in the air-conditioning and refrigeration sectors. In 1992 the Chapter organized a one-day seminar on the topic "CFC Issue - Now & Future", followed by discussions which provided inputs for the working group on air-conditioning and refrigeration. In association with the Institute of Engineers, Malaysia, several workshops and training programs were arranged for practicing engineers on CFC-related issues.

PROJECT DESCRIPTION

This project has been designed on the basis of being implemented by a non-profit organization (MASHRAE), with assistance from UNEP/IEPAC. While MASHRAE will be the main implementing institution, the UNEP/IEPAC has agreed to carry out a national-level training program using US$60,000 of the total project budget. In this manner, organizations other than MASHRAE will benefit from the training program. For example, members of PPK Malaysia (the Association for Shopping and High Rise Complex Management) will also participate in the training program.

Presently, the Malaysian Chapter of ASHRAE operates an office of one of its office bearers. Via links provided by office bearers and the membership, ASHRAE has direct access to the multitude of service contractors aligned with the major suppliers of chillers in the country.

There are currently more than 1000 small service operators who perform servicing and maintenance on refrigeration and air-conditioning equipment, including commercial building chillers. These operators are closely linked to the major chiller manufacturers and suppliers based in Malaysia. The level of training and educational background of these operators is generally low. In order to alter current practices which result in significant discharge of ODS into the atmosphere, it is therefore essential that adequate training in CFC recycling is provided in Malaysia.

The proposed project aims to accomplish the following:

(A) Establish, jointly with the Department of Environment, the necessary infrastructure for a refrigerant recovery network within the Malaysia.

(B) Provide hands-on training in the recycling of chiller refrigerant to a core group of service operators.

(A) NETWORK

As the cornerstone of the chiller recycling project, a refrigerant recovery network will be set

up via the leasing of recovery/recharge machines to service operators, who will use the machines to recover refrigerants which are normally vented during annual chiller servicing. In order to establish the network, chiller owners and their equipment will be registered with MASHRAE, which will maintain recycling network records. Through this linkage, a schedule will be instituted for sharing the use of recycling/recovery machines among the various chiller companies. A written agreement for the leasing of machines will be executed prior to the release of any equipment to service operators. During the period when a chiller company has access to recovery/recharge equipment, it will be able to use the equipment for the servicing of all chillers within the company's own service network.

It is anticipated that the network will be effective in promoting comprehensive participation by chiller companies, since the Chief Executive Officers of both Carrier Malaysia and York Malaysia are on the MASHRAE BOG, while most other companies are MASHRAE members closely identified with the society.

A key advantage of the establishment of a user network is that it will assist by creating a registry of the majority of all chillers, chiller owners, and chiller companies in Malaysia. A second advantage to having the user network managed by MASHRAE is that by placing record-keeping responsibility within MASHRAE, there would no need for additional oversight or regulatory action on the part of the Malaysian Department of Environment. However, while the network's databank will be managed by MASHRAE's Secretariat during project implementation, all records will be turned over to the Department of Environment upon conclusion of the project, to facilitate the keeping of permanent records on the project by the Government of Malaysia.

It should also be noted that with some modification to the equipment with respect to pressure settings and seals, the equipment to be used under the project can also be used for HCFC-22 and HCFC-123 recycling, thereby making a significant contribution to the reduction of HCFCs in addition to CFCs.

(B) TRAINING

The training component of the project will be carried out both as a crucial first step in providing national-level training for service technicians, and as an ongoing regional exercise for broadening the scope of training to include service technicians in all parts of Malaysia. It is envisioned that training at the national and regional levels will be carried out during the first year of the project, in order to facilitate broad implementation of the recycling project in subsequent years.

It has been agreed that UNEP's IEPAC will support the national-level round of training during the first phase of the project. UNEP has undertaken similar training efforts in the Philippines, Ghana, and Kenya and using their services will prove to be a cost-effective use of the Multilateral Fund's resources. This national training exercise will have a dual purpose. It will train service technicians who will then be able to initiate chiller recycling within their respective companies; and it will also serve as a "training the trainer" exercise so that representatives from each company in attendance will be able to take the skills they have learned back to different regions of Malaysia in order to train others in refrigerant recycling. This ripple effect will serve to disseminate recycling expertise to all levels through in-house interaction among service technicians at companies represented at the national training workshop.

MASHRAE will also organize smaller regional training workshops in support of the program. During these regional training workshops, MASHRAE will be able to draw on the skills of service technicians in the area that have gone through the national-level training, and who have been practicing refrigerant recycling in their region.

It is envisioned that in addition to technical skills developed during the training workshops, a code of good practice will be disseminated to service contractors during the training sessions. This will serve to promote the responsible and consistent use of the recovery/recharge machines throughout Malaysia.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

Based on the need to service chillers at least once annually, the geographic accessibility of certain regions, the time required to transport equipment to and from each site, and the time necessary for servicing at each site (one to two days), the following numbers of recovery/recharge units are estimated as adequate for carrying out the project in each regions specified:

Northern Region:	5 units (1 as standby)
Southern Region:	5 units (1 as standby)
Central Region:	12 units (1 as standby)
East Malaysia:	8 units (2 as standby one each in Sarawak and Sabah)
TOTAL	**30 units**

PROJECT COSTS

The total project cost of US$ 832,600 covers the investment costs plus net incremental operating costs over the first four years. This project will not provide the enterprise with any incremental revenues.

Investment Costs: Total investment costs of US$ 634,800 are detailed in Annex A. The main component of this cost is the purchase and delivery of recycling units for US$ 554,800. Additional costs totalling $83,000 are included for regional training, of which UNEP will administer and provide services for US$60,000..

Net Incremental Operating Costs: Incremental costs under the project are projected to be $62,400 per year of the project, which represents two seconded staff (plus overhead costs) associated with equipment management and maintenance. Given a ten percent discount rate, the net present value of these costs over the first four years of the project results in net incremental operating costs of US$ 197,800.

No operating savings as a result of CFC recovery will be realized by the implementing enterprise (MASHRAE). MASHRAE's involvement in the project is strictly limited to managing the recycling network, and is not itself involved in the recovery of CFCs. Any CFC savings realized by the project will be limited to the owners or operators of the chillers that are serviced. MASHRAE will require each chiller servicing company participating in the program to provide detailed logs of recycling machine use under the program, in order to track the use of recycled refrigerant by service companies, ensuring that the use of recycled refrigerant is accounted for during servicing.

Local Ownership: MASHRAE is a 100% Malaysian non-profit organization, which will be reflected in cost calculations for the grant.

Other Costs. A 15% contingency has been included in the grant to ensure adequate funding of project costs following project appraisal. An additional 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 requested grant for MASHRAE is US$ 990,000. This amount was calculated as follows: the present value of the net incremental operating costs over the first four

years of the project were added to the total investment costs. The resulting total project cost was multiplied by the percentage of Malaysian ownership. 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, representing the total OTF grant.

UNIT ABATEMENT COST (UAC)

As derived in Annex C, the UAC calculated over the ten year life of the project is US$1.49 per ODP-weighted kg of ODS phased out. This number is derived from the incremental annualized capital costs of US$ 93,546, the net annual incremental operating costs/savings of US$ 62,400, and average annual savings of approximately 105 ODP-weighted MT.

PROJECT IMPLEMENTATION

The Malaysian Department of Environment shall be responsible as the National Executive Implementing Agency in collaboration with MITI, the Ministry of Finance and other relevant government agencies for the implementation and maintenance of the program. The Malaysian Chapter of ASHRAE (MASHRAE), as the Implementing Agency which owns the recovery and recycling units, shall institute a year-long training and service program in association with service operators throughout the country. It is the intention of the Department of Environment for industry to take the lead in refrigerant recycling prior to the implementation of any regulatory measures to ban the import of CFC-based equipment. This regulatory measure is expected to be implemented in five (5) years time.

Use of recovery/recharge equipment subsequent to the implementation of such regulatory measures shall be based on a cost recovery basis when units are leased to service operators.

It should also be noted that while considerations regarding the cost of refrigerants will have a strong influence on retrofitting or replacing existing chillers, this project will be able to achieve immediate reductions in the amount of ODS released into the atmosphere through its provision of incentives based on recycling. Nevertheless, certain effective regulatory measures may eventually be needed to complement the measures included within the scope of this project. Educating chiller users on issues relating to the environment can be more effective in the long term and should be carried out on a continuous basis.

SCHEDULE

Six months lead time for the tender and procurement of equipment is required prior to the implementation of the program.

REQUIRED REGULATORY ACTIONS

At present, the Government of Malaysia levies varying duties on imported equipment. Because duties and taxes are considered transfer payments between organizations rather than true economic costs, the Multilateral Fund does not consider such costs as incremental. Hence, in order to reduce the total costs incurred by Intitri, it is recommended that the Malaysian government waive the import duty for all equipment supplied for this project.

RESULTS

Direct Project Impacts

Eliminating the loss of 105 MT of CFC's annually into the atmosphere. This estimate is based on the ability of the project to successfully reach 90% of the CFC-11 and CFC-12 chillers in

Malaysia, and a recycling efficiency of 85% (see "Sector Background" for details).

Of the 105 MT of CFCs eliminated under the project, it is estimated that 70 MT will be eliminated as a result of the recycling network, and that the remaining 35 MT will be eliminated through improved service and maintenance practices, supported by the training component of the project.

Indirect Project Impact

Long term educational and ethical awareness of good conservation practices to be carried out in order to minimize damage to the environment.

THE MALAYSIA CHAPTER OF ASHRAE's COMMITMENT

The Chapter is committed to its founding objectives of advancing the science and practice of heating, refrigerating and air-conditioning in the country and towards a better environment.

ANNEX A
Capital Costs (US$)

(A) Network for Recycling and Recovery Units

	ITEM	COST
1.	30 CFC-11/12 recovery/recharge units (capacity of 1,300 lbs. of CFC)	@ $13,000 per unit = $390,000
2.	Spare parts and tools (15%)	@ 15% of $390,000 = $58,500
3.	Repair and maintenance of recycling units after warranty period.	$4,000
4.	Portable CFC detectors (30 units)	@ $350 per unit = $10,500
5.	Shipping and Insurance	@ 20% of total equipment costs = $91,800
	Sub total	**$554,800**

(B) Training of Local Trainers & Engineering

	ITEM	COST
1.	Preparation of training manuals, teaching aids and facility preparation	$15,000 (UNEP To Provide)
2.	Expert consultant - Travel & Lodging - Technical Assistance Services	$30,000 (UNEP To Provide)
3.	Technician training program at 4 regions (costs for consumables & labor)	$20,000
4.	Sponsorship of Regional Seminar/Workshop on CFC Recycling (150 participants)	$15,000 (UNEP To Provide)
5.	Translation of workshop materials into Malay	$3,000
	Subtotal	**$83,000**

TOTAL INVESTMENT COSTS $637,800

ANNEX B
Incremental Operating Costs (US$)

Annual net incremental operating costs will represent the cost of maintaining two seconded staff to carry out management and maintenance of equipment. The total annual cost of the staff is $62,400.

Four-year Incremental Operating Costs: $249,600

Net Present Value over four years[2]: **$197,800**

2 At a discount rate of 10%

ANNEX C
Unit Abatement Cost

A. ODS Savings

ODP of CFC-11 and CFC-12	1.0
CFCs Phased out	105 MT
Economic Life of Project	10 years
Average Annual ODS Phased Out	105 ODP-weighted MT

B. Incremental Capital Costs

Total investment costs	$583,800
Annualized incremental capital costs	$94,034

C. Net Annualized Incremental Operating Costs $62,400

UAC ($/kg ODP phase out) 1.49

Malaysia

REVIEW OF A TRAINING/RECOVER/RECYCLE PROJECT

Training, recovery and recycle during chiller servicing in Malaysia

Modified Proposal by the World Bank, February 1995

RTU-UNWB-LK-95/080-lk

Scope

The project under review covers the set up of recovery and recycle operations in Malaysia, together with training courses for engineers.

Technology and organisation

Recovery and recycle of the quantities of refrigerant lost during servicing of chillers is important. If it concerns quantities in the order of 200 metric tonnes, as mentioned in the project proposal, the set up of a recycle network is worthwhile and cost effective. However, it **requires that recovery is made compulsory.**

It is considered appropriate to organise this network under the MASHRAE organisation, which organisation has well-established links to the ASHRAE organisation in the US (where many chiller experts are members).

Training is required, indeed. Detailed consideration of the training needs yields the correct conclusion that this should be part of the training programme for chillers which is conducted by UNEP/IE PAC; it is adequately addressed in the proposal.

Environmental impact

Reduction of the emissions of CFCs has a positive environmental impact. Health and safety impacts are not different from the normal servicing operation.

Quantities recovered

The proposal mentions that 1470 chiller units are in operation in Malaysia, containing 766 tonnes of CFCs. Acceptable figures are given concerning the number of CFC-11 and CFC-12 chillers; also regarding their regional distribution.

The average chiller leakage is assumed to be 8%, which is a correct estimate, given the number of CFC-11 and CFC-12 chillers. Taking into account the leakage, and the amount of of refrigerant which is assumed to be recoverable (re-usable), the calculated impact of 105 metric tonnes annually is correct. This comes from both recovery and reuse, and from better practices.

Project costs

No comments to the costs for the recovery and recycling units.

As mentioned in the proposal, UNEP IE/PAC will be involved in the good practice and chiller maintenance training; this at a certain cost, which will be provided by UNEP. In how far it is possible to consider a contribution by chiller owners (who will spent less on CFC material) to the training conducted by UNEP IE/PAC and MASHRAE ?

The calculation of the UAC value is correct, although it needs to be updated if more data from the training costs will be available.

It is assumed that UNEP IE/PAC also reviews this modified proposal.

Operating costs

Incremental operating costs are stated to be due to maintaining two seconded staff at USD 62,400 annually, for management and servicing purposes; this is correct. It is also stated that the net cash flow due to the CFC amounts recovered is not transferred to MASHRAE,

but is used as a stimulus to perform the recycling and recovery operation. In principle this can be agreed to.

The proposal correctly mentions that a logbook should be kept by the contractors and should be controlled by MASHRAE. The amount that can be recovered equals about 70,000 kilograms, which represents a value of 150-200,000 USD. This should be taken into account (in particular since these large amounts could introduce certain practices, amongst which "double-counting").

Once the recovery is common practice -after a year or so- one could consider a contribution to MASHRAE in case equipment is made available to an organisation (which is reasonable, since the operating costs will apply to e.g. one year).

