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

Twelfth Meeting
Montreal, 28-30 March 1994

PROJECT PROPOSALS: INDIA

This document includes the following project proposals and the Fund Secretariat's Comments and Recommendations:

Project presented by UNIDO

1. Conversion of electronic cleaning processes from ODS solvents to wet-media blasting and aqueous cleaning (ITI-Mankapur)

Projects presented by the World Bank

1. Conversion of CFC-11/Polyol Systems to low/non-ODS formulations (Manali Petrochemical, Ltd.)

2. Conversion of CFC-11/polyol systems to low/non-ODS formulations (UB Petroproducts, Ltd.)

3. ABC-DCP Manufacturing facility (Real Value Appliances Limited)

4. Conversion from Halon 1211 to ABC-DCP in portable extinguisher manufacturing (Real Value Appliances Limited)

5. ODS phase-out in sterilisation and siliconisation of disposable syringes and needles (Hindustan Syringes & Medical Devices Private Ltd.)

6. Syringe and hypodermic needle manufacturer using CFC-113/Silicone replacement (Albert David Ltd.)

7. Conversion of compressor designs for refrigerators and appliances from CFC-12 to HFC-134a (Kirloskar Copeland Ltd.)

8. Modification of CFC-12 Mobile Air Conditioning Manufacturing for HFC-134a (Subros Limited)

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India	
PROJECT TITLE:	Conversion of electronic cleaning processes from ODS solvents to wet-media blasting and aqueous cleaning at ITI-Mankapur	
BUDGET:	Capital Cost:	US $1,067,400
	Operational Cost:	US $ (28,035)
	Total:	US $1,020,000
	13% Overhead:	US $ 132,600
INCREMENTAL COSTS:	US $1,152,600	
ODS PHASE-OUT:	48.4 tonnes ODP per year	
COST EFFECTIVENESS[1]:	US $23.8/kg of phased-out ODP	
PROJECT DURATION:	18 months	
IMPLEMENTING AGENCY:	UNIDO	
NATIONAL COORDINATING AGENCY:	Ministry of Environment and Forest	

TECHNICAL REVIEW COMPLETED: YES _X_ NO _

SECRETARIAT'S COMMENTS

1. ITI Mankapur is producing digital switches for telephone systems, printed circuit boards and hybrid circuits, using CFC-113, CFC-12, methyl chloroform. These are currently used for flux removal, precision cleaning and photoresist developments and stripping operations. Under this project, the company will eliminate the use of ODSs by converting to an aqueous cleaning process.

2. The project proposal did not include independent technical review paper. Therefore, the Fund Secretariat commissioned a review by an independent consultant.

3. Although the consultant agrees that this project is obviously needed, he commented that the project has insufficient information, in-depth review of cost estimates cannot be made, the potential for utilizing existing equipment has not been adequately addressed, the estimated costs of capital equipment appear high, operating costs for power consumption and raw materials seemed high.

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

4. UNIDO's agreed to clarify its project proposal taking into account the comments.

SECRETARIAT'S RECOMMENDATION

1. The Secretariat recommends to give permission to proceed for this project. UNIDO should prepare a detailed document taking into account comments from the technical reviewer.

2. Additional cost for finalizing this project should be offset against project preparation funds for India previsously disbursed to UNIDO.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India
PROJECT TITLE:	Conversion of CFC-11/Polyol Systems to low/non-ODS formulations (Manali Petrochemical, Ltd.)
BUDGET:	US $579,600 (capital cost) US $100,000 (operational cost) US $20,400 (financial agent fee) US $700,000 (total project budget)
INCREMENTAL COSTS:	US $481,000
ODS PHASE-OUT:	N/A
COST EFFECTIVENESS:	N/A
PROJECT DURATION:	Phase IA: 1 year Phase IB: 2 years
IMPLEMENTING AGENCY:	The World Bank
NATIONAL COORDINATING AGENCY:	Ministry of Environment and Forests

TECHNICAL REVIEW COMPLETED: YES _X_ NO ___

SECRETARIAT'S COMMENTS

1. The Executive Committee approved at its Eleventh Meeting the technology transfer component of this project at a cost of US $219,000, hence the incremental costs associated with the present submission is US $481,000

2. Manali is an 100 per cent-owned Indian enterprise which has been producing, under a technology transfer agreement since 1990, a broad range of polyether and polyester polyol formulations as well as propylene and propylene oxide as feedstocks.

3. The enterprise has an installed capacity of 7,500 tonnes/year in two plants, of which only 25 per cent is currently utilized. This is expected to increase to 65-70 per cent by 1996. Manali's own forecast for its domestic market share in 1993-1994 is 45 per cent and 50 per cent in flexible and rigid foams, respectively.

4. The company currently consumes 60 tonnes of CFC-11 annually.

5. The project consists of two phases:

Phase I: Application of development for conversion of CFC-11/polyol systems to low/non-ODS formulations; and

Phase II: Establishment of manufacturing and supply capability for low/non-ODS systems.

6. Funding is requested at this stage to finance Phase I of the project.

7. Phase I is further subdivided into:

1) Phase I-A: (Flexible Moulded Foams)

(a) licence technology from ARCO Inc. of USA to manufacture polyol formulations for flexible moulded foams using a water-blown system instead of CFC-11. Funding for this licence was approved at the Eleventh Meeting of the Executive Committee;

(b) training in and outside India; and

(c) field trials at the foam manufacturers.

Cost of Phase I-A would cover: purchase of technology, foam producing equipment, foam testing equipment, travel and training.

2) Phase I-B: (Rigid Foams)

(a) enter into a technical consultancy agreement with Mitsui of Japan to provide the technical guidance in development of rigid formulations. Funding for this consultancy was approved at the Eleventh Meeting of the Executive Committee;

(b) purchase required catalysts, chemicals and alternative blowing agents (HCFC-22, HCFC-141b, HFC-134a and cyclopentane) for testing purposes;

(c) buy additional high pressure dispensing equipment and large, life-size moulds to simulate operating conditions of refrigerator producers; and

(d) buy additional testing equipment.

8. The enterprise will test a variety of blowing agents as substitutes to CFC-11 in new formulations.

9. The enterprise will test the behaviour of the different formulations under high pressure foaming machines and in moulds used in domestic refrigerators.