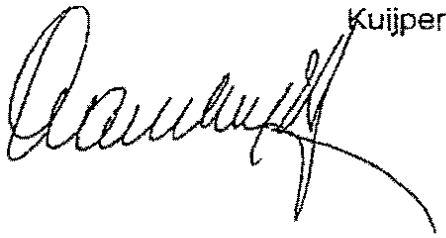
Recommendations

The instalment of recycle and recovery equipment, and training is recommended, provided the adequate attention is given to the savings that are involved in reducing the CFC consumption.

The above is recommended in the assumption that UNEP IE/PAC has an opportunity to review the final proposal.

Eindhoven, 16 February 1995

Kuijpers, L.J.M.



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COUNTRY:	Malaysia
PROJECT TITLE:	Phase Out of CFC-12 Mobile Air Conditioner (MAC) System Production Equipment and Conversion to HFC-134a MAC System Manufacturing
SECTOR COVERED:	Mobile Air Conditioning
ODS USE IN SECTOR:	1,200 MT (New equipment and servicing)
PROJECT IMPACT:	Phase out of 120 ODP-Weighted MT of CFC-12
PROJECT DURATION:	4 years
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	ODS Reduction Investment Costs: US$ 2,885,548 Incremental Operating Costs: US$ 2,462,761 Total Project Costs: US$ 5,348,309
GRANT EFFECTIVENESS:	US$ 20.18/ODP-Weighted kg of ODS Phased Out
REQUESTED OTF FINANCING:[1]	US$ 2,495,000 as grant
IMPLEMENTING ENTERPRISE:	Nippondenso Capital SDN BHD
COORDINATING MINISTRY:	Malaysian Department of the Environment (DOE)

PROJECT SUMMARY

This project will phaseout 120 MT of CFC-12 consumption in the MACs sector, by converting MAC production at Nippondenso Capital Sdn Bhd from units compatible with CFC-12 to units compatible with HFC-134a. The plant currently manufactures MACs for both the Original Equipment Market (OEM) and the Replacement Equipment Market (REM), and is the leading producer of MACs in Malaysia. Nippondenso has already begun conversion of its plant, and this project provides retroactive financing for these efforts and sufficient funds for Nippondenso to complete its conversion to non-ODS MAC production.

TECHNICAL ASSESSMENT

This project was approved by the OORG MACs reviewer on May 14, 1995. The preliminary review of February 13, 1995 approved the compressor portion of the project and sought confirmation on the start date of the conversion of the condenser line to assess whether the technology being converted to was appropriate at that time. In addition, the reviewer requested more details about the receiver drier, piping and hose lines and suggested that an HFC-134a recovery program be included to minimize global warming impacts. The revised proposal had addressed all of these issues. Moreover, following the MAC OORG working group meeting guidelines released in February, 1995, the revised proposal has also reduced the requests for technical assistance training, eliminated the request for incremental operating costs but added a request for funding of incremental royalty costs.

PROJECT OBJECTIVE

[1] Includes 15 percent contingency and 3 percent financial agent fee. Incremental operating costs are not being requested.

The objective of this project is to assist in the phaseout of CFC-12 in the MAC sector by targeting upstream production of CFC-12 MAC equipment at Nippondenso. To achieve this objective, the project will support the introduction of HFC-134a MAC manufacturing facilities at Nippondenso Capital Sdn Bhd, the largest supplier of MAC units to the automobile industry in Malaysia.

SECTOR BACKGROUND

CFC-12 is widely used in the MAC industry in Malaysia. It is used as coolant in air conditioning systems for a wide variety of vehicles, including passenger cars, commercial vehicles, trucks and buses. The Malaysian Country Programme has identified the MAC and refrigeration sectors as the main consumers of ODS in Malaysia, as compared to the electronics, foams and aerosols sectors. It is estimated that the MAC and refrigeration sectors represent 49 percent of total ODS consumption. To address CFC-12 consumption in the MAC sector, Malaysia has already developed a CFC-12 MAC recycling project, which has received Executive Committee approval and is currently being implemented. This project, however, will focus on stabilizing and reducing the stock of CFC-12 using vehicles at the point of manufacturing, rather than on preserving the supply of CFC-12 available for the existing stock of CFC-12 using vehicles currently on the road. It will also provide an effective complement to MAC recycling efforts, ensuring that CFC phaseout in the Malaysian MAC sector will target both current and future consumption.

ENTERPRISE BACKGROUND

Nippondenso Capital Sdn Bhd is a Malaysian Incorporated Company with the following equity structure:

Paid up Capital:	MR$6,300,000.00
Equity Structure:	73 percent Malaysian
	27 percent Foreign (ND Japan)

Currently, Nippondenso Capital Sdn Bhd is the market leader in the manufacture and distribution of automotive and bus air conditioners in Malaysia. Major customers at the OEM level for passenger cars include the following:

Customer	Percentage of Supply	
Proton (National car)	55	
Toyota	100	
Daihatsu	100	
Ford	100	
Honda	100	(Accord)
Volvo	100	(850)
Mercedez	100	(Compressor)
Others	30	

To date, Nippondenso is estimated to supply 60-65 percent of the total market for automobile MACs in Malaysia. Nippondenso is also the market leader in the manufacture of bus air conditioners. Based on 1993 sales figures, Nippondenso's domestic sales constituted 86 percent of total sales, while export sales constituted 14 percent. Nippondenso's main export markets are Thailand, Indonesia, Pakistan, and Singapore. Exports to Thailand are carried out mainly under the BBC and ASEA-PTA scheme. In 1992, total sales were valued at RM 118 million per year, and it is expected that total sales will increase by over 13 percent to RM 134 million per year by 1993. Nippondenso Capital Sdn Bhd currently employs approximately 320 people for its MACs operations.

Nippondenso's annual production of MACs for passenger cars is approximately 110,000 -

120,000 units. Current installed production capacity is approximately 10,000 units per month if based on 2-1.2 shift, and monthly sales are currently estimated at 6,000 units (complete MAC systems). Local manufacturing content is also very high, estimated to be 60 percent by value. Major component parts such as compressors, evaporators, condensers, hoses and plastic casings are all locally produced or assembled.

With the phaseout of CFC-12 production worldwide, and the resulting reduction of CFC-12 imports to Malaysia, Nippondenso will be able to play a leading role in introducing CFC-free technologies to the Malaysian MACs sector by developing a manufacturing capacity for MAC units based on HFC-134a. As the current market leader in MACs production in Malaysia, and having established close existing relationships with many Malaysian car firms, it is estimated that almost all car models currently dependent upon Nippondenso's MACs will be converted to HFC-134a air conditioning systems through this project. For CFC-free manufacturing operations, Nippondenso Capital Sdn Bhd and Nippondenso Japan have a technical agreement which covers the various technical aspects of phaseout and conversion. A copy of the technical agreement is attached.

PROJECT DESCRIPTION

This project will support Nippondenso's efforts to complete conversion of its existing CFC-12 MAC production to HFC-134a MAC production. Nippondenso actually *began conversion of its factory in late-1992*, and had *completed conversion of the CFC-12 compressor and condenser lines to HFC-134a by the end of 1994.*

As an upstream project to eliminate the overall capacity for CFC-12 use in the MACs sector, this project will lead to indirect phaseout of CFC-12 refrigerant. The project will lead to indirect phaseout of 120 MT of CFC-12 per year by eliminating the production of new MAC units based on CFC-12 refrigerant, with the exception of those required for warranty purposes.

Section A below describes Nippondenso's current or "baseline" production, while Section B describes Nippondenso's post-project HFC-134a production.

A. Baseline Description: Current Production

The Nippondenso plant currently produces complete MAC systems (units), and manufactures (or assembles/welds) all major system components. The following are the major MAC components which Nippondenso currently manufactures for its assembly of complete MAC units:

- compressors (assembly)
- evaporators
- condensers - (these have already been converted to HFC-134a)
- receiver/drier (assembly/welding)
- compatible piping lines
- compatible hose lines

Note: The first column of Annex A lists all equipment currently used to produce CFC-12 components.

B. Post-Project Description: New Production

Nippondenso will continue to produce or assemble all major components of its new HFC-134a MAC units. All six (6) major component production and assembly lines listed above will be converted entirely to HFC-134a MAC production, with the exception of the compressor line, which will require both the existing CFC-12 production line and a new HFC-134a line. Parallel production for CFC-12 and HFC-134a compressors will continue over the four-year life of the project, due to CFC-12 MAC

warranties and existing market claims, which will represent 10% of Nippondenso's compressor production. All other component parts that have been converted for compatibility with HFC-134a can be sufficiently altered for CFC-12 use without the need for maintaining existing CFC-12 production.

Nippondenso will use its project grant funding to convert its current CFC-12 MAC production line to a line compatible with the manufacture and assembly of HFC-134a MAC units. It should be noted that the first stages of conversion began in 1992 and continue through the present (see "Project Implementation Schedule" below), and technology choices therefore *reflect the best information available at the time the project began and conversion was initiated.*

A detailed description of each component of the conversion project is provided below:

New Production Line for HFC-134a MAC Units

Design changes and manufacturing process modifications will have to be made for nearly all of the MAC system components (with the exception of the evaporator) due to significant changes in the physical characteristics and properties of the new refrigerant. As a result of conforming to recommended international SAE standards for HFC-134a MAC units, Nippondenso has had to make a number of product design and manufacturing process changes in order to meet all recommended specifications. Many of these changes are based on the following general HFC-134a incompatibilities with current CFC-12 systems:

- Compressor oils: conventional oils are not compatible with HFC-134a compressors;
- Water solubility: HFC-134a is more water soluble, increasing water content -- a change in desiccant material also affects the design of the receiver drier;
- Materials: swelling and permeability of hoses and seal materials is more pronounced with HFC-134a due to increased water content;
- System Pressure: greater system pressure in HFC-134a MAC systems require certain modifications, including a new pressure switch.
- Fittings: the new HFC-134a system must incorporate modified fittings for system components as a result of the changes in refrigerant physical properties.

In light of these general incompatibilities, and in order to convert factory production to the HFC-134a compatible MAC units that reflect *international SAE standards* for HFC-134a systems, the plant has already begun undertaking the following specific process changes (see "Project Implementation Schedule" below), and has begun investing in equipment where indicated[2]:

1) Compressor Assembly: The baseline CFC-12 compatible compressor line manufactured compressors which were incompatible with HFC-134a. Several key modifications to the current HFC-134a compressors were taken into account, in order to conform to international SAE standards. Based on these standards, the new HFC-134a compressors are being manufactured to accommodate:

   - synthetic rather than mineral oils used in current CFC-12 compressors
   - new types of seals which are not soluble in HFC-134a (nitrite butadiene to RBR)
   - modified joint valves with different diameters (flare to "O" ring)
   - new pressure switches

2 Technical documentation for certain aspects of component conversion are attached in Annexes D, E, and F, for reference.

Nippondenso has fully implemented conversion of the compressor line by installing the equipment listed below, during 1993-94. All equipment listed was required to conform to recommended SAE international automotive engineering standards for system integrity and operation.

- helium leak testing equipment
- moisture testing equipment
- gas charging equipment
- oil charging equipment
- degreasing tank
- performance testing equipment

Note: A detailed equipment list and budget is attached as Annex A, and conversion dates are included in the Project Implementation Schedule below. Technical information including diagrams and technical specifications are included in Annex D.

2) Evaporator Manufacture: No equipment investments will be required for manufacturing evaporators. The only change in design will involve changing the joints used in order to prevent wrong connections, and this can be done without added equipment.

3) Condenser Manufacture: The old condenser line produced condensers that were not compatible with HFC-134a. A redesign of the condenser was necessary for HFC-134a MAC production. This redesign began in 1992 and was completed by the end of 1994. The funding request for this portion of the project is therefore entirely retroactive. New condensers must be manufactured to accommodate:

- new multi-flow design which will enable the condenser to have an increased heat releasing efficiency, to attain cooling performance equivalent or higher than conventional systems. The multi-flow design ensures a higher heat exchange efficiency, while conventional condensers are of the single-pass type. This modification is necessary due to the higher pressure setting of the HFC-134a system.
- a lowered fin height and decreased tube thickness, due to multi-flow design.
- joint changes to prevent wrong connections.

The above design modifications to the condenser result in an overall increase in condenser size. Whereas the old condenser was based on a "serpentine" system, the new condenser uses a "multi-pass" (parallel flow) system, which is currently recommended as the best alternative design. Due to the redesign of the component, new equipment investments have been made in order to accommodate these changes in component specifications, as follows:

- tube bending machine
- tube cutting machine
- fins forming equipment
- hand bending bench
- leakage testing equipment
- parts caulking equipment

Note: A detailed equipment list and budget is attached as Annex A, and conversion dates are included in the Project Implementation Schedule below.

4) FF Receiver Drier Assembly/Welding: The receiver drier will be redesigned for compatibility with the size and technical requirements of the new HFC-134a MAC system, in order to conform to international SAE standards for HFC-134a systems. Significant modifications will be made as a result of the *change in desiccant material* (described below), which results in

both design and manufacturing process changes. The following is a listing of the items on the receiver drier manufacturing line that will require modification and/or equipment investment in order to ensure that Nippondenso's new HFC-134a receiver driers conform to the international automotive engineering standards mentioned above:

- filter plate assembly
- drier filling
- body spinning
- TIG welding
- leak testing procedures

A parts list comparison between BG (R-12) and FF (R-134a) receiver driers is shown in Table 1 in Annex E, along with other general technical documentation. The CFC-12 receiver drier assembly line consists of nine production steps while the HFC-134a assembly line consists of twelve production steps. A comparison between the BG and FF completely-knocked-down (CKD) parts used during the in-house assembly process is also shown in Figure 1, Annex D. The in-house assembly processes for BG and FF receiver driers are compared in Table 2, and illustrated in Figures 2 and 3, Annex E. Technical justifications for process changes and equipment are as follows:

Filter Plate Assembly: Whereas bags of silica gel were used in the BG (R-12) process, the FF (R-134a) process requires a change in desiccant type, which in turn requires the use of zeolite molecular sieves. In the FF system, the increased moisture content due to the greater solubility of R-134a requires a complete change of desiccant material. *Zeolite bags are not practical because of insufficient moisture absorption properties.* Because zeolite molecular sieves are measured and filled into the housing body, it is necessary to retain these sieves by means of the lower and upper filter plates (c.f. Fig. 3). These requirements have imposed an additional process step for filter plate assembly. Different jigs are, in addition, required to hold the housing bodies.

Drier Filling: With the introduction of zeolite molecular sieves for the FF process, it is necessary to procure filling equipment which can dispense a premeasured amount of zeolite material into the housing body. This necessitates the drier filling equipment listed in Annex A.

Body Spinning: The design (and shape) of the receiver drier will be modified by Nippondenso in order to accommodate the change in desiccant material (from silica gel bags). As described above, the previous CFC-12 system relied on bags of desiccant which were placed inside the receiver drier. The new system, in order to effectively conform to SAE standards, has been designed so that desiccant is filled into the body of the receiver drier. This requires that the housing body must be spun following the filling of the zeolite desiccant material directly into the body of the receiver drier (c.f. Fig. 3), in order to increase the efficiency of moisture absorption. This step is not required for the BG process, but is required in the FF process. The housing body could not be imported as a pre-spun CKD component because of the filling design described above.

TIG Welding: The BG production process involves MIG welding which simply joins the housing body and cap together (Fig. 2). The FF welding process, known as TIG welding, involves the union of the receiver cap and the housing body, which have different dimensions and wall thicknesses than the BG cap and housing body (Fig. 3). The MIG welding process is not feasible for use in the FF process, per the following factors:

- Difference in housing body thickness and receiver caps. The MIG welding process is not suitable for the thinner housing walls of the FF receiver driers.
- Greater defect/reject rate in production.
- Different receiver drier dimensions, requiring different welding equipment.

- Need to maintain MIG welding equipment for parallel production of R-12 receiver driers to accommodate warranty requirements.

Leak Testing: At present, Nippondenso uses N_2 leak testing equipment for the BG process. However, due to the inherently different properties of CFC-12 and HFC-134a, Nippondenso will incorporate higher-precision leak-testing equipment into its manufacturing process. This will ensure that Nippondenso will conform to recommended international (SAE) engineering standards for leakage and system integrity, and will be allowed to continue producing MAC units which are consistent with its existing technical standards.

Note: A detailed equipment list and budget is attached as Annex A, and scheduled conversion dates are included in the Project Implementation Schedule below. All technical documentation for the receiver drier line is attached in Annex E.

5) Piping Line: In order to conform to international SAE and ISO standards, several aspects of the piping system, including *redesigned pipe specifications and connections* (piping blocks and joints), will require equipment investment. Most significant are the changes in bulging equipment from one based on a 2P design to equipment based on an 8P design, and other changes as a result of the need for unique fittings for the modified HFC-134a system. Detailed technical documentation for the required modifications are included in Annex F, attached.

Equipment investments required to convert the piping line to an HFC-134a design are:

- 8P bulging machine
- 8P bulging die
- block joint caulking
- bulging process machine

Note: A detailed equipment list and budget is attached as Annex A, and conversion dates are included in the Project Implementation Schedule below.

6) Hose Lines: Hose lines will also require modifications in order to conform to international SAE and ISO standards, including changes in *connections, threads and fittings* specific to HFC-134a systems. Both hose and piping lines must adjust to the higher pressure and increased water content of an HFC-134a system. Hose size will be modified to accommodate increased system pressure, and pipe ends will be coated with rubber in order to prevent slippage in the new nylon-lined HFC-134a hose. Due to the existing procurement channels available to Nippondenso in Malaysia, its baseline manufacturing system requires the purchase of various parts of the hosing line from different sources. Since it is not possible to obtain hosing which is suitably pre-coated with rubber within the baseline procurement process, it must invest in rubber-coating equipment in order to adapt to the requirements of the HFC-134a system.

The attached diagrams in Annex F describe the technical differences and process requirements involved in the conversion to HFC-134a systems. The following new equipment will be required to adapt hose lines to the HFC-134a system:

- crimping machine
- rubber coating machine

Start-up Assistance and Training

In order to ensure that the conversion of the manufacturing line is carried out effectively, Nippondenso Japan will provide start-up assistance and training to its plant in Malaysia. Technical assistance is currently provided through a technical assistance agreement between Nippondenso

Japan and Nippondenso Malaysia. A copy of this technical assistance agreement, which includes discussion of the cost structure ("Technical Assistance Agreement Between Nippondenso Co., Ltd. and Nippondenso Capital Sdn. Bhd."), is attached as Annex G for reference.

Technical assistance for the manufacturing conversion at Nippondenso Malaysia will include expert consulting, design assistance, and process support from Nippondenso Japan. The costs of start-up assistance are summarized below based on figures from the years 1992-1994. Component manufacturing lines benefiting from technical assistance are shown in parentheses:

Year	Technical Assistance Fee to Nippondenso Japan (USD)
1992	$13,575 (compressor, condenser, piping)
1993	$18,400 (compressor, condenser, piping)
1994	$13,320 (receiver drier, hosing, piping)

In addition to component-specific technical assistance, one of the chief manufacturing staff at the Malaysia plant and an assistant will undertake overseas training at Nippondenso Japan. The costs for training in Japan reflect one trip for two technicians, for a total of approximately $7,800 USD.

Costs for start-up technical assistance and training are included in section F of the detailed budget, which is attached as Annex A.

Incremental Royalty Costs

Per the guidance provided by the OORG MAC Working Group, Nippondenso is also seeking a one time reimbursement for incremental royalty costs. It was recommended by the WORKING Group that royalty fees be compensated only to the degree to which they exceed on a per unit basis those which may previously been levied against CFC-12 MAC production and that such fees should be calculated on the basis of two years at the current production level. After deducting taxes, in 1994, Nippondenso Japan charged US$2.19 for a complete CFC-12 MAC and US$2.75 for a complete HFC-134a. Per the terms of Nippondenso's agreement, the per unit royalty costs are fixed at 2.5 percent of the selling price net of all applicable. Nippondenso produces and sells 6,000 complete units each month. Nippondenso therefore requests a one time incremental royalty cost of US$80,640.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

HFC-134a is widely accepted among the automotive industry as the most viable alternative refrigerant to CFC-12 for use in MACs. HFC-134a is a zero ODP alternative.

For the small remaining portion of Nippondenso's MAC manufacturing and services business designated to after-market CFC-12 systems, Nippondenso will incorporate CFC-12 recycling equipment into its plant and distributor network. Nippondenso has already installed HFC-134a recovery equipment at all authorized distributor and service sites, due the global warming potential (GWP) of HFC-134a.

The World Bank's designated Local Financial Intermediary in Malaysia will require, in writing, verification of the final disposition of all baseline equipment included in the manufacturing conversion project. Verification will include the following:

- proof of equipment *incorporation into modified manufacturing processes*; or
- proof of payment for scrap sales (estimated no to exceed US$ 10,000); and
- proof that scrapped equipment was not sold with the intent to be reincorporated into CFC-12 MAC manufacturing.

PROJECT COSTS

As described below, and detailed in the relevant annexes, the total project cost over the first four years of the project (investment costs and net incremental costs) is US $5,348,309.

Investment Costs: Investment costs of US $2,885,548 are detailed in Annex A.

Net Incremental Operating Costs: Although net incremental operating costs of US $2,462,761 are projected over the first four years of the project, no reimbursement for incremental operating costs have been included in Nippondenso's grant request.

However, for purposes of documentation, net incremental operating cost calculations are provided in detail in Annex B. These costs are equal to the net present value of the first four years of incremental operating costs, and reflect the difference in baseline and new unit production costs multiplied by the number of units for the years 1995-98, and a ten percent discount rate.

Other Costs: A 15 percent contingency was also included to ensure adequate funding of project costs following project appraisal. An additional three percent 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 overall project costs are calculated as follows: the total investment cost is added to the present value of incremental operating costs over the first four years of the project. Note that because Nippondenso is not requesting funds to cover incremental operating costs, for the purpose of calculating contingency, fee and grant, the total project cost is assumed to be only the investment costs. The adjusted total project cost is multiplied by the percentage of Malaysian ownership (73 percent). This figure is increased by a 15 percent contingency to yield the grant amount. Finally, this figure is increased by 3 percent to account for the financial institution fee. The resulting total is US $2,495,090. The company has agreed to cover any additional costs above its approved grant amount using its own funds.

UNIT ABATEMENT COST (UAC)

As derived from Annex C, the UAC calculated over the ten year life of the project is US $3.91 per ODP-weighted kg of ODS phased out. This number is derived from the incremental annualized capital costs of US $469,610, the net annualized incremental operating costs (none requested), and annual savings of approximately 120 ODP-weighted MT of ODS.

REQUIRED REGULATORY ACTIONS

At present, the Government of Malaysia levies varying duties on imported equipment. Because duties and taxes are considered transfer payments between organizations rather than true economic costs, the Multilateral Fund does not consider such costs as incremental. Hence, in order to reduce the total costs incurred by Nippondenso, it is recommended that the Malaysian government waive the import duty for all equipment supplied for this project.

Per the guidance of the MAC OORG Working Group meeting of January, 1995, Nippondenso will not be seeking reimbursement for incremental operating costs. It is suggested that these costs could and should be passed on to the OEM manufacturers. However, it is important to note that in Malaysia, recovery of these costs by the MAC manufacturers may be difficult because automobile prices are regulated by the Government. Specifically, because MAC units are considered a standard accessory, the Ministry of Trade and Industry must first approve an increase in the price of automobiles. It is recommended, therefore, that the Ministry of Trade and Industry approve an increase of approximately US$10 in the price of automobiles to enable MAC manufacturers to pass on the incremental operating cost of MAC production.

RESULTS

This project will eliminate the use of at least 120 MT of ODP-weighted MT of CFC-12 in the first year of implementation.

PROJECT IMPLEMENTATION SCHEDULE

TASK	1993	1994	1995	1996
Develop R-134a compressor production line	X	X		
Convert to R-134a condenser line	X	X		
Convert to R-134a receiver drier line			X	X
Convert to R-134 compatible piping line	X	X	X	
Convert to R-134a compatible hose line			X	X
Complete manufacturing conversion				X
Follow-up visit from international MACs expert				X

Baseline Production Equipment	New Equipment for R-134a Production	US($)
C) FF RECIEVER DRIER		
1 Press Fitting M/C		
2 Drying Oven for dryer		
3 Semi-Auto MIG Welder		
4 Press Fitting		
5 Leakage Checking		
6 Argon Arc Welder	1 Leak Testing Equipment	$50,000
	2 Tig Welding Equipment	$307,227
	3 Holder Assy 1	$10,937
	4 Dryer Filling Equipment	$12,177
	5 Holder Assy 2	$10,032
	6 Holder Caulking Equipment	$62,674
	7 Body Spining Equipment	$430,117
	8 Center Caulking Equipment	$68,819
	9 Jigs and Tools	$201,094
	Total	$1,153,077
D) PIPING LINE		
1 2P Bulging Machine	1 8P Bulging Machine	$72,846
2 Chamfering Machine		
3 2P Bulging Die	2 8P Bulging Die	$42,968
4 Couplers		
	3 Block Joint Caulking Equip.	$71,048
	4 Bulging Process machine	$27,344
	Total	$214,205
E) HOSE LINE		
1 Crimping Machine	1 Crimping Machine	$35,155
2 Press Fitting M/c		
3 Hose/Connector m/c		
4 Hose uncoiler		
5 Drying Oven		
6 Leak Tester		
	2 Rubber Coating machine	$390,625
	Total	$425,781
F) Start-up Technical Assistance and Training		
1 Specialized Training for R-134a A/C System Manufacturing at Nippondenso Japan (one trip for two technical staff)		$7,813
2 Technical assistance from Nippondenso Japan for Manufacturing Conversion		$45,299
1992 (compressor, condenser, piping line)		$13,674
1993 (compressor, condenser, piping line)		$18,404
1994 (receiver drier, piping and hosing lines)		$13,320
	Total	$53,111
H) One Time Incremental Royalty Costs		
2 Years of incremental Royalty Costs at Current Production Level		$80,640
TOTAL INVESTMENT COST		$2,885,648

ANNEX B
Net Incremental Operating Costs/Savings (US$)

COST ITEM	1995	1996	1997	1998
Baseline (per unit)				
Compressor	163.31	163.31	163.31	163.31
Condenser	37.90	37.90	37.90	37.90
Evaporator	9.86	9.86	9.86	9.86
Piping Line	62.27	62.27	62.27	62.27
Receiver Drier	7.41	7.41	7.41	7.41
Hose Line	14.13	14.13	14.13	14.13
TOTAL	**294.88**	**294.88**	**294.88**	**294.88**
Post-Project (per unit)				
Compressor	167.77	167.77	167.77	167.77
Condenser	29.41	29.41	29.41	29.41
Evaporator	14.66	14.66	14.66	14.66
Piping Line	68.50	68.50	68.50	68.50
Receiver Drier	8.17	8.17	8.17	8.17
Hose Line	16.25	16.25	16.25	16.25
TOTAL	**304.76**	**304.76**	**304.76**	**304.76**
Incremental Operating Costs (per unit)				
Compressor	4.46	4.46	4.46	4.46
Condenser	-8.48	-8.48	-8.48	-8.48
Evaporator	4.79	4.79	4.79	4.79
Piping Line	6.23	6.23	6.23	6.23
Receiver Drier	0.75	0.75	0.75	0.75
Hose Line	2.12	2.12	2.12	2.12
TOTAL	**9.87**	**9.87**	**9.87**	**9.87**
Net Incremental Operating Costs (# of units x per unit incremental operating cost)	67,405 units x 9.87 = **665,287**	75,600 x 9.87 = **746,172**	82,700 x 9.87 = **816,249**	93,160 x 9.87 = **919,489**

NPV @ 10 percent (4 years)	**US $2,462,761**

ANNEX C
Unit Abatement Cost

A. **ODS Savings**

ODP of CFC-12	1
Use of CFC-12 in 1994	120 MT
Economic Life of Project	10 years
Average Annual ODS Phased Out	120 MT

B. **Incremental Capital Costs**

Total Investment Costs	US $2,885,548
Annualized Incremental Capital Costs	US $469,610

C. **Net Annualized Incremental Operating Costs** none requested

UAC (US$/kg ODP phaseout) = 3.91

COUNTRY OF ORIGIN: MALAYSIA

PROJECT TITLE: Phase Out of CFC-12 mobile Air Conditioner (MAC) System Production Equipment and Conversion to HFC-134a MAC System Manufacturing.