SECRETARIAT'S RECOMMENDATION

1. The Secretariat recommends final approval of the project taking into consideration the Committee's approval at its Eleventh Meeting of the cost of technology transfer.

2. Since Phase I of this project would develop foam formulation for the refrigeration sector and other sectors (e.g., flexible foam end users), the cost of testing for these end users should not be provided from the Multilateral Fund in the future.

3. US $481,000 is recommended as the balance of the incremental costs of this project.

4. This project should be implemented within the context of a strategy to be developed for the phase-out of ODS in the foam sector in India.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India
PROJECT TITLE:	Conversion of CFC-11/polyol systems to low/non-ODS formulations (UB Petroproducts, Ltd.)
BUDGET:	US $597,000 (capital cost) US $ 35,000 (operational cost) US $632,000 (total project budget) US $ 17,064 (financial agent fee)
INCREMENTAL COSTS[1]:	US $385,864
ODS PHASE-OUT:	N/A
COST EFFECTIVENESS:	N/A
PROJECT DURATION:	Phase I: 1 year (1994) Phase II: 2 years (1995-96)
IMPLEMENTING AGENCY:	The World Bank

NATIONAL COORDINATING AGENCY: Ministry of Environment and Forests

TECHNICAL REVIEW COMPLETED: YES _X_ NO ___

SECRETARIAT'S COMMENTS

1. The Executive Committee considered this project at its Eleventh Meeting and approved funding for the technology transfer in the amount of US $200,000.

2. Established in 1992, UBP manufactures polyurethane chemical systems (polyol and isocyanate) with or without CFC-11 for the foam industry. The technology is conventional and was provided by Enichem of Italy which has a 10 per cent share of ownership.

3. UBP products are used in insulated thermoware, general insulation applications, and flexible moulded foams for automotive and furniture applications. It also supplies systems, without CFC-11, to domestic refrigerator producers.

4. Utilized production capacity is 25 per cent of the 8,000 tonne/year installed capacity. Utilization of capacity is expected to progressively increase to about 55 to 60 per cent after five years.

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1 The incremental costs differ from the budget by accounting for 10 per cent transnational ownership, 3 per cent financial agent fee and US $200,000 approved at the Eleventh Meeting of the Executive Committee.

5. The project aims at importing new technology from its Italian Partner (Enichem) which is reported to be a world leader in polyurethane systems/intermediate and has an active ongoing programme in CFC replacement in foam blowing applications.

6. The project's objective is to use the imported new technology to develop formulated polyol and isocyanate foam systems that can be used with CFC alternate blowing agents.

7. The project also seeks to test and characterize polyol systems to establish a facility for high pressure polyol blending and to modify the polyol plant.

8. The project is to be implemented in two phases:

1) <u>Phase I</u> (1994)

This phase will consist of:

(a) transfer of technologies from Enichem for CFC-alternate based systems applicable to both rigid insulation foams and flexible moulded foams. Funding was approved at the Eleventh Meeting of the Executive Committee;

(b) establishing high pressure foam machinery and test facilities;

(c) evaluation of alternate technologies and choice of appropriate blowing agents for each end-use applications;

(d) production of suitable, base polyols; and

(e) testing and characterization at the enterprise and at customer locations, and adaptation of systems to specific customer needs.

2) <u>Phase II</u> (1995-1996)

This phase will consist of:

(a) commercial production of formulated polyols;

(b) trial testing at customers end as well as adaptation of low ODS blowing agent technology to specific customer needs/requirements; and

(c) training of customer's technicians and provision of assistance in equipment modifications.

SECRETARIAT'S RECOMMENDATIONS

1. The project is recommended for final approval within the framework of a sector strategy for India that should take into consideration other polyol and foam producers.

2. Testing equipment provided for in this project should serve the foam producers. Therefore, future requests for testing in the foam sector should not be approved.

3. The incremental cost of the project in the amount of US $385,864 is recommended.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India
PROJECT TITLE:	(1) ABC-DCP Manufacturing facility at Real Value. Requested incremental costs: US $620,900 (2) Conversion from Halon 1211 to ABC-DCP in portable extinguisher manufacture at Real Value. Requested incremental costs: US $588,600
ODS PHASE-OUT:	Project (1): 480 tonnes of Halon 1211 and 120 tonnes of CFC-12 Project (2): 100 tonnes of Halon 1211 and 25 tonnes of CFC-12
COST EFFECTIVENESS:	N/A
PROJECT DURATION:	Project (1): 1 year Project (2): 1 ½ years
IMPLEMENTING AGENCY:	The World Bank/IDBI

NATIONAL COORDINATING AGENCY: Ministry of Environment and Forests

TECHNICAL REVIEW COMPLETED: YES _X_ NO ___

SECRETARIAT'S COMMENTS

1. The two projects emanate from the same enterprise, Real Value Appliances Limited.

Project (1)

2. Real Value has imported halon and dry powder to fill extinguishers which were assembled by it from locally procured and imported components.

3. Real Value wishes to establish manufacturing facility for the production of 1000 tonnes of dry powder, based on a technology transfer agreement with ABC-DCP manufacturers in the developed countries.

4. Real Value has not produced halon or CFC-12 in the past. Therefore, this project would not replace an existing ODS production capacity.

Project (2)

5. Real Value has at the present an assembly line to assemble fire extinguishers from locally procured as well as imported components.

6. Quality standards of locally procured components are reported to be not compatible with the dry powder.

7. Real Value wishes to establish a production line for the productions of cans and valves for extinguishers suitable for dry powder.

8. The incremental nature of this activity is in doubt.

SECRETARIAT'S RECOMMENDATIONS

1. India is a producer of Halons but not of ABC dry chemical powder.

2. India is a large consumer of halons which, to a large extent, is imported since local production cannot yet meet the existing demand.

3. The consumption of halon in India is widely distributed.

4. Both projects (1) and (2) are ineligible for funding according to the Indicative List of Categories of Incremental Costs.

5. Project (1) may become eligible if an equivalent halon production capacity is shut down.

6. Project (2) may become eligible if when compared with imports is more cost effective.

7. The Secretariat recommends that the two projects should be deferred pending the development of a sectoral strategy to phase out production and non essential uses of halons in India.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India
PROJECT TITLE:	ODS phase-out in sterilisation and siliconisation of disposable syringes and needles.
BUDGET:	Phase I: Incremental capital cost US \$358,600 Incremental operating cost US \$434,200 Financial Agent Fee US \$ 23,800
INCREMENTAL COSTS:	US \$816,600
ODS PHASE OUT:	50 mt/y of CFC-12
COST EFFECTIVENESS[1]:	US \$16.3/kg CFC-12 phased out
PROJECT DURATION:	Phase I: 1 year
IMPLEMENTING AGENCY:	The World Bank/IDBI
NATIONAL COORDINATING AGENCY:	Ministry of Environment and Forests

TECHNICAL REVIEW COMPLETED: YES _X_ NO ___

SECRETARIAT'S COMMENTS

1. Hindustan Syringes Ltd. is a manufacturer of syringes, needles and IV cannulas. These products cater to approximately 55 per cent of the market share in India. Export to developed countries accounts for approximately 20 per cent of the turnover.

2. The objective of Phase I of the project is to replace the existing sterilisation system (CFC-Ethylene oxide) with a carbon dioxide-ethylene oxide system.

3. The project summary provides capital cost and operational costs. The latter are calculated over a 4-year period without justification.

4. Phase II (not submitted) of the project would probably cost US \$700,000 (similar to Albert David project).

SECRETARIAT'S RECOMMENDATION

1. The Secretariat recommends permission to proceed with this project. Final approval would be contingent on providing details on the existing base line and on revising the calculation of operating costs. Also a justification for a transitional period of 4 years should be provided.

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1 Determined as the ratio of incremental costs to the estimated annual saving of ODP (\$/ODP_{kg}). For CFC-11, ODS=ODP

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India	
PROJECT TITLE:	Syringe and hypodermic needle manufacturer using CFC-113/silicon replacement.	
BUDGET:	Incremental capital cost	US $625,700
	Incremental operating cost	US $ 64,700
	Financial Agent Fee	US $ 20,700
INCREMENTAL COSTS:	US $711,100	
ODS PHASE OUT:	8-9 tonnes of CFC-113	
COST EFFECTIVENESS[1]:	US $83.7/kg CFC-113 phased out	
PROJECT DURATION:	1 year	
IMPLEMENTING AGENCY:	The World Bank/IDBI	
NATIONAL COORDINATING AGENCY:	Ministry of Environment and Forests	
TECHNICAL REVIEW COMPLETED:	YES _X_ NO ___	

SECRETARIAT'S COMMENTS

1. Albert David Limited manufactures hypodermic syringes and needles; it has a 20 per cent market share of these products. CFC-113 is used in siliconisation and block testing of needles.

2. The objective of the project is to phase out 8 tonnes per year of CFC-113.

3. Albert David will import a new needle assembly machine and new technology which will not use CFC-113.

4. The proposal does not mention whether CFC-12 is used in the sterilization of the syringes at the present.

5. Capital costs of the project are for the purchase of a new needle assembly machine, training, installation and trial-run.

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1 Determined as the ratio of incremental costs to the estimated annual saving of ODP ($/$ODP_{kg}$). For CFC-11, ODS=ODP

6. The proposal does not mention whether the new line is a replacement of the CFC-113 using line or it will be in addition to it.

7. Operational costs of the project are calculated for 4 years. No justification was provided for using the four year period.

SECRETARIAT'S RECOMMENDATION

1. The Secretariat recommends permission to proceed with this project pending recalculation of incremental cost taking into consideration the value of the baseline. Justification for a 4-year transitional period will also have to be provided.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India
PROJECT TITLE:	Conversion of compressor designs for refrigerators and appliances from CFC-12 to HFC-134a.
BUDGET:	US $1,183,000
INCREMENTAL COSTS:	US $622,300
ODS PHASE OUT:	N/A
COST EFFECTIVENESS:	N/A
PROJECT DURATION:	Phase I: 4 years Phase II: 2 years
IMPLEMENTING AGENCY:	The World Bank/IDBI
NATIONAL COORDINATING AGENCY:	Ministry of Environment and Forests
TECHNICAL REVIEW COMPLETED:	YES _X_ NO ___

SECRETARIAT'S COMMENTS

1. Kirloskar Copeland Ltd. is a joint venture between the Indian enterprise Kirloskar (51 per cent) and Copeland Corporation (49 per cent) which was set up to produce CFC-12 compressors.

2. The objective of the project is to convert production of CFC-12 compressors to that of HFC-134a. The project will be implemented in two phases.

3. The first phase will be for design development, prototyping and testing of HFC-134a compressors and customer training. This phase will be completed in 4 years.

4. The second phase, which might start concurrently with the first phase, will be for the establishment of HFC-134a compressor manufacturing facilities. This phase will conclude with the preparation of a feasibility report for the commercial production of HFC-134a compressors to be implemented as the third phase.

5. The Executive Committee approved at its Tenth Meeting a similar project in India (Shriram Refrigeration Industries) at half the cost requested for Kirloskar Copeland Ltd.

6. The high cost of Kirloskar project is due to the cost of a testing equipment, very costly oil reclaimer charger, retooling and customer training. Although some of these cost items were included in Shriram, their costing was moderate.

7. The issue of the incrementality of testing equipment, especially when requested in several projects in the same sector in the same country, was raised at the Tenth Meeting of the Executive Committee. Test equipment such as controlled ambient test room, data acquisition system, calorimeter, data logger, life test equipment are (or should be) all associated with the existing baseline, only the cost of modification of such equipment is incremental.

8. Customer training is not eligible in the context of this project and therefore its cost should not be funded.

SECRETARIAT'S RECOMMENDATION

1. The Fund Secretariat recommends approval of the project. Customer training at a cost of US $140,000 should not be approved. Adjusting the requested amount for customer training and the associated financial intermediary fees, US $547,900 should be approved if the Committee decides that new testing equipment is eligible.