SECTOR COVERED: Mobile Air Conditioning

IMPLEMENTING ENTERPRISE: NIPPONDENSO CAPITOL SDN BHD

RELATIONSHIP TO COUNTRY PROGRAMME: This proposal appears to be compatible with the country's action plan, and the sectorial strategy.

TECHNOLOGY:

A). The environmental, safety, and technical considerations are based on the best technology available and are as recommended by all automotive technical societies and all automotive companies the writer is aware of.

B). The technology proposed is not considered transitional. The proposals go directly to the system and refrigerant accepted universally as the standard for the foreseeable future. There is no intermediate refrigerant considered acceptable by the industry.

C). There appears to be adequate provision for competent technical support.

ENVIRONMENTAL IMPACT:

The use of HFC-134a to replace CFC-12 is recognized as the most effective approach to reducing ODS.

The identification of the funding dedicated to washing equipment and exhaust equipment attest to these concerns. The proposal includes a request for waste water treatment funds.

PROJECT COSTS:

Some expenditures have been made in before technology confirmed the need, including compressor testing. Some costs are to improve component integrity and to conform to S.A.E. standards.

The document acknowledges the obligation of accountability for salvage and disposition of replaced equipment.

IMPLEMENTATION TIMEFRAME:

The implementation time frame appears reasonable and appropriate.

RECOMMENDATIONS:

I recommend the commitments made be approved, and the balance of the program be approved as proposed.

OORG REVIEWER.....R. L. PROCTOR.

DATE.....MAY 14, 1995

COUNTRY:	Malaysia
PROJECT TITLE:	Phase-Out of CFC-12 Mobile Air-Conditioner System (MAC) Manufacturing Equipment and Conversion to HFC-134a MAC System Manufacturing Equipment
SECTOR COVERED:	Mobile Air Conditioning
ODS USE IN SECTOR:	1,200 MT (New equipment and servicing)
PROJECT IMPACT:	Phase out of 80 ODP-weighted MT of ODS (75 ODP-weighted MT of CFC-12 and 5 ODP-weighted MT of 1,1,1-Trichloroethane)
PROJECT DURATION:	4 years
PROJECT ECONOMIC LIFE:	10 years
TOTAL PROJECT COST:	ODS Reduction Investment Costs: US $1,071,072 Incremental Operating Costs/(Savings): US $2,026,469 Total Project Costs: US $3,097,541
COST EFFECTIVENESS:	US $2.18/ODP-Weighted kg of ODS phased out
REQUESTED OTF FINANCING[1]:	US $1,268,700 as grant
IMPLEMENTING ENTERPRISE:	APM Air-Conditioners Sdn Bhd ("APMAC")
COORDINATING MINISTRY:	Malaysian Department of the Environment (DOE)

PROJECT SUMMARY

This project will phase out a total of 80 ODP-weighted MT per annum of ozone depleting substances (ODP) in the Malaysian MAC sector. The project will phase out 72 ODP-weighted MT of CFC-12 per annum by converting CFC-12 MAC manufacturing system to systems based on HFC-134a. The project will also phase out 3 ODP-weighted MT of CFC-12 used during line testing of CFC-12 MAC systems. In addition, the project will phase out approximately 5 ODP-weighted MT per annum of 1,1,1-trichloroethane (TCA) which is presently used in the CFC-12 MAC manufacturing process. As an upstream project targeting the capacity to produce MAC systems based on CFC-12, the project will achieve its phaseout goals indirectly, by converting the MAC manufacturing equipment at APM Air-Conditioners Sdn Bhd (APMAC). APMAC is seeking Ozone Trust Fund (OTF) grant financing to provide manufacturing equipment necessary for conversion only.

TECHNICAL ASSESSMENT

This project is being submitted to the OORG reviewer for his final review. Preliminary reviews of May 13, 1995 and June 4, 1995 sought more information on the background of the German company (Dynamics) which will be providing the technology transfer and clarifications on the costs of training and waste water treatment. The reviewer also requested more details about the condenser brazing section and that the last section of the investment costs be streamlined to take into account of the OORG guidelines. The revised proposal of June 6, 1995 has addressed all of these issues.

[1] Includes 15 percent contingency and 3 percent financial intermediary fee. Incremental operating costs are not being requested.

PROJECT OBJECTIVE

The overall objective of this project is to phase out the use of CFC-12 in the MAC sector by converting existing local CFC-12 MAC production facilities at APMAC to HFC-134a MAC production facilities.

SECTOR BACKGROUND

CFC-12 is widely used in the MAC industry in Malaysia. It is used as coolant in air conditioning systems for a wide variety of vehicles, including passenger cars, commercial vehicles, trucks and buses. The *Malaysian Country Programme* (Update 1994) has identified the MAC and refrigeration sectors as the main consumers of ODS in Malaysia, as compared to the electronics, foams and aerosols sectors. It is estimated that the MAC and refrigeration sectors represent 52 percent of total ODS consumption (estimated at 8876 MT in 1994), while solvents represent 31 percent, and foams 13 percent. The MAC sector consumed approximately 1171 MT of CFC-12 in 1994. APMAC is one of five MAC component manufacturers in Malaysia, the others being Nippondenso, Sanden, UCM and Patco.

Malaysia already has one Executive Committee-approved project in the MAC sector. However this project encompasses only recycling of an estimated 370 MT of CFC-12 in order to preserve the supply of CFC-12 required for vehicle already using CFC-12. The APMAC conversion project, however, will focus on stabilizing and reducing the stock of CFC-12 using vehicles at the point of manufacture. It will also provide an effective complement to MAC recycling efforts, ensuring that CFC phaseout in the MAC sector will target both current and future consumption.

ENTERPRISE BACKGROUND

APM Air-conditioners Sdn Bhd (APMAC) is a 100% Malaysian owned company with a paid-up capital of US $200,000. It is a subsidiary of Tan Chong Holdings Bernad, a public listed company. In 1994, APMAC recorded a turnover of US $14,400,000. Currently, APMAC employs 220 people in different areas related to its MAC production lines. APMAC has a maximum installed production capacity of 72,000 MAC systems per annum.

APMAC started its CFC-12 mobile air-conditioning system and component production in 1981 and has been a Malaysian Standard/ISO 9002 accreditated company since 1992. Many of its APMAC's MAC systems are developed locally but APMAC has an existing technical assistance agreement to acquire the CFC-12 serpentine technology with Zexel Corporation, Japan.

APMAC supplies original equipment market (OEM) systems and components, estimated at approximately 25% of its total production figure of 72,000 MAC components (condensers and evaporators) in 1994 to Nissan, Subaru, Audi, Ford, Chrysler, Cherokees, Isuzu and Citroen. Since the third quarter of 1994, APMAC has been exporting a small number of CFC-12 MAC systems to Indonesia (estimated at approximtely 240 units of CFC-12 MAC systems). APMAC also exports MAC components (condensers or evaporators) for the replacement equipment market (REM) to countries in the Asia-Pacific region such as Thailand, Singapore, China, Taiwan, South Korea and Hong Kong. However, the export component (condensers) to Non-Article 5 countries, averaged from 1992 to 1994 is estimated at only 4% of the total condenser production.

APMAC has an existing waste water treatment facility (for treating hexavalent chromium in waste water) which has an installed treatment capacity of 20 m^3/shift. This works out to a treatment capacity of approximately 3 m^3/hr for an 8-hour shift.

PROJECT DESCRIPTION

In December 1994, APMAC decided to invest in new equipment to manufacture parallel flow condensers for HFC-134a MAC systems. Due to the different physical properties of HFC-134a, and in

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order to conform to *International Society for Automotive Engineers' (SAE)* standards. APMAC has decided to convert to parallel flow (PF) condensers. APMAC has targetted implementation of its parallel flow HFC-134a MAC components production beginning from June 1995 onwards. As such, it will be seeking only minimum OTF financing to enable it to produce HFC-134a PF condensers which also included modification to its existing waste water treatment plant. APMAC is also seeking retroactive OTF financing for some equipment which has already been ordered for the purpose of producing HFC-134a PF condensers.

For the HFC-134a PF condensers, APMAC has opted to secure professional expertise to enable itself to produce such condensers. In this respect, APMAC has identified a German company (Dynamics) who will transfer the necessary technology (one-time buy off) for the production of PF condensers. A summary of the technology to be transferred to APMAC as well as some additional information about Dynamics is enclosed as Annex E.

As an upstream project to eliminate the overall capacity for CFC-12 use in the MAC sector, this project will lead to an indirect phaseout of CFC-12 refrigerant. The project will indirectly lead to the downstream elimination of 72 ODP-weighted MT of CFC-12 per year (based on 1994 production figure of 72,000 MAC systems with an average charge size of 1kg per MAC unit), and approximately 3 ODP-weighted MT used during line testing of completed MAC systems) by significantly decreasing the production of new MAC units based on CFC-12. In addition, the project will also lead to the direct phase out of 50 MT (5 ODP-weighted MT) of 1,1,1-TCA used in the cleaning of formed fins and tubes.

This conversion project will make equipment and/or process changes to the following components of the manufacturing line:

- Condenser Tube Cutting and Fin Forming
- Condenser and Evaporator Assembly
- Condenser and Evaporator Cleaning
- Condenser and Evaporator Brazing
- Piping Forming and Bulging
- Final Assembly Process (Line Testing)

Condenser Tube Cutting and Fin Forming

In HFC-134a MAC, the most crucial part that must be modified in order to maintain similar cooling capacity as a CFC-12 MAC is the heat exchange system which comprises of the condenser and the evaporator. APMAC has opted to produce the parallel flow (PF) condensers which require smaller heat exchanging surface area for superior heat exchanging rate. The evaporator component does not require much modification for the HFC-134a MAC system and as such, APMAC will not be requesting for any OTF financing for this component. Note that APMAC has paid for training in its evaporator conversion using its own funds.

In the CFC-12 condensing unit, the condensing unit is formed by two components: main corrugated tubes and heat exchanging fins. The evaporators and condenser tubes are bent into a serpentine shape for existing CFC-12 units. For PF condensers, the condenser tubes are first straightened as they come in rolled form and precut according to the specified lengths according to the condenser type to be produced. These precut tubes are to be joined to the main condenser tube during the assembly process described later. It is very important that the cuttings made to the condenser tubes are free from chips which would otherwise cause blockages, severely impairing the performance of the condensers.

APMAC has recently ordered a serpentine tube bending machine for bending its evaporators which could easily be retrofitted for the process changes described above for the PF condensers. This would involve primarily the acquisition of tube rollers (required to straighten the rolled condenser tubes) and the addition of carbide-type cutters (required for "chipless" cutting of PF condenser tubes). As such, APMAC is requesting OTF financing for the following:

- Procurement of tube rollers c/w toolings

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- Procurement of carbide-type tube cutters c/w toolings

In the fin forming process for CFC-12 MAC systems, the heat exchanging fins for serpentine condensers and evaporators are formed from cladded aluminium foils. In the HFC-134a MAC systems, the heat exchanging fins are of different dimensions and thickness. APMAC's existing fin forming machine (Itaya, Japan) cannot be retrofitted to support the production of the HFC-134a MAC fins. In order to carry out the process change associated with fin forming, APMAC is requesting OTF financing for:

- Procurement of an automatic fin corrugating machine c/w form roll

Condenser and Evaporator Assembly

In CFC-12 MAC systems, the serpentine condensers and evaporators are manually core-assembled, i.e., the heat exchanging fins are fixed between the serpentine tubes, and the necessary pipe connections and jigs/fixtures are attached. The core-assembled condensers and evaporators are then brazed using the vacuum brazing process. For the PF condensers, the precut condenser tubes and the heat exchanging fins have to be fixed into precise positions in order to conform to international SAE standards. Because of the multiple joints involved for the PF condensers, this process has to be done by semi-auto process where workers would manually position the tubes and fins followed final joining of the tubes by a core assembly machine. Manual joining of the tubes and fins prior to brazing is not applicable due to the greater reject rates. In addition, new jigs would be required due to the change in dimensions between the CFC-12 condensers and PF condensers. In order to carry out this process change, APMAC is requesting OTF financing for the following:

- Procurement of a core assembly machine (semi-auto)
- Jigs for assembly

Condenser and Evaporator Cleaning

At present, APMAC uses 1,1,1-trichloroethane (1,1,1-TCA) coupled with ultrasonic cleaning to clean cutting oils from the formed fins and tubes of the CFC-12 condensers and evaporators. In 1994, APMAC consumed approximately 50 MT (5 ODP-weighted MT) of 1,1,1-TCA for its cleaning operations. As 1,1,1-TCA is also an ozone depleting substance, APMAC will also phase out the use 1,1,1-TCA in its cleaning process for the HFC-134a PF condensers. In conformance to international SAE standards, APMAC intends to replace its existing ultrasonic cleaning operation utilizing 1,1,1-TCA with a corresponding pre-flux cleaning equipment which uses an alkaline base cleaning and deionized water. The cleaning equipment, which is part and parcel of the nocolok brazing furnace unit, comprise of a deionized water cleaning machine, fluxing unit, flux dryer and brazing furnace. Details of the pre-flux cleaning equipment is attached as Annex D.

Waste water is expected from the operations of this pre-flux cleaning equipment. APMAC is presently conducting feasibility tests with the assistance of local consultants to determine the modifications required to its existing waste water treatment facility to treat the waste waters produced from its alkaline based pre-flux cleaning process. To accomodate the change in the cleaning process to phaseout 1,1,1-TCA, APMAC is requesting OTF financing for:

- An alkaline based pre-flux cleaning process (part of the cost included together with the nocolok furnace unit
- Modifications to existing waste water treatment facility

Because wastewater effluent produced is a result of both condenser and evaporator cleaning, funding requested for waste water treatment modifications has been reduced by 50 percent.

Condenser and Evaporator Brazing

For the CFC-12 condensers and evaporators, APMAC uses the vacuum brazing process to seal the heat exchanging fins to the main tubes. In order to conform to international SAE standards for the

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HFC-134a PFCs, APMAC will be using the non-corrosive flux brazing (nocolok) process. This necessitates a continuous nocolok brazing furnace.