2. If the Committee decides that only the cost of modification of testing equipment is eligible, US $238,520 of testing equipment cost should be deducted from the request and US $403,800 should be approved with a request for the implementing agency to submit an amendment to this approval at the next Committee meeting for the cost of modifying the testing equipment.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India	
PROJECT TITLE:	Modification of CFC-12 Mobile Air Conditioning Manufacturing for HFC-134a	
BUDGET:	US $2,313,600	
INCREMENTAL COSTS:	US $1,710,000 -	approved amount at 11th Meeting
	US $ 315,000 -	additional funds requested at this Meeting
	US $2,025,000 -	adjusted project request
ODS PHASE-OUT:	84 MT CFC-12	
COST EFFECTIVENESS[1]:	US $20.36 per Kg. ODP -	based on 11th Meeting approval
	US $24.11 per Kg. ODP -	with this amendment
PROJECT DURATION:	2 years	
IMPLEMENTING AGENCY:	The World Bank	
NATIONAL COORDINATING AGENCY:	Ministry of Environment and Forests (MOEF)	
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _	

SECRETARIAT'S COMMENTS

1. This project was approved at the Eleventh Meeting of the Executive Committee in the amount of US $1.071 million. The additional funds requested for this meeting entail the addition of a contingency fund of 15 per cent and the application the three per cent fee for the services of a financial intermediary to execute the project after the grant agreement is signed.

2. The Committee has approved several projects without contingency costs included. The Committee has also approved amendments to projects following project appraisal and the final assessment of project costs.

SECRETARIAT'S RECOMMENDATION

3. The Secretariat recommends the deferral of a decision on this project amendment until the final project appraisal has been completed. At that time, a decision could be taken on whether or not additional costs for project execution should be funded.

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1 Determined as the ratio of incremental costs to the estimated annual saving of ODP ($\$/ODP_{Kg}$). For CFC-11, ODS=ODP

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

COUNTRY	India	
PROJECT TITLE	Conversion of electronic cleaning processes from ODS solvents to wet-media blasting and aqueous cleaning at ITI-Mankapur	
SECTORS COVERED	Solvents	
ODS USE IN SECTOR	4,876 MT (ODP-weighted) of ODS solvents in 1991	
PROJECT IMPACT	Phase out annual consumption of 36.9 MT of CFC-113; 4.5 MT of CFC-12; 2 MT of CTC and 23 MT of 1,1,1 trichloroethane (total 48.4 ODP-weighted MT)	
PROJECT DURATION	18 months	
PROJECT ECONOMIC LIFE	10 years	
TOTAL PROJECT COST	Investment (capital) costs, US$	1,067,400
	Incremental operating costs/savings, US$	(28,035)
	Project preparation costs, US$	19,365
	Total Project Costs, US$	1,020,000
OWNERSHIP STRUCTURE	100 per cent Indian	
PROPOSED MF FINANCING	US$ 1,020,000	
UNIT ABATEMENT COST	US$ 3.40/kg of phased-out ODS	
COUNTERPART ENTERPRISE	Indian Telephone Industries through Centre for Materials for Electronics Technology (C-MET) of Department of Electronics	
IMPLEMENTING AGENCY	UNIDO	
COORDINATING MINISTRY	Ministry of Environment and Forest	

PROJECT SUMMARY

This project will phase out the use of CFC-113/methanol/nitro methane blend (TMS formula); CFC-12; CFC-113/methylene chloride blend (TMC formula); and methyl chloroform in the flux removal, precision cleaning and photoresist development and stripping operations at the Mankapur Factory of the Indian Telephone Industries Limited (ITI-Mankapur). The main product of the ITI-Mankapur is digital switches for telephone systems manufactured under ALCATEL (France) license. Under the same roof, ITI-Mankapur produces printed circuit boards, hybrid circuits, relays, metal and plastic parts, etc. which are used in the assemblies for switches and as well as are separately marketed. The phasing out of ozone depleting substances (ODSs) will be accomplished by replacing the currently used solvent-based cleaning methods with three different types of water-based processes: continuous aqueous process for flux removal; aqueous batch processes for metal and plastic part cleaning and flux removal; and water-based photoresist development and stripping.

The project will employ commercially available technologies in one of India's largest ODS consuming sectors. Previous country studies and the Country Programme which is under preparation have identified the sector as a high priority area.

1. PROJECT OBJECTIVE

The objective of this project is to phase out the use of CFC- 113/methanol/nitro methane blend (TMS blend); CFC-12; CFC-113/methylene chloride blend (TMC blend); and methyl chloroform (MCF) in electronics cleaning operations. The processes in which ODSs are utilized, will be replaced with aqueous cleaning processes.

As one of the first projects formulated in the solvent-based electronics cleaning sector in India, this project has additional targets. Considering the structure of the Indian electronics industry and required steps to phase out ODSs in electronics cleaning, it is expected that this project will additionally identify and strengthen a focal point which will (also see the chart on the next page):

- Help to increase awareness in the selected electronics industries regarding need for phasing out ODSs and, for this purpose, collect and compile technical and technological information.

- Generate information and provide technical support regarding problems associated with phasing out of ODSs by the electronics industry, which include process development, materials compatibility testing, reliability testing, cost-effectiveness analysis, technology selection and drawing up of equipment specifications.

- Accumulate adequate problem solving know-how during the implementation phase of this project so that the projects of a similar nature can be implemented in other locations

In cooperation with the Ministry of Environment and Forest, the Centre for Materials for Electronics Technology (C-MET) of the Department of Electronics (DOE) has been identified as the focal point[1].

2. SECTOR BACKGROUND

The solvents sector is the largest user of ozone depleting substances (ODSs) in India. The size of consumption has been investigated in a number of studies[2]. According to most recent information presented at the Solvents Workshop convened in June 1993 and revised in the first draft of the India Country Programme in August 1993, in 1991, the solvent sector consumed 100 MT of CFC-12, 300 MT of CFC-113, 4,000 MT of carbontetrachloride and 550 MT of 1,1,1-trichloroethane (MCF), i.e., a total of 4,876 MT of ODP (ozone depletion potential)-weighted consumption, that is 36.9 per cent of total ODP-weighted consumption in India. The solvent consumption in India in 1991 is given in the following table and chart.

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1 The Centre for Materials for Electronics Technology (C-MET) set up by DOE has experts in the various materials used in the electronics industry covering chemicals, polymers and other related products such as solvents, cleaning agents etc. and in materials development and commercialization of the R&D results.

2 a) Report of the Task Force on National Strategy of Phasing out Ozone Depleting Substances, Ministry of Industry, March 1992 (updated March 1993).
b) Compiled consumption data, Multilateral Fund Secretariat, March 1993.
c) Solvents Workshop, Country Programme Preparatory Meetings Series, 21-25 June 1993. New Delhi.
d) India Country Programme, First Draft, 9 August 1993.