APMAC has found that it is more cost-effective to operate only one type of brazing process and it has decided to convert its vacuum brazing process for its present serpentine evaporators to the no-colok brazing process. This change in the brazing process would have a brazing capacity of 12,000 MAC condensers and evaporators per month as against the present brazing capacity of 6,000 MAC condensers and evaporators per month. Note that although brazing capacity increases, other modifications to condenser assembly and fin forming sections will not have an impact on condenser production capacity. APMAC realises that since there is an increase in brazing capacity and that there is no process change in the design of its evaporators which accounts for half of the brazing operations, it will therefore be eligible for OTF financing to cover 25% of the investment cost required fo the nocolok brazing furnace (viz., for the condenser section) and is willing to cover the other 75% of investment cost on its own resources. The change in the brazing process therefore necessitates the following:

- Procurement of a nocolok brazing furnace unit (25% of total cost requested)

Piping Forming and Bulging

In order to conform to international SAE standards for HFC-134a MAC systems, pipes with previously flared-end required for the CFC-12 MAC system need to be changed to the 'O'-ring bulge end which is accomplished using a new 6-punch process. As the new refrigerant, HFC-134a has smaller molecular structure, tighter seals would be required to guard against leakage. The piping connectors have to be changed to the 'O'-ring and bulged type. The hosing material also have to be changed to one which would not react with HFC-134a. All these design changes explain the respective request for a new pipe bulging machine and a new hose caulking machine, complete with the attendant toolings required. In addition, additional sets of crimping dies would be required. In summary, APMAC is seeking OTF financing for the following items to accommodate the process change described above:

- Procurement of a pipe bulging machine c/w dies and toolings
- Procurement of a hose caulking machine c/w dies and toolings

Final Assembly Section (Leak Detection and Line Testing)

Following the brazing process, both the condensers and evaporators would be examined against any possible leaks. For the HFC-134a condensers and evaporators, leak testing will be performed using portable helium leak testers due to the inherent differences in the physical properties of HFC-134a. In order to conform to International SAE standards, APMAC will request OTF financing for:

- Procurement of two units of portable helium leak-test kits

Technical Assistance and Training

APMAC has opted for a one-time buy off of the necessary technology for its HFC-134a MAC PF condenser manufacturing. It has identified a German company, Dynamics Project Engineering who is willing to provide the technical know-how on HFC-134a PF condenser. Some of the materials required for PF condensers will be secured through Helmut Lingemann GmbH & Co. (Helima). A copy of the details of technology transfer together with estimated costs, and some background information on Helima are attached as Annex E.

The technology transfer will include expert consulting, design and development assistance, and start-up process support. In addition, three chief manufacturing staff will undertake a one-time overseas training at Germany in line with the guidelines of the OORG MACS Working Group. The costs for technical training in Germany is approximately US $10,000 per person but as APMAC is requesting for 50 percent of this cost since it has paid for its evaporator conversion using its own funds. The three staff are expected undertake the in-house training of APMAC's staff and trouble-shooting during the actual implementation of the project.

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JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

HFC-134a is internationally accepted as the most viable alternative refrigerant to CFC-12 for use in MAC. HFC-134a is also a zero ODP alternative.

The World Bank's designated Local Financial Intermediary in Malaysia, will require, in writing, verification of the final disposal of all baseline equipment included in the manufacturing conversion project. This will include the following:

- Proof of equipment incorporation into modified manufacturing process;
- Proof of payment for scrap sales; and
- Proof that scrapped equipment was not sold with the intent to be reincorporated into CFC-12 MAC manufacturing.

PROJECT COSTS

As described below, and detailed in the relevant annexes, the total project cost over the first four years of the project (investment costs and net incremental costs) is US $3,097,541.

Investment Costs: Investment costs of US $1,071,072 are detailed in Annex A.

Net Incremental Operating Costs: Although net incremental operating costs of US $2,026,469 are projected over the first four years of incremental operating costs, no reimbursement of incremental operating costs have been included in APMAC's grant request.

A more detailed breakdown of the operating costs and the assumptions used for each year of the project are provided in Annex B for purposes of documentation. These costs are equal to the net present value of the first four years of incremental operating costs discounted at a ten percent discount rate.

Other Costs: A 15 percent contingency (US $160,661) was also included to ensure adequate funding of project costs following project appraisal. An additional 3 percent (US $36,952) 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 overall project costs are US $3,097,541; this amount reflects the sum of the total investment cost and the net present value of the incremental operating costs over the first four years of this project.

Note that because APMAC is not requesting funds to cover incremental operating costs, the requested OTF grant is US $1,268,700. This amount was derived as follows: the total investment costs was increased by a 15 percent contingency to yield the grant amount. This figure was then increased by 3 percent to cover the financial institution fee. APMAC has agreed to cover any additional costs above its approved grant amount using its own funds.

UNIT ABATEMENT COST (UAC)

As derived from Annex C, the UAC calculated over the ten year life of the project is US $2.18 per ODP-weighted kg of ODS phased out. This number is derived from the incremental annualized capital costs of US $174,311 and annual savings of approximately 80 ODP-weighted MT of ODS.

REQUIRED REGULATORY ACTIONS

At present, the Government of Malaysia levies varying duties and taxes on imported equipments. Because duties and taxes are considered as transfer payments between organizations rather than true

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economic costs, the Multilateral Fund does not consider these costs as incremental. Hence, in order to reduce the total costs incurred by APMAC, it is recommended that the Malaysian government waive the import duties for all equipment supplied for this project.

Following the recommendations of the MACS OORG Working Group meeting of January 1995, APMAC will not be seeking reimbursement for incremental operating costs. However, it is suggested that these costs could and should be passed on to the OEM manufacturers. It is important however, to note that recovery of the incremental operating costs by the MAC manufacturers may be difficult because automobile prices are regulated by the Government. MAC units are considered a standard government approved accessory and is usually included in the price of the automobile. For this reason, any increase in the price of the automobile must first be approved by the Malaysian Ministry of Trade and Industry (MITI). It is recommended, therefore, that MITI approves an increase of approximately US $8 in the price of automobiles to enable the APMAC to pass on the incremental operating cost of its MAC production.

RESULTS

This project will eliminate the use of at least 75 ODP-weighted MT of CFC-12 and 5 ODP-weighted MT of 1,1,1-TCA for the MAC sector during the first year of implementation. Market and company growth indicate that these values might increase in the subsequent years.

PROJECT IMPLEMENTATION SCHEDULE:

TASK	1995	1996	1997	1998
Procurement of equipment :				
• PFC tube rollers and carbide cutters	X			
• Automatic fin corrugating machine	X			
• Semi-auto core assembly machine	X			
• Continuous nocolok brazing furnace	X			
• Pipe bulging machine	X			
• Hose caulking	X			
• Helium portable leak testers	X			
One time overseas training to Germany (3 persons)		X		
Production schedule :				
• Piping	60%	100%	100%	100%
• Hosing	60%	100%	100%	100%
• Evaporator (serpentine)	100%	100%	100%	100%
• Parallel flow condenser		50%	75%	100%
Follow-up visit from International MAC expert				X

ANNEX A

INVESTMENT COSTS FOR HFC-134A PRODUCTION

I. EQUIPMENT

Condenser Assembly and Fin Forming Section	Capacity Replacement	Cost (US$)
• Tube rollers and carbide cutters	100%	26,250
• Automatic fin corrugating machine c/w form roll	100%	322,560
• Core assembly machine (semi-auto)	100%	210,000
	Sub-total :	**558,810**
Piping and Hosing Section		
• Pipe bulging machine c/w die toolings	100%	50,232
• Hose caulking machine c/w die toolings	100%	30,030
	Sub-total :	**80,262**
Condenser Brazing Section		
• Continuous nocolok brazing furnace c/w deionized water for pre-flux cleaning	*25%	273,000
* *Total cost : US $1.09 million. APMAC is only claiming for the PF condensers component which accounts for 25% of the furnace brazing as it will bear the other 75% investment cost (for brazing of the serpentine evaporators which do not require any change from existing design and, an expected increase in brazing capacity).*		
• Jigs for assembly	100%	52,500
	Sub-total :	**325,500**
Waste Water Treatment		
• Modifications costs to existing waste water treatment plant	50%	**10,500**
Leak Detection & Line Testing		
• Portable helium leak-tester kits (2 units)	100%	**31,000**

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II. TRAINING		Cost (US$)
• One-time overseas training in HFC-134a MAC systems (for 3 chief manufacturing staff to Germany)	50%	15,000

III. TECHNOLOGY TRANSFER AGREEMENT (Details in Annex E)

• Technology transfer assistance Dynamics Project Engineering, Germany: - Consulting - Design - Information/Process support	50,000

TOTAL INVESTMENT COST : US $1,071,072

ANNEX B

NET INCREMENTAL OPERATING COSTS/(SAVINGS) FOR HFC-134A PRODUCTION (US$)

COST ITEM	1995	1996	1997	1998
Baseline* (per unit) :				
• Condenser	26.00	26.00	26.00	26.00
• Evaporator	26.50	26.50	26.50	26.50
• Piping	10.41	10.41	10.41	10.41
• Hosing	21.47	21.47	21.47	21.47
TOTAL	**84.38**	**84.38**	**84.38**	**84.38**
Post-project* (per unit) :				
• Condenser	21.00	21.00	21.00	21.00
• Evaporator	30.00	30.00	30.00	30.00
• Piping	13.42	13.42	13.42	13.42
• Hosing	27.70	27.70	27.70	27.70
TOTAL	**92.12**	**92.12**	**92.12**	**92.12**
Incremental Operating Costs (per unit) :				
• Condenser	(5.00)	(5.00)	(5.00)	(5.00)
• Evaporator	3.50	3.50	3.50	3.50
• Piping	3.01	3.01	3.01	3.01
• Hosing	6.23	6.23	6.23	6.23
TOTAL	**7.74**	**7.74**	**7.74**	**7.74**
Net Incremental Operating Costs : (No. of units x per unit incremental operating costs)	72,000 units x US $7.74 **US $557,280**	79,200 units x US $7.74 **US $613,008**	87,120 units x US $7.74 **US $674,309**	95,832 units x US $7.74 **US $741,740**

NPV @ 10 percent (4 years)	**US $2,026,469**

* *Estimate based on raw material costs only*

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ANNEX C

UNIT ABATEMENT COST (UAC)

ODS Savings

ODP of CFC-12	1.0
Use of CFC-12 in 1994	72 MT (indirect) + 3 MT (direct)
Economic Life of Project	10 years
Average Annual ODS Phased Out	75 ODP-weighted MT
ODP of 1,1,1-TCA	0.1
Use of 1,1,1-TCA in 1994	50
Economic Life of Project	10 years
Average Annual ODS Phased Out	5 ODP-weighted MT
Total Annual ODS Phased Out	**80 ODP-weighted MT**

Incremental Capital Costs

Total Investment Costs	US $1,071,072
Annualized Incremental Capital Costs	US $174,311
Net Annualized Incremental Operating Costs	none requested

UAC (US$/kg ODP phase-out) : 2.18

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COUNTRY OF ORIGIN: MALAYSIA

PROJECT TITLE: Phase Out of CFC-12 Mobile Air Conditioner System (MAC) Manufacturing Equipment and Conversion to HFC-134a MAC System Manufacturing Equipment.

IMPLEMENTING ENTERPRISE:
APM Air-conditioners Sdn Bhd ("APMAC")

SECTOR COVERED: Mobile Air Conditioning

RELATIONSHIP TO THE COUNTRY PROGRAM:
This project proposal appears to be compatible with a total program focused at the elimination of the use of CFC-12 as a MAC refrigerant.

TECHNOLOGY:
The technology uses HFC-134a as a refrigerant, which is considered the only acceptable alternative at this time. Standards and specifications have been published by recognized international technical associations.

The condenser design is acknowledged by OORG as the most favored design .

The manufacturing technology is procured from a recognized source.

A major redirection of the manufacturing facility, including increases in production capacity and replacement of vacuum brazing operations used to manufacture evaporators, is being modified to include the requirements for the use of HFC-134a refrigerant. The requested funding is for the modifications to the condenser assembly line. The increases in production capacity and changes to the evaporator design are being funded by the enterprise.

ENVIRONMENTAL IMPACT:

The reduction in CFC emissions projected in the proposal are reasonably attainable. The proposal replaces an environmentally inert vacuum brazing process with one which requires waste water treatment, and includes a funding requirement.

page 2 of 2, Maliaysia, APM Air conditioners Sdn Bhd ("APMAC")

PROJECT COSTS:

The proposed costs appear reasonable, however the allocation of expense between 1) manufacturing capacity increases, 2) evaporator design changes, 3) changes to accommodate parallel flow condensers, 4) piping changes, and 5) changes to conform to the recognized international standards for use of HFC 134-a, will be challenging. The only segments recognized as conforming to the OORG recommended practices is the parallel flow condenser, piping modifications and conformance to recognized International Standards.

The proposal implies training and technology transfer is prorated, waste water treatment, and some manufacturing equipment is not.

IMPLEMENTATION TIME FRAME:

The proposed implementation time frame is reasonable. Some retroactive financing is requested in the proposal.

RECOMMENDATIONS:

The OORG reviewer recommends approval of this project provided funding allocation and accountability can be effectively achieved.

OORG REVIEWER----------R. H. PROCTOR.

REVIEW DATE----------9 JUNE, 1995

COUNTRY:	Malaysia	
PROJECT TITLE:	Conversion of Metal Cleaning Process from 1,1,1-Trichloroethane (TCA) to Hydrocarbons	
SECTOR COVERED:	Solvent Cleaning	
ODS USE IN SECTOR:	500 MT of CFC-113 in 1993 2620 MT of 1,1,1-TCA in 1993 662 MT of Total ODP-weighted consumption	
PROJECT IMPACT:	Phaseout of 33.6 MT of TCA (3.36 ODP-weighted MT)	
PROJECT DURATION:	1 year.	
PROJECT ECONOMIC LIFE:	15 years.	
TOTAL PROJECT COST:	ODS Reduction Investment Costs: Incremental Operating Savings: Total Project Costs:	US $130,000 US $15,215 US $114,785
GRANT EFFECTIVENESS:	US $38.50/ODP-weighted kg of ODS phased out	
REQUESTED OTF FINANCING[1]:	US $133,200 as grant	
IMPLEMENTING ENTERPRISE:	**Eng Teknologi Sdn. Bhd.**	
COORDINATING MINISTRY:	Malaysian Department of the Environment (DOE).	

Includes 15 percent contingency and 3 percent financial agent fee.

PROJECT SUMMARY

This project will eliminate 33.6 MT of 1,1,1-trichloroethane currently used in the metal cleaning process at Eng Teknologi Sdn Bhd by converting its existing metal cleaning process from TCA to hydrocarbon based solvent. The project will provide Eng Teknologi Sdn Bhd with two units of solvent degreaser equipment which will allow Eng Teknologi to continue with its current metal cleaning process. As the choice of replacement solvent is combustible, Eng Teknologi will undertake various safety modifications at its plant.

TECHNICAL ASSESSMENT

This project proposal was approved by the OORG technical reviewer on February 21, 1995.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of TCA in metal cleaning by switching to non-ozone depleting hydrocarbon solvent.

SECTOR BACKGROUND

The solvent cleaning sector in Malaysia uses mainly CFC-113 and 1,1,1-trichloroethane (TCA). CFC-113 had been used for solvent cleaning in the electronics, semiconductor, electrical and metal industries with a total consumption figure of 1441 MT ODS in 1989. Since 1990, with increasing awareness on CFCs especially among the multinational companies the total consumption of CFC-113 had declined by 65% to 500 MT in 1993.

Meanwhile, TCA has been used as a substitute for CFC-113 and its consumption figure rose from 54 MT in 1989 to 2620 MT in 1993, representing a 4752% increase. The largest users of TCA are in the correction fluids industry and, the degreasing and metal cleaning industry. Many of the enterprises using TCA for

degreasing are small and medium-scaled industries (SMIs). Nevertheless, it is projected that there would be drastic switch-over away from TCA to non-ODS alternatives in order to remain competitive in the international market, especially in view of labeling requirements being instituted in some developed countries.

ENTERPRISE BACKGROUND

Eng Teknologi Sdn. Bhd. is a manufacturer of jigs and fixtures, tools and dies and precision metal products. The company employs 220 people and is located in Penang. It is 100 percent Malaysia owned and was established in 1979. In 1993, the company reported revenues of approximately US $8 million.

In 1993, Eng Teknologi Sdn. Bhd. consumed 33.6 metric tons (MT) of TCA. Eng typically operates two 8-hour shifts per day and 6 days per week. The operating schedule may change depending on demand. The precision metal parts manufactured contain cuttings, tapping oils and particulates which need to be cleaned before these parts are shipped to customers.

Eng Teknologi Sdn. Bhd. currently uses 2 vapor degreasers in its cleaning operations. The TCA vapor degreasers clean approximately 2 million parts per month. These parts are used by local manufacturers in the hard disk drive industry.

PROJECT DESCRIPTION

For this project, Eng Teknologi Sdn. Bhd. will eliminate its use of TCA by removing the two existing vapor degreasers and replacing them with hydrocarbon degreasers. The capacity of the equipment to be purchased is approximately the same as the existing TCA vapor degreasers. The conversion to non ozone-depleting technology consists of the following elements:-

1. Process development and material compatibility tests.
2. Retrofitting.
3. Purchase of 2 batch ultrasonic cleaning machines for use with hydrocarbon solvents/refractometer.
4. Safety.
5. Disposal.

1. PROCESS DEVELOPMENT AND MATERIAL COMPATIBILITY TESTS

Prior to the purchase of new equipment, Eng Teknologi Sdn. Bhd. has performed material compatibility and process development tests to select the optimal cleaning equipment and cleaning solvents. The company has evaluated items such as changes in worker function and compatibility of materials such as substrate and coatings with the new solvents.

In addition, the company has tested the effectiveness of the single solvent system, where only one solvent is necessary to clean and dry parts and found the results to be acceptable. After the new cleaning equipment has been purchased and installed, additional tests may have to be carried out to optimize the cleaning process.

Eng Teknologi Sdn. Bhd. will replace the 2 existing vapor degreasers at Plot 69, Persiaran Kampung Jawa, Bayan Lepas Non-Free Trade Zone, 11900 Bayan Lepas, Penang, Malaysia.

2. RETROFITTING

Eng currently has two units of ultrasonic vapor degreasers. Eng considered retrofitting existing degreasers and for forced drying, add an air-blow and vacuum oven drying stations. The retrofitting will require changing pumps, dismantling heaters, grounding, adding chiller system, sensors and alarm systems. The retrofitting is not only cumbersome but cost is not substantially different from a new hydrocarbon system. A retrofitted system is not visually appealing and may be subjected to ridicule by their customers who will audit the cleaning systems. Additionally, retrofitted equipment usually do not come with warranty. Eng decided to use new hydrocarbon cleaning equipment.

3. BATCH ULTRASONIC CLEANING MACHINES/REFRACTOMETER

The hydrocarbon cleaning equipment consists of multiple tanks. The process includes rinsing with ultrasonic agitations followed by 2 rinse with cleaner solvents, air blowing to remove excess solvents on the parts and, vacuum oven drying. The cycle time is dependent on part configurations (complexities, blind holes etc.), cutting fluids (amounts, viscosities) and customers' specifications. The cycle times for the different parts have been evaluated and range from 1 to 3 minutes per tank.

A refractometer measuring equipment is required to measure the oil content in the hydrocarbon solvent. The refractive index measured is compared against a master refractive index versus oil content chart. As the range of refractive indices for both oil and solvent are close, it is necessary to use a refractometer with high resolution.

4. SAFETY

Combustion occurs when 3 elements are present: presence of combustible vapor in sufficient concentration, ignition source and air (specifically oxygen). Removal of any one of these 3 elements will thus prevent combustion.

To displace oxygen, it will be necessary to blanket the equipment with an inert gas such as nitrogen. This is an expensive option. It is therefore more practical to focus on the other 2 elements.

The equipment incorporates design to remove ignition sources by indirect heating of the oven, grounding and removing static electricity build-up. In addition, there will be training on good housekeeping practices to ensure that there are no ignition sources such as welding and smoking in the vicinity and, sign boards warning of fire hazards are to be prominently displayed.

The vapor concentration at room temperature is insufficient for combustion to occur because of the relatively low evaporation rate (and high flash point) of the solvent. At elevated temperatures, evaporation rate increases. The equipment has chilling features in the tank and vacuum suction in the oven to ensure that vapor concentration at worst does not exceed specified percent of LEL. Measurements of vapor concentrations at worst case locations in the oven and above solvent surfaces of similar working designs indicate that vapor concentrations are within specified % of LEL.

In addition, temperature sensors and alarms are included to warn against breakdown of equipment. Given the low vapor concentration (of about 10% of TLV-TWA and LEL) in the working environment, it is essentially not necessary to incur additional cost in improving existing facility ventilation.

5. DISPOSAL

Spent hydrocarbon solvents are disposed through licensed contractors who use the solvents as additive to low-grade paint or blended into fuel oil for turbines and kilns.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

1. SELECTION OF REPLACEMENT CHEMICALS

The following groups of chemicals were considered for the replacement of TCA.

(i) Chlorinated solvents including methylene chloride (MC), perchloroethylene (PCE) and

trichloroethylene (TCE).

(ii) Hydrochlorofluorocarbon (HCFC).

(iii) Semi-aqueous system (alkaline/solvent/de-ionized water)

(iv) Hydrocarbon (HC)

(I) CHLORINATED SOLVENTS

Chlorinated solvents are known to be good replacement and can be used as drop-in for TCA with minor modifications to the equipment. These chemicals are however, very toxic (25-50 ppm Threshold Limit Value/Time Weighted Average) and very hazardous to workers' health. It will require substantial capital investments to seal the cleaning area and equipment and extensive ventilation system. In addition, it will be necessary to monitor very carefully workers' health by regular medical check-ups.

Should any worker's health be affected as a result of the chemicals, it will create complex liability issues and this will be disastrous for the company's reputation. There is also a general fear that these chlorinated solvents may come under increasing phase-out pressure in the future. It was thus decided that chlorinated solvents will not be used as replacements.

(II) HCFC

HCFC is also an ozone depleting chemical. The price is also prohibitive, estimated at 3 to 4 times that of TCA. Considering that 33.6 MT of TCA is consumed annually, operation cost is expected to increase substantially should HCFC be used. Moreover, HCFC has a long atmospheric life and its ODP means that it is not a long-term substitute for TCA. It was decided that HCFC will not be used as replacement.

(III) SEMI-AQUEOUS SYSTEM

This system utilizes an alkaline or solvent to degrease and deionized water (DI) for rinsing. Whilst this system offers safety and operation cost is not expected to differ significantly, heavy capital investments are required not only for cleaning equipment but also waste treatment system. The cleaning cycle-time will also be appreciably longer because of the slow drying water.

Maintenance of the alkaline mixture and DI water integrity are considered critical to ensure product cleanliness and reliability. Semi-aqueous system was thus not further considered as a possible alternative.

(iv) HYDROCARBON (HC)

Hydrocarbon offers 4 main advantages over semi-aqueous system namely :

(i) Degrease oil-based coolant more effectively.

(ii) Cycle-time is faster because it is more volatile.

(iii) Maintenance is easier requiring less control on process parameters.

(iv) Reliability (corrosion) is more consistent and less dependent on process parameters.

In addition:

The hydrocarbon solvents do not contain halogens and have an ozone depleting potential of zero.

The solvents have vapor pressures well below those of the halogenated solvents. Consequently, these low vapor pressures virtually eliminates fugitive emissions from the cleaning process:

Product	mm Hg (vapor pressure at 20 °C)
CFC 113	270
1,1,1-TCE	100
Hydrocarbon	0.03 to 3

Hydrocarbon solvents have low impact on aquatic environment. Unless used in semi-aqueous processes, the solvents will not come into contact with water except during spills. The solvents have very low water solubility and are also less dense than water. Thus during any accidental release, they will remain on the surface and evaporate off.

There are, however, 2 major obstacles to overcome; the relatively slower drying time of hydrocarbon compared to TCA and the combustible nature of hydrocarbon.

Hydrocarbon was preferred provided these obstacles can be satisfactorily addressed. These issues

are discussed under project description.

PROJECT COSTS

As detailed below, the total project cost over the first four years of the project (investment costs and net incremental savings) is US $114,785.

INVESTMENT COSTS of US $130,000 are detailed in Annex A. Eng Teknologi will not be requesting for a recycling equipment as the spent solvent will be disposed off as described under Section 5 of Project Description.

NET INCREMENTAL OPERATING SAVINGS. Given a ten percent discount rate, the net present value of the incremental operating cost minus the offsetting savings over the first four years of the project results in a net incremental operating savings of US $15,215. A more detailed breakdown of the operating cost and the assumptions used for each year of the project are provided in Annex B.

LOCAL OWNERSHIP FRACTION. The total project cost was multiplied by the fraction of local ownership (100%) to determine the eligible project cost.

OTHER COSTS. A 12% contingency was also included to ensure adequate funding of project costs following project appraisal. An additional US 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 requested OTF grant for Eng is US $133,200. The amount was calculated as follows: the present value of the net incremental operating savings over the first four years of the project were subtracted from the total investment costs. The resulting total project cost was multiplied by the percentage of Malaysian ownership. This figure was increased by a 12 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee. The company has agreed to cover any additional costs above its approved grant amount using its own funds.

UNIT ABATEMENT COST (UAC)

As derived in Annex C, the UAC calculated over the fifteen year life of the project is US $3.66 per ODP-weighted kg of ODS phased out. This number is derived from the incremental annualized capital costs of US $17,092, the net annualized incremental operating savings of US $4800 and an average annual savings of approximately 3.36 ODP-weighted MT.

REQUIRED REGULATORY ACTIONS

At present, the Government of Malaysia levies varying duties on imported equipment. Because duties and taxes are considered transfer payments between organizations rather than true economic costs, the Multilateral Fund does not consider such cost as incremental. Hence, in order to reduce the total costs incurred by Eng Teknologi Sdn Bhd, it is recommended that the Malaysian government waive the import duty for all equipment supplied for this project.

RESULTS

This project will eliminate the use of at least 3.36 ODP-weighted tons of ODS in the first year of implementation.

SCHEDULE

Eng Teknologi is committed to the phase out of its CFC-based degreasing process as soon as possible. The conversion of TCA to hydrocarbon solvent cleaning is expected to be implemented in the second quarter of 1995.

ANNEX A
CAPITAL COSTS

EQUIPMENT:

(2 units hydrocarbon degreasers comprising ultrasonic agitations, cooling systems, vacuum oven drying and programmable controllerat	US $116,000 US $58,000.00 per unit)
1 Unit Refractometer Measuring Equipment	US $10,000
Installation Costs	US $4,000
Scrap value of existing equipment	US ($1,500)

TRAINING:

Training for Eng Teknologi's Engineers (3 persons)	US $1,000

TRANSPORTATION:

Shipping and Insurance	US $500

TOTAL : US $130,000

ANNEX B
NET INCREMENTAL OPERATING COSTS

1. USAGE

In estimating the usage the following factors were considered:

1.1 Unlike the 1,1,1-TCA degreaser, the new hydrocarbon batch degreaser is not equipped with a recycling unit. Recycling trials indicate a drop in the cleaning efficiency of recycled solvent which affects cleanliness integrity of the parts. It was noted that Eng Teknologi's customers are hard disk drive manufacturers who assemble the parts in clean room environment and have critical cleanliness specifications.

1.2 The parts are individually jigged (not stacked and overlapped) and most carry-over hydrocarbon solvent are recovered at the air-blow station.

1.3 The relative slow evaporation rate of hydrocarbon solvent more than compensate for the loss in not recycling the solvent. Small scale trials and mass production runs of similar working designs indicate a saving of approximately 10% usage.

2. CHEMICAL

The costs of 1,1,1-TCA and hydrocarbon solvent are both about US $2.00/litre. It is necessary to compare cost based on volume rather than weight. The production volume is expected to be constant over the next 4 years. Baseline usage is approximately 24,000 litres and post project 21,600 litres per year.