ODS consumption in the solvents industry is split between electronics, metal cleaning and other processes such as textiles, pharmaceuticals, pesticides, chlorinated rubber, etc. Cleaning processes used in the electronics industry consumed in 1991, 150 MT CFC-113, 75 MT CTC and 30 MT of MFC and included flux removal (printed-circuit cards and hybrid circuits), semiconductor manufacturing, microelectronic component cleaning, metal and plastic part cleaning and photoresist development and stripping. The use of ODSs in electronics cleaning in India has been increasing as a result of the development of the electronics industry.

Phasing out of ODSs in Indian Electronics Industry

The role of a focal point of know-how

- Phasing out ODSs
  - Technological data base
    - Awareness in the sector
      - Large enterprise
        - *Reliability testing*
        - *Process development*
        - *Technology selection*
        - *Equipment selection*
        - Site preparation
        - Installation
        - Operator training
        - ODS-free cleaning
      - Small-to-medium enterprise
        - *Reliability testing*
        - *Process development*
        - *Technology selection*
        - *Equipment selection*
        - *Site preparation*
        - *Installation*
        - *Operator training*
        - ODS-free cleaning

Note: *Generally, activities written in italic require external technical assistance and will be carried out by the focal point of the sector.*

ODS consumption in India

(ODP-weighted figures; unconstrained scenario, i.e., no ODS phase-out over the reporting period)

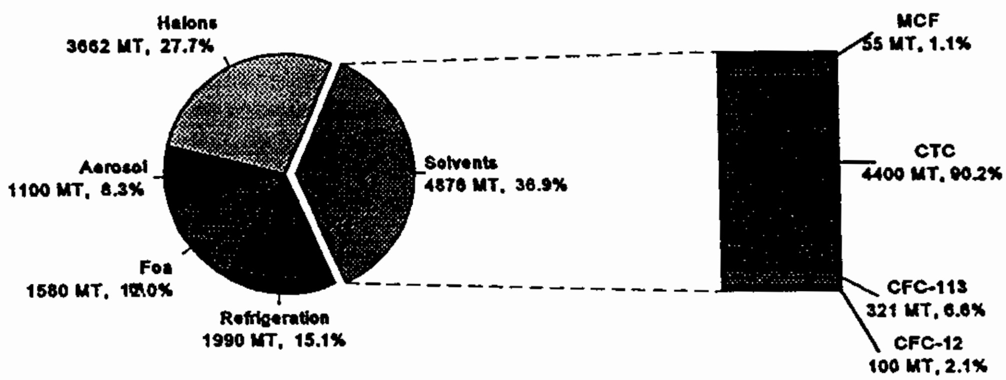
Types of ODS	1991 Consumption					
	All sectors			Solvents		
	Actual, MT	ODP-weighted		Actual, MT	ODP-weighted	
		MT	%		MT	%
CFC-11	1,900	1,900	14.4	0	0	0.0
CFC-12	2,850	2,850	21.6	100	100	2.1
CFC-113	320	342	2.6	300	321	6.6
Sub-Total	5,070	5,092	38.6	400	421	8.7
Halon-1211	550	1,650	12.5	0	0	0.0
Halon-1301	200	2,000	15.1	0	0	0.0
Sub-Total	750	3,650	27.6	0	0	0.0
CTC	4,000	4,400	33.3	4,000	4,400	90.2
MCF	550	66	0.5	550	55	1.1
TOTAL	10,370	13,208	100.0	4,950	4,876	100.0
Sectoral distribution						
Aerosols	1,100	1,100	8.3			
Foams	1,580	1,580	12.0			
Refrigeration	1,990	1,990	15.1			
Solvents	4,950	4,876	36.9			
Halons	750	3,662	27.7			
TOTAL	10,370	13,208	100.0			

Source: a) Tentative figures as discussed at the "Solvents Workshop, Country Programme Meetings Series, 21-25 June 1993, New Delhi."

b) India Country Programme, First Draft, 9 August 1993.

ODS consumption in India

1991 figures in ODP-weighted MT



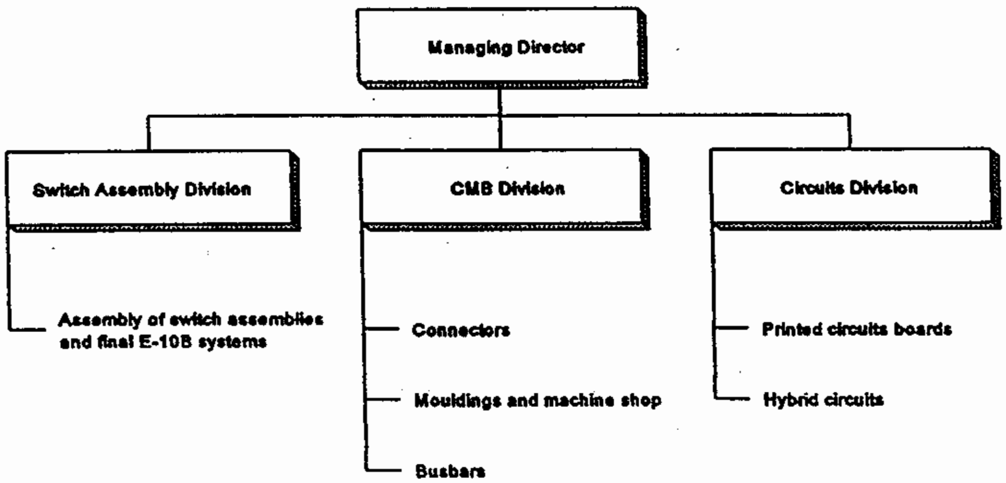
3. ENTERPRISE BACKGROUND

Indian Telephone Industries Limited is a 100 per cent Government of India owned company. ITI has six units all over India and manufactures the entire range of telecommunication equipment and accessories such as telephones, switching, transmission, satellite, fibre optic equipment. Annual production of ITI exceeds Indian Rs. 7 billion (about US$ 233 million).

ITI-Mankapur is one of the largest units of ITI employing 3,550 people. The initial investment in the Factory was Rs. 2,000 million in 1983. The major product of ITI Mankapur, is digital switching equipment for public telecommunication network. Presently, E-10 B digital switchers under license from ALCATEL (France) are manufactured. Annual capacity is 500,000 lines. ITI-Mankapur is in the process of upgrading its main product with OCB-283/CSN digital switcher, also from ALCATEL.