3. INCREMENTAL OPERATING SAVINGS

The incremental operating savings under the proposed project are shown below:

YEAR	1	2	3	4
Baseline (US$)	48,000	48,000	48,000	48,000
Post-project (US$)	43,200	43,200	43,200	43,200
Savings (US$)	4,800	4800	4,800	4,800

NPV @ 10 percent (4 years) :US $15,215

ANNEX C
UNIT ABATEMENT COST

A. ODS SAVINGS

ODP of TCA	0.1
Use of TCA in 1994	33.6 MT
Economic Life of Project	15 years
Average Annual ODS Phased Out	3.36 ODP-weighted MT

B. INCREMENTAL CAPITAL COSTS

Total investment costs	US $130,000
Annualized incremental capital costs	US $17,092

C. NET ANNUALIZED INCREMENTAL OPERATING SAVINGS US $4,800

UAC (US$/kg ODP phase out) = US $3.66

DEPARTMENT OF ENVIRONMENT,
MINISTRY OF SCIENCE, TECHNOLOGY
AND ENVIRONMENT,
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JALAN RAJA LAUT,
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Our Ref: AS 91/120/004/
Your Ref: 011 Jld.1/(7)
Date: 8 June, 1995

Mr. Konrad von Ritter
Economist, Agriculture and Environment Division
Country Department 1
East Asia and Pacific Region
Washington, D.C 20433
USA

Dear Sir,

My Government would like officially to invite the World Bank as Implementing Agency and formally endorsed to carry out ODS phase out projects as belows:

i.	MASHRAE	} Already endorsed since 1993
ii.	NIPPODENSO	}
iii.	TENCHO	}
iv.	MONDIAL	
v.	BAN SENG LEE	
vi.	STAR FOAM	
vii.	TRANSFREEZE	
viii.	PENANG TRADING	
ix.	ENG TEK	
x.	AE TECH	
xi.	WIDETECH	

Thank you.

Yours sincerely,

(ISMAIL ITHNIN)
for the Director-General of the Environment,
Department of Environment,
Malaysia

B. H. BAXTER

FACSIMILE

ODS/MAP Proj
Eng & Tech

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Internet100044.564@compuserve.com

Date:.21.2.95.....

To:Abid Karmali.Mike.Zatz.
...David Hathaway.ICF
.cc.Tom.Waltz.WB.OORG.Coord.
....Konrad.von.Ritter.WB..
.....

No. of pages including cover page.5.

Gentlemen,

Please find appended my assessments of the proposals from AE Technology and Eng Technologi Sdn Bhd of Malaysia.

Kind regards

DATE: 2/22/95
ROUTING: JC/KVR
ASIA FILES (Y) OR (N)
LOG # 240

Bryan Baxter.

PLEASE NOTE CHANGE OF AREA CODE FROM (0)462 TO (0)1462

Ozone Operations Resources Group

TECHNICAL REVIEW

(Part 1: Malaysia AE Technology Salangor.)

1. **Country of origin:** Malaysia

2. **Project title:** Conversion of metal cleaning process from 1,1,1, trichloroethane (TCA)to hydrocarbon at AE technology Sdn. Bhd. in Salangor.

3. **Sector/sub-sector:** Solvent cleaning.

4. **Relationship to country programme:** Elimination 16.8 ODP weighted MT of TCA representing 2.3% of total sector use.

5. **Technology**

(a) Four options have been considered as substitutes for the existing TCA process. These were :-

Chlorinated solvents including methylene chloride (MC), perchlorethylene, (PCE), and trichloroethylene (TCE).

Hydrochlorofluorocarbons. (HCFC).

Semi-aqueous system (alkaline solution-deionised water)

Hydrocarbon.

Chlorinated solvents were eliminated on the primary grounds of toxicity and worker safety, with secondary consideration given to equipment costs and safety installations. (No consideration was given to the risk of eco- toxicity due to ground water contamination).

HCFC was eliminated due to ozone depletion potential and solvent costs, quoted as 3 to 4 times that of TCA.

Semi-aqueous cleaning although accepted as the safest, was rejected on the grounds of equipment costs and waste treatment costs.

Hydrocarbon solvent cleaning was the preferred option based on the following considerations:-

Effective with oil based coolant..

Short cleaning cycle time.

Simple maintenance.

Product reliability.

(b) The technology is not transitional.

(c) Feasibility of transfer to country.

(i) There is no formal technology transfer agreement.

(ii) There is no licensing agreement. There is a fee to cover the costs of a financial institution which would oversee procurement etc. of 3%.

(iii)Other technologies were considered, see above. The choice of the hydrocarbon option is probably best with regard to currently available technology and cost. However the use of trichlorcethylene **in a properly designed hermetically sealed cleaner system** would probably be better, but unfortunately the only available system (eg the German Dage machines) are expensive. In addition the use of such machines still requires proper disposal of the chlorinated solvent to avoid ground water contamination and therefore burning waste hydrocarbon as a fuel additive is probably the best option within the country in question. In the description of the process no mention is made of effluent scrubbing in the hot air drying of components which would give rise to considerable emissions of hydrocarbon and thus result in some direct global warming and low evel ozone formation. Exhaust cleaners could be considered as an option to overcome this.

(iv) The recommended technology is very cost effective.

6. Environmental Impact.

(a) The chosen technology has zero ODP. The direct GWP due to emission of hydrocarbon solvent vapours could be reduced by the installation of exhaust scrubbers. The indirect GWP due to power consumption is low due in part to the choice of a low temperature, non-distillation cleaning.

7.Project costs.

(a) All the cost components listed are essential to the process conversion. The proposed equipment will maintain the existing level of service.

(b) Because of the difference in physical and chemical properties of the replacement hydrocarbon compared with the current TCA, none of the existing equipment will be re-useable.

(c) Cost of equipment.
(i) All of the specified equipment specified is essential to the project.
(ii) The finding that all the baseline equipment should

be replaced is consistent with the recommended technology.

(iii) The requests for additional equipment is consistent with the project description.

(iv) None of the baseline equipment could be modified to perform needed in the replacement technology.

(v) The fate of scrapped equipment is not addressed in the proposal.

(vi) There is no calculation of scrap value of salvageable equipment.

(vii) The new equipment will maintain the existing level of service.

(d) Training and related costs.

Since the new system will not involve very different operating procedures, the in-house training will be sufficient.

(e) Operating costs.

(i) The installation of the new process will result in a nett incremental operating cost saving of $54,962.

(ii) All operating savings are included in the project.

(iii) The calculated level of savings are entirely consistent with those of similar projects.

8. **Implementation timeframe.**

The proposed implementation timeframe of 1 year is not unreasonable having regard to the scale of the work required.

9. **Recommendations.**

(a) Approval as proposed.

(b) Propose the installation of exhaust scrubbers on the component driers, if feasible.

(Part 2: Eng Technologie Sdn Bhd Penang.)

1. **Country of origin:**	Malaysia.
2. **Project Title:**	Conversion of Metal cleaning process from 1,1,1, Trichloroethane (TCA) to hydrocarbons.
3.**Sector/sub-sector:**	Solvent cleaning.
4.**Relationship to country programme:**	Phase-out of 3.36 ODP weighted MT

of TCA, represents 0.515 of total sector use.

Note: This proposal is virtually identical technically to the above proposal for AE technology apart from the decision not to use solvent recovery in the system. Having regard to the much smaller solvent consumption in this proposal (21,600 litres per annum compared with 108,000 litres per annum) and the fact that most of the carry over hydrocarbon solvent will be recovered at the air blow station, this would seem to be a sensible cost saving.

Consequently section 5. is identical with that for the previous assessment.

6. Environmental Impact.

(a) The chosen technology has zero ODP. The direct GWP has been effectively minimised by the entrapment of the vapours in the component driers.

7. Project costs. Comments as for the AE Technology report above.

8. Implementation timeframe.

The proposed time frame of 1 year is probably justified as similar equipment as that proposed for AE technology will have to be procured and installed and although of smaller operating size it will probably take a similar time to install and commission.

9. Recommendations.

Approval as proposed.

OORG Technical Reviewer: B. H. Baxter

Date review completed: 21st Feb 1995

COUNTRY:	Malaysia
PROJECT TITLE:	Conversion of Metal Cleaning Process from 1,1,1-Trichloroethane (TCA) to Non-Ozone Depleting Organic Solvents
SECTOR COVERED:	Solvent Cleaning
ODS USE IN SECTOR:	500 MT of CFC-113 in 1993 2620 MT of 1,1,1-TCA in 1993 662 MT of Total ODP-weighted consumption
PROJECT IMPACT:	Phaseout of 33.6 MT of TCA (3.36 ODP-weighted MT)
PROJECT DURATION:	1 year.
PROJECT ECONOMIC LIFE:	15 years.
TOTAL PROJECT COST:	ODS Reduction Investment Costs: US $125,500 Incremental Operating Savings: US ($11,538) Total Project Costs: US $113,962
GRANT EFFECTIVENESS:	US $38.50/ODP-weighted kg of ODS phased out
REQUESTED OTF FINANCING[1]:	US $133,200 as grant
IMPLEMENTING ENTERPRISE:	Ban Seng Lee Industries Sdn. Bhd. (BSLI)
COORDINATING MINISTRY:	Malaysian Department of the Environment (DOE).

PROJECT SUMMARY

This project will eliminate 33.6 MT (3.36 ODP-weighted MT) of 1,1,1-trichloroethane (TCA) currently used in the metal cleaning process at Ban Seng Lee Industries Sdn Bhd (BSLI) by converting its existing metal cleaning process from TCA to hydrocarbon based solvent. The project will provide BSLI with one unit of batch hydrocarbon degreaser equipment which will allow BSLI to continue with its current metal cleaning process. As the choice of replacement solvent is combustible, BSLI will undertake various safety modifications at its plant.

TECHNICAL ASSESSMENT

This project proposal was approved by the OORG Technical Reviewer on May 12, 1995.

[1] Includes 15 percent contingency and 3 percent financial agent fee.

PROJECT OBJECTIVE

The objective of this project is to eliminate the use of TCA in metal cleaning by switching to non-ozone depleting hydrocarbon solvent.

SECTOR BACKGROUND

The solvent cleaning sector in Malaysia uses mainly CFC-113 and 1,1,1-trichloroethane (TCA). CFC-113 had been used for solvent cleaning in the electronics, semiconductor, electrical and metal industries with a total consumption figure of 1441 MT ODS in 1989. Since 1990, with increasing awareness on CFCs especially among the multinational companies the total consumption of CFC-113 had declined by 65% to 500 MT in 1993.

Meanwhile, TCA has been used as a substitute for CFC-113 and its consumption figure rose from 54 MT in 1989 to 2620 MT in 1993, representing a 4752% increase. The largest users of TCA are in the correction fluids industry and, the degreasing and metal cleaning industry. Many of the enterprises using TCA for degreasing are small and medium-scaled industries (SMIs). Nevertheless, it is projected that there would be drastic switch-over away from TCA to non-ODS alternatives in order to remain competitive in the international market, especially in view of labeling requirements being instituted in some developed countries.

ENTERPRISE BACKGROUND

Ban Seng Lee Industries Sdn. Bhd. (BSLI) is a manufacturer of jigs and fixtures, tools and dies and precision metal stamping products. The company employs 200 people and is located in Selangor. It is 100 percent Malaysian owned and was established in 1977. In 1993, the company reported revenues of approximately US $5 million.

In 1993, BSLI consumed 33.6 metric tons (MT) of TCA. The company expects that its cleaning requirements will remain constant over the next few years. BSLI typically operates two 8-hour shifts per day and 6 days per week. The operating schedule may change depending on demand.

BSLI currently uses one batch degreaser in its cleaning operations. The TCA degreaser cleans approximately 5 million parts per month. These parts are used by local manufacturers in consumer electronic industries such as audio and video equipment. The manufacturers assemble the parts into finished products for local and overseas markets.

The stamping parts usually contain stamping oils and particulates, and thus need to be cleaned prior to shipping to customers. Very often, the stamping parts come in various shapes and sizes ranging from as small as a few mm to as large as 30 cm. The parts to be cleaned are typically placed clustered in a basket.

PROJECT DESCRIPTION

For this project, BSLI will eliminate its use of TCA by removing its existing vapor degreaser and replacing them with hydrocarbon degreaser. The cleaning capacity of the equipment to be purchased is approximately the same as the existing TCA degreaser. The conversion to non ozone-depleting technology consists of the following elements:-

1. Process development and material compatibility tests
2. Retrofitting
3. Purchase of 1 batch ultrasonic cleaning machine for use with hydrocarbon solvents/refractometer
4. Safety
5. Training
6. Disposal

1. Process Development and Material Compatibility Tests

Prior to the purchase of new equipment, BSLI has performed material compatibility and process development tests to select the optimal cleaning equipment and cleaning solvents. The company has evaluated items such as changes in worker function and compatibility of materials such as substrate and coatings with the new solvents.

In addition, the company has tested the effectiveness of the single solvent system, where only one solvent is necessary to clean and dry parts and has found the result very satisfactory. After the new cleaning equipment has been purchased and installed, additional tests may have to be carried out to optimize the cleaning process.

BSLI will replace the existing degreasers at Lot 47687, Jalan Bukit Idaman 6, Taman Bukit Idaman, 68100 Batu Caves, Selangor, Malaysia.

2. Retrofitting

BSLI current degreaser comprises two simple immersion tanks. Worker manually lower the basket by up/down movements. The total cleaning process requires 3 to 4 minutes. The equipment cannot be retrofitted and the associated scrap value has been disccounted for in the final calculation as shown under Annex A.. BSLI proposes to procure an automatic hoist to replace the manual lowering of the baskets. However, as this procurement represents an enhancement in efficiency from its present operation, BSLI is willing to finance the automatic hoist using its own funds.

3. Batch Cleaning Machine

The batch hydrocarbon equipment shall comprise two immersion tanks, one air blowing stage followed by an oven drying stage. The air blowing and oven drying stages are necessary to dry the cleaned parts because of the relatively low evaporation rate of hydrocarbon solvent.

However, even with enforced drying, the relatively small and flat parts which BSLI specialises in producing will not completely dry when they are placed clustered together. These parts can only dry under high vacuum centrifugal type of oven or when the parts are placed in a rotating drum in the air blowing and oven drying tanks. The latter option is more cost effective. As such, the system selected need to operate on both dip basket for the larger parts (about 30 cm) and rotating drum for the smaller parts (about 3 cm).

Such a system as described above would therefore require two different types of jigs (basket and drum). However, the worker need to lower the jig manually into the tanks as in the TCA degreaser. The cleaning cycle time for the hydrocarbon equipment is also expected to be longer given the additional enforced drying stages. To achieve the same cleaning throughput, BSLI will either need to expend more manpower or add a multiple-arm automatic hoist to transfer the jigs. BSLI has opted to select the latter option but realises that this option will be considered as a possible enhancement over the existing TCA degreaser. For this reason, BSLI is willing to finance the procurement of the automatic hoist on its own.

A refractometer measuring equipment is required to measure the oil content in the hydrocarbon solvent. The refractive index measured is compared against a master refractive index versus oil content chart. As the range of refractive indices for both oil and solvent are close, it is necessary to use a refractometer with high resolution.

4. Safety

Combustion occurs when 3 elements are present: presence of combustible vapor in sufficient concentration, ignition source and air (specifically oxygen). Removal of any one of these 3 elements will thus prevent combustion.

To displace oxygen, it will be necessary to blanket the equipment with an inert gas such as nitrogen. This is an expensive option. It is therefore more practical to focus on the other 2 elements.

The equipment incorporates design to remove ignition sources by indirect heating of the oven, grounding and removing static electricity build-up. In addition, there will be training on good housekeeping practices to ensure that there are no ignition sources such as welding and smoking in the vicinity and, sign boards warning of fire hazards are to be prominently displayed.

The vapor concentration at room temperature is insufficient for combustion to occur because of the relatively low evaporation rate (and high flash point) of the solvent. At elevated temperatures, evaporation rate increases. The equipment has chilling features in the tank and vacuum suction in the oven to ensure that vapor concentration at worst does not exceed specified percent of LEL. Measurements of vapor concentrations at worst case locations in the oven and above solvent surfaces of similar working designs indicate that vapor concentrations are within specified % of LEL.

In addition, temperature sensors and alarms are included to warn against breakdown of equipment. Given the low vapor concentration (of only approximately 10% of TLV-TWA and LEL) in the working environment, it is essentially not necessary to incur additional cost in improving existing facility ventilation.

5. Training

The training component will include training of personnels on the new equipment as well as the relevant training to each department (e.g. production, process and quality control). In addition, all personnels will be trained on the safety aspects of handling the hydrocarbon solvent as elaborated under item 4 of this section. However, BSLI is requesting OTF financing for sending three of its engineers for training on the new equipment only. These engineers, in turn, are expected to train other workers of BSLI on the operation of the new equipment.

6. Disposal

Spent hydrocarbon solvents are disposed through licensed contractors who use the solvents as additive to low-grade paint or blended into fuel oil for turbines and kilns.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

1. Selection of Replacement Chemicals

The following groups of chemicals were considered for the replacement of TCA.

(i) Chlorinated solvents including methylene chloride (MC), perchloroethylene (PCE) and trichloroethylene (TCE).

(ii) Hydrochlorofluorocarbon (HCFC).

(iii) Semi-aqueous system (alkaline/solvent/de-ionized water)

(iv) Hydrocarbon (HC)

<u>(I) Chlorinated Solvents</u>

Chlorinated solvents are known to be good replacement and can be used as drop-in for TCA with minor modifications to the equipment. These chemicals are however, very toxic (25-50 ppm Threshold Limit Value/Time Weighted Average) and very hazardous to workers' health. It will require substantial capital investments to seal the cleaning area and equipment and extensive ventilation system. In addition, it will be necessary to monitor very carefully workers' health by regular medical check-ups.

Should any worker's health be affected as a result of the chemicals, it will create complex liability issues and this will be disastrous for the company's reputation. There is also a general fear that these chlorinated solvents may come under increasing phase-out pressure in the future. It was thus decided that chlorinated solvents will not be

used as replacements.

(ii) HCFC

HCFC is also an ozone depleting chemical. The price is also prohibitive, estimated at 3 to 4 times that of TCA. Considering that 33.6 MT of TCA is consumed annually, operation cost is expected to increase substantially should HCFC be used. Moreover, HCFC has a long atmospheric life and its ODP means that it is not a long-term substitute for TCA. It was decided that HCFC will not be used as replacement.

(iii) Semi-Aqueous System

This system utilizes an alkaline or solvent to degrease and deionized water (DI) for rinsing. Whilst this system offers safety and operation cost is not expected to differ significantly, heavy capital investments are required not only for cleaning equipment but also waste treatment system. The cleaning cycle-time will also be appreciably longer because of the slow drying water.

Maintenance of the alkaline mixture and DI water integrity are considered critical to ensure product cleanliness and reliability. Semi-aqueous system was thus not further considered as a possible alternative.

(iv) Hydrocarbon (HC)

Hydrocarbon offers 4 main advantages over semi-aqueous system namely :

(i) Degrease oil-based coolant more effectively.
(ii) Cycle-time is faster because it is more volatile.
(iii) Maintenance is easier requiring less control on process parameters.
(iv) Reliability (corrosion) is more consistent and less dependent on process parameters.

In addition:

The hydrocarbon solvents do not contain halogens and have an ozone depleting potential of zero.

The solvents have vapor pressures well below those of the halogenated solvents. Consequently, these low vapor pressures virtually eliminates fugitive emissions from the cleaning process:

Product	mm Hg (vapor pressure at 20 °C)
CFC 113	270
1,1,1-TCE	100
Hydrocarbon	0.03 to 3

Hydrocarbon solvents have low impact on aquatic environment. Unless used in semi-aqueous processes, the solvents will not come into contact with water except during spills. The solvents have very low water solubility and are also less dense than water. Thus during any accidental release, they will remain on the surface and evaporate off.

There are, however, 2 major obstacles to overcome; the relatively slower drying time of hydrocarbon compared to TCA and the combustible nature of hydrocarbon.

Hydrocarbon was preferred provided these obstacles can be satisfactorily addressed. These issues are discussed under project description.

PROJECT COSTS

As detailed below, the total project cost over the first four years of the project (investment costs and net incremental savings) is US $114,785.

Investment Costs of US $125,500 are detailed in Annex A. BSLI Teknologi will not be requesting for a recycling equipment as the spent solvent will be disposed off as described under Section 5 of Project Description.

Net Incremental Operating Savings. Given a ten percent discount rate, the net present value of the incremental operating cost minus the offsetting savings over the first four years of the project results in a net incremental operating savings of US $11,538. A more detailed breakdown of the operating cost and the assumptions used for each year of the project are provided in Annex B.

Local Ownership Fraction. The total project cost was multiplied by the fraction of local ownership (100%) to determine the eligible project cost.

Other Costs. A 12% contingency was also included to ensure adequate funding of project costs following project appraisal. An additional 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 requested OTF grant for BSLI is US $133,200. The amount was calculated as follows: the present value of the net incremental operating savings over the first four years of the project were subtracted from the total investment costs. The resulting total project cost was multiplied by the percentage of Malaysian ownership (100%). This figure was increased by a 12 percent contingency to yield the grant amount. Finally, this figure was increased by 3 percent to account for the financial institution fee. The company has agreed to cover any additional costs above its approved grant amount using its own funds.

UNIT ABATEMENT COST (UAC)

As derived in Annex C, the UAC calculated over the fifteen year life of the project is US $3.83 per ODP-weighted kg of ODS phased out. This number is derived from the incremental annualized capital costs of US $16,500, the net annualized incremental operating savings of US $3640 and an average annual savings of approximately 3.36 ODP-weighted MT.

REQUIRED REGULATORY ACTIONS

At present, the Government of Malaysia levies varying duties on imported equipment. Because duties and taxes are considered transfer payments between organizations rather than true economic costs, the Multilateral Fund does not consider such cost as incremental. Hence, in order to reduce the total costs incurred by BSLI, it is recommended that the Malaysian government waive the import duty for all equipment supplied for this project.

RESULTS

This project will eliminate the use of at least 3.36 ODP-weighted tons of ODS in the first year of implementation.

SCHEDULE

BSLI Teknologi is committed to the phase out of its CFC-based degreasing process as soon as possible. The conversion of TCA to hydrocarbon solvent cleaning is expected to be implemented in the third quarter of 1995.

ANNEX A
Capital Costs

Equipment:

Material compatibility, safety and process development	- completed -
1 unit batch hydrocarbon degreaser	US $110,000
1 unit refractometer measuring equipment	U$10,000
Installation	US$5,000
Scrap value of existing equipment	US($1,500)

Training:

Training for BSLI engineers (3 persons)	US	$1,500

Transportation:

Shipping and Insurance	US	$500

TOTAL : US $125,500

ANNEX B
Net Incremental Operating Costs

1. Usage

In estimating the usage the following factors were considered:

1.1 Both the TCA and hydrocarbon solvent degreasers are equipped with a recycling unit.

1.2 Because of the large quantities that are cleaned, it is not practical to stack or jig each part in an orderly manner in the cleaning baskets. The clustering of parts results in substantial entrappment of solvent and carry-over to the air blowing stage. Whilst the air blowing stage does remove some of the carry-over, some carry-over solvent are host in the oven (note that the oven design take this into consideration to prevent % vapor concentration exceeding the specified % LEL).

1.3 The relative slow evaporation rate of hydrocarbon solvent more than compensate for the loss arising from the carry-over. Mass production runs of similar working designs indicate savings of approximately 10% usage.

2. Chemical

The costs of 1,1,1-TCA and hydrocarbon solvent are both about US $2.00/litre. It is necessary to compare cost based on volume rather than weight. The production volume is expected to be constant over the next 4 years. Baseline usage is approximately 24,000 litres and post project 21,600 litres per year.

3. Manpower

For both TCA and hydrocarbon solvent degreasers, 2 workers are required. There is thus no net change in manpower requirement.

4. Electricity

The electricity requirement of the hydrocarbon degreaser is about 6 kw more than the TCA degreaser. Based on a 16-hours day and a 24-days working month, the increased electricity consumption per year is 9,216 kwh. This translates to an incremental operating cost of approximately US $1,160 in electricity consumption.

5. Disposal

The cost of disposal is a small fraction of the chemical costs. The difference in disposal costs is not expected to differ significantly.

6. Incremental Operating Savings

The incremental operating savings under the proposed project are shown below:

Year	1	2	3	4
Baseline (US$) • Chemical	48,000	48,000	48,000	48,000
Post-project (US$) • Chemical • Electrical	43,200 1,160	43,200 1,160	43,200 1,160	43,200 1,160
Savings (US$)	3,640	3,640	3,640	3,640

NPV @ 10 percent (4 years) :US $11,538

ANNEX C
Unit Abatement Cost

A. **ODS Savings**

ODP of TCA	0.1
Use of TCA in 1994	33.6 MT
Economic Life of Project	15 years
Average Annual ODS Phased Out	3.36 ODP-weighted MT

B. **Incremental Capital Costs**

Total investment costs	US $125,500
Annualized incremental capital costs	US $16,500

C. **Net Annualized Incremental Operating Savings** US ($3,640)

UAC (US$/kg ODP phase out) = US $3.83

DEPARTMENT OF ENVIRONMENT,
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AND ENVIRONMENT,
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Our Ref: AS
Your Ref: 91/120/004/011 Jld.1/(79
Date: 8 June, 1995

Mr. Konrad von Ritter
Economist, Agriculture and Environment Division
Country Department 1
East Asia and Pacific Region
Washington, D.C 20433
USA

Dear Sir,

My Government would like officially to invite the World Bank as Implementing Agency and formally endorsed to carry out ODS phase out projects as belows:

i.	MASHRAE	}	Already endorsed since 1993
ii.	NIPPODENSO	}	
iii.	TENCHO	}	
iv.	MONDIAL		
v.	BAN SENG LEE		
vi.	STAR FOAM		
vii.	TRANSFREEZE		
viii.	PENANG TRADING		
ix.	ENG TEK		
x.	AE TECH		
xi.	WIDETECH		

Thank you.

Yours sincerely,

(ISMAIL ITHNIN)
for the Director-General of the Environment,
Department of Environment,
Malaysia

c/(wld.ban.wp)/IT-ar/080695

Ozone Operations Resources Group
(OORG)

TECHNICAL REVIEW

1. Country of origin: Malaysia.

2. Project title: Conversion of metal cleaning process from 1,1,1, Trichloroethane (TCA) to Non-Ozone depleting Organic Solvents.

3. Sector Covered: Solvent Cleaning.

3a ODS use in sector: 500 MT of CFC 113 solvent in 1993.
2622 MT of 1,1,1, (TCA) in 1993.
662 MT ODP weighted consumption.

4. Relationship to Country programme. Details of the Country programme are not provided.

5. Technology:

a) The choice of a hrdrocarbon cleaning system is justified by the strict requirements of surface finish on the jigs and fixtures, which would be seriuosly damaged by the use of aqueous cleaning, and by the greater ease of drying.

b) The technology is not transitional, as it does not depend upon a solvent or chemicals which might face future bans.

c) Feasibility of transfer to the country concerned

i) There is no formal technology transfer, but there is a well organised training plan which will ensure a proper start up and maintenance of product quality.

ii) There is no licensing agreement.

iii) Other technologies were considered, including chlorinated solvents, HCFC, aqueous, etc and the hydrocarbon method was chosen to avoid toxicity or the corrosive risks of the other options.

iv) The Unit abatement costs are $ 3.83 per ODP Kg. This is a very reasonable figure and includes the technology for reduction of flammability risk.

6. Environmental Impact:

(a) The ODP of the project is zero, but there will be direct GWP due to the hydrocarbon evaporation to atmosphere. This will be significant because the main principal of flammability reduction is the use of efficient extraction to maintain the workplace concentration below the combustible level.

(b) The major Health and safety hazard in this proposal is the flammability risk of the use of Hydrocarbon solvent. Provisions to reduce this includ ethe reduction of hydrocarbon vapour levels to below 10% of Lower Explosive level (LEL) by extraction and by the use of chillers on the cleaning tanks to educe the vapour pressure of the solvent.

7. Project costs:

(a) All the cost components identified in the project are essential to the conversion, and the proposed equipment will maintain the existing level of service.

(b) None of the proposed new equipment would have been expected to be found in the existing installation. The change to a flammable solvent is such a fundamental change that all the equipment would require replacement.

(c) Cost of equipment.

(i) The base line costs are addressed properly.

(ii) The finding that none of the existing equipment should be replaced is correct.

(iii) All the requests for equipment are consistent with the project plan.

(iv) None of the base line equipment can be modified for the new process.

(v) The fate of the scrapped equipment is not described.

(vi) A nominal $1,500 is given for scrap value of existing equipment; it is not detailed.

(vii) The new plant will maintain the previous production rate.

(d) Appropriateness of training and related costs, if any.

The majority of training will be provided by BSLI in house. However three Engineers will be sent for training at the suppliers premises, and funding for this has been applied for from the OTF.

e) Operating costs

(i) There will be a nett annualized operating cost saving of $3,640.

(ii) The major operating cost saving appears to be reduction in solvent costs. Energy costs of drying are lower than would be the case with a water based system..

(iii) The operating cost given and their relation to the technology chosen are entirely consistent with experience.

8. Implementation timeframe.

The timeframe proposed is feasible.

9. Recommendations

(a) Approval as proposed.

OORG Technical reviewer: .....B.H. Baxter.....

Date Review completed: .....12/5/95.....

B.H. BAXTER.