The manufacturing divisions of ITI-Mankapur are shown in the figure below.

Manufacturing divisions of ITI-Mankapur



The Switch Exchange Assembly Division produces switch assemblies at a rate of about 1,000 cards/day. Required cleaning is basically soldering flux removal and is carried out in a continuous, 3-zone vapour degreaser (OSL, France, Model 88-06510) using an azeatrop of trichlorotrifluoro ethane ($C_2Cl_3F_3$, CFC-113) and methanol (CH_3OH) with nitro methane stabilizer (TMS blend). Solvent consumption was 37.0 MT in the one year period between 1 April 1992 and 31 March 1993. The CFC concentration of the solvent is 95 per cent, and the purchase price is Rs. 75/kg (about US$ 2.50/kg). The total electric power requirement of the degreaser is about 28 kW and it daily consumes 400 kWh electric energy working 16 hours. As of June 1993 and in U.P. State, industrial electric energy costs Rs. 2/kWh (about US$ 0.07). The Division works on two shifts of 8 hours each and 2 operators per shift are employed at the cleaning station.

The CMB Division (connectors, mouldings and machined parts, busbars) employs three cold solvent, ultrasonicly agitated, batch processing bath degreasers to clean relay parts and connectors (KERRY, UK, Model Compact 450). The solvent used is dichlorodifluoromethane (CCl_2F_2, CFC-12). The respective annual production capacity of the Division is 2 million connectors and 1.1 million relays and 5 MT of solvent are consumed annually to clean them. The purchase price of the solvent is around Rs. 75/kg (about US$ 2.50/kg). The power requirement of each degreaser is 1 kW yielding a maximum daily energy consumption of 16 kWh–total consumption 48 kWh. The Division works on two shifts of 8 hours each and 1 operator per shift is employed at the cleaning bath. Additionally, the CMB Division uses annually 20 MT of tricholoroethylene (TCE) in different degreasing processes.

The Circuits Division produces hybrid circuits and printed circuit boards. The hybrid circuits unit has an annual production capacity of 1.5 million circuits. The residual soldering flux on the circuits is cleaned in a multistage, cold solvent, ultrasonicly agitated, batch processing bath degreaser (KERRY, UK). Annually, 2 MT of TMC blend solvent consisting of trichlorotrifluoroethane (CFC-113) and methylene chloride (CH_2Cl_2, dichloromethane, DCM) is used. The purchase price of the solvent is around Rs. 75/kg (about US$ 2.50/kg). Power requirement of the degreaser is 1kW yielding a maximum daily energy consumption of 16 kWh. Additionally, 2 MT of carbontetrachloride (CTC) are consumed annually to perform other cleaning tasks. The Division works on two shifts of 8 hours each and 1 operator per shift is employed at the hybrid circuit cleaning process.

The installed capacity of the PCB unit is 26,000 m^2/year. ODSs are used in the photoresist development and stripping operations. The photoresist development is performed in a batch processing bath using 1,1,1-trichloroethane (CH_3CCl_3, TCA or methyl chloroform, MCF). Annual solvent consumption is 23 MT. The stripping bath also works on batch processing and uses annually 47 MT of methylene chloride (CH_2Cl_2 or dichloromethane, DCM) as the solvent. The unit cost of solvents for the photoresist development and stripping operations is approximately Rs. 30/kg (about US$ 1.00/kg).

A summary of information on solvent use at ITI-Mankapur is presented in the following three.

ODS solvent using equipment at ITI-Mankapur

ACTIVITY	PRODUCTION CAPACITY	PURPOSE	EQUIPMENT USED	YEAR OF PURCHASE	COST Rs Mill
Switching exchange assembly	1000 Cards/day @ 16hours/day	Cleaning of solder fluxes from populated PCBs	Freon cleaning station Model 88-06510, OSL, France	1985	0.7
Component assembly	Connectors: 2 million/year Relays: 1.1 million/year	Degreasing of metal and plastic parts of relays & connectors	Utrasonic cleaning station Model 450, . KERRY COMPACT, UK (3 nos)	1985	1.0 (each)
Hybrid circuits	1.5 million circuits/year	Cleaning of solder fluxes from hybrid circuits	Multistage ultrasonic cleaner, VIBRONICS	1985	1.0
Printed circuit boards	26,000 m^2/year	a) Photoresist development b) Photoresist stripping	a) Development bath b) Stripping bath	1987 1987	2.0 3.0

ODS solvent costs of ITI-Mankapur

DIVISION/PURPOSE	AMOUNT MT/year	UNIT PRICE US$/kg	ANNUAL COST, $	ODS AMOUNT MT/year	ODP-WEIGHTED AMOUNT MT/year
Switching exchange assembly/ Flux removal					
Trichlorotrifluoro ethane ($C_2Cl_3F_3$, CFC-113) and methanol (CH_3OH) with nitro methane (TMS blend); 95%	37.0	2.50	92,500	35.2	37.6
Component assembly/ Cleaning of metal and plastic parts					
Dichlorodifluoromethane (CCl_2F_2, CFC-12); 90%	5.0	2.50	12,500	4.5	4.5
Tricholoroethylene (TCE)	20.0	1.00	20,000	0.0	0.0
Hybrid circuits/Flux removal					
Methylene chloride (CH_2Cl_2, dichloromethane, DCM) and trichlorotrifluoroethane (CFC-113) (TMS blend); 86%	2.0	2.50	5,000	1.7	1.8
Carbontetrachloride (CTC)	2.0	1.00	2,000	2.0	2.2
Printed circuit boards					
a) Photoresist development: 1,1,1-trichloroethane (CH_3CCl_3, MCF)	23.0	1.00	23,000	23.0	2.3
b) Stripping of photoresist: methylene chloride (CH_2Cl_2, DCM)	47.0	1.00	47,000	0.0	0.0
TOTALS	136.0		202,000	66.4	48.4

Types and annual consumptions of ODS (and other) solvents used at ITI-Mankapur

Purpose	Chemical Compositions	Amount used in MT/ year (1/4/92 to 31/3/93)
Cleaning of solder fluxes from populated PCBs	Azeatrop of trichlorotrifluoro ethane ($C_2Cl_3F_3$, CFC-113) and methanol (CH_3OH) with nitro methane (TMS blend): 95%	37.0
Degreasing of metal and plastic parts of relays & connectors	• Dichlorodifluoromethane (CCl_2F_2, CFC-12); 90% • Tricholoroethylene (TCE)	5.0 20.0
Cleaning of solder fluxes from hybrid circuits	• Methylene chloride (CH_2Cl_2, dichloromethane, DCM) and trichlorotrifluoroethane (CFC-113) (TMC blend); 86% • carbontetrachloride (CTC)	2.0 2.0

Purpose	Chemical Compositions	Amount used in MT/ year (1/4/92 to 31/3/93)
a) Photoresist development b) Photoresist stripping	a) 1,1,1-trichloroethane (CH_3CCl_3, TCA or methyl chloroform, MCF)	23.0
	b) Methylene chloride (CH_2Cl_2, dichloromethane, DCM)	47.0
TOTAL		136.0

5. PROJECT DESCRIPTION

5.1 SECTOR-WIDE APPROACH

The electronics industry uses a variety of chemical substances in the manufacturing processes and packaging operations. Some of these include chemicals which are polluting the environment, out of which a number of them are classified as ozone depleting substances.

Considering this, a broad based programme to enhance the awareness about use of such substances in the electronics industry, development of alternatives for replacing/phasing out of such substances etc. is being pursued under the activities of the Centre for Materials for Electronics Technology (C-MET) of the Department of Electronics, Government of India. This would be a part of the overall programme of the Government of India which is being implemented under the overall coordination of the Ministry of Environment and Forest.

The replacement of ODSs in electronics industry applications with aqueous processes will require extensive engineering know-how to carry out tasks such as:

- Reliability testing
- Material compatibility testing and process development
- Technology selection
- Equipment selection
- Purchase of aqueous cleaning machines and systems
- Site preparation
- Installation of machinery
- Operator training

Therefore, the overall programme conceived for implementation here includes awareness of the industry towards phasing out of these chemicals and taking up activities with the help of industry and R&D institutions to develop substitutes for the actual usage as well as taking up demonstration projects with the help of experts in the field and translating the knowledge and experience gained to the other enterprises of the electronics industry and to the other sectors.

It is, therefore, decided that C-MET of DOE will take part in the project from its start in order to accumulate information and experience to assist ITI-Mankapur as well as other enterprises of the Indian electronics industry.

5.2 DESCRIPTION OF THE ITI-MANKAPUR PROJECT

As discussed in the section above, the replacement of ODSs in electronics industry applications with aqueous processes requires extensive engineering know-how to perform a number of tasks. Each of these tasks, or project elements, is shown in the chart on the next page and explained in detail below.

Reliability testing, material compatibility testing and process development

Reliability testing, material compatibility testing and process development will be performed by C-MET, in close cooperation with ITI-Mankapur, prior to the purchase of the aqueous cleaning machines in order to choose the best equipment and to decide if water additives are necessary to achieve the desired cleaning results. The process development work is to be documented with graphs, charts, and data showing that the ITI-Mankapur project has determined that the aqueous cleaning process is a good decision. The process development work particularly will be completed prior to ordering the high-volume continuous operation aqueous cleaning machine for the Switching Exchange Assembly Division.

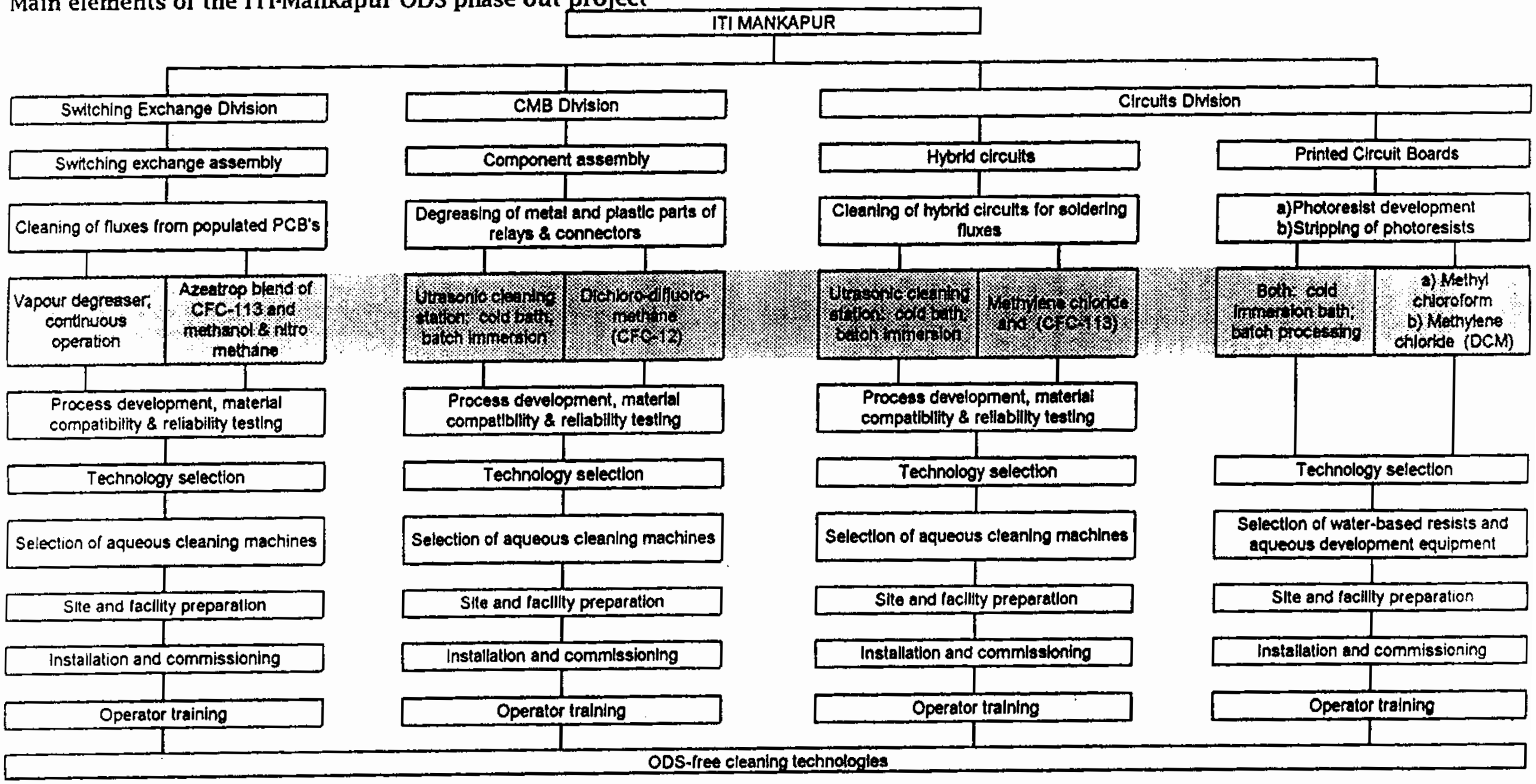
C-MET is required to complete and document reliability testing of aqueous cleaning systems for the CMB and Circuits Divisions prior to ordering the four additional systems. The reliability tests should evaluate the long term effects of increased moisture inside the electronic assemblies, parts and components that may be attributed to the use of the aqueous cleaning process.

Technology selection, equipment selection and purchase of aqueous cleaning machines

ITI-Mankapur will phase out the use of CFC- 113/methanol/nitro methane blend (TMS formula); CFC-12; CFC-113/methylene chloride blend (TMC formula); carbontetrachloride and methyl chloroform in the flux removal, precision cleaning and photoresist development operations in its three manufacturing divisions by selecting and utilizing the appropriate aqueous processes. ITI-Mankapur currently uses one multi-stage continuous operation vapor degreaser, four batch operation immersion type ultrasonic degreasers and one each of photoresist developing and stripping baths which are to be removed and replaced.

At the end of the project implementation, all solvents with a ODP will be eliminated. However, ITI-Mankapur will continue to use some Trichloroethylene (TCE) and Dichloromethane (DCM) in various cleaning operation. It is planned that, all chlorinated solvents will be eliminated before the year 2000.

Main elements of the ITI-Mankapur ODS phase out project



There are several technologies and equipment available in the market, and it depends to a great extent on the type of process and technology chosen for cleaning. For the large scale, high production applications, there is continuous, conveyor-operated equipment which has a range of controls which can be included, depending on the amount of labour available for monitoring operations, and the quality requirements. This applies to both the aqueous and the semi-aqueous (such as solvent wash/water rinse) equipment. Aqueous systems generally use water filtration and purification to enable water recycling and to capture waste stream contaminants. Semi-aqueous systems normally use carbon absorption or membrane separation techniques to recycle both the water and the solvent streams. If the electronic circuit assemblies have high quality requirements, and/or are difficult to clean due to complex geometries of design, then mechanical assistance through the use of strong, directed sprays may be required.

ODS-free cleaning technologies are implemented by different suppliers using fairly different hardware and software components and widely varying system integration philosophies. Particularly when the automatic workpiece transport systems are included, the cleaning system has to be designed and built individually. Capabilities of the suppliers and those of their products and systems should be evaluated *in situ* before the final decision.

Therefore, a study-tour for the technical staff/managers of C-MET and ITI-Mankapur will be arranged to visit aqueous and semi-aqueous equipment and system manufacturers and electronic industry enterprises which phased out the ODS's using these systems. It is desirable to arrange the timing of the study-tour to coincide with a technical/industrial fair which would give an across-the-board comparison/evaluation possibility.

Purchase of aqueous cleaning machines and systems

Continuous operation aqueous cleaning system

A typical continuous operation aqueous cleaning system is shown in the schematic diagram given on the next page. This system includes the following components:

a) Main sub-system includes cleaning, rinsing, drying and deionizer units. Its cost can be in the range of US$ 200,000 to 300,000 depending upon the automation and control requirements. (In the case of semi-aqueous technology, submerged sprays or inert blanketed sprays are often included in the design, normally as part of the quote.)

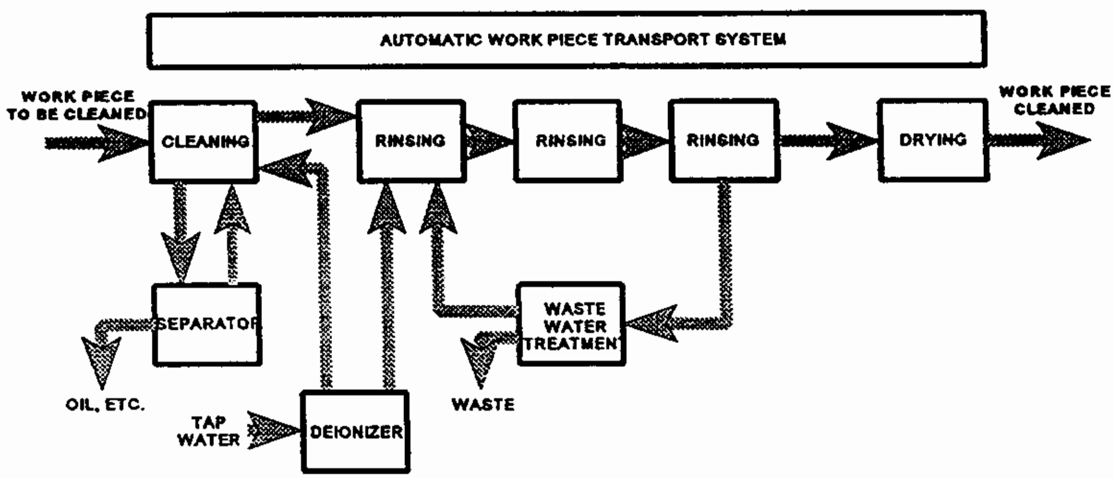
b) The water filtration and recycling sub-system (waste water treatment system) can be integrated into the main sub-system and costs about US$ 50,000 extra.

c) Computerized work piece transport system which has to be custom-built to match the other system components and would cost around US$ 60,000.

Batch operation aqueous cleaning systems

The aqueous cleaners to replace the present ultrasonic systems will be smaller than the above and will be designed for batch processing. The following table shows the capacities and functions of the batch operation aqueous cleaners. As it is seen from the table, the non-ODS systems do not aim at any capacity increase but represent an one-to-one replacement scheme.

Continuous operation aqueous cleaning system



Comparison of present and proposed batch operation aqueous cleaning systems

Location	No.	Capacity (tank size in cm) of the present ultrasonic systems using ODS's	Capacity (tank size in cm) of the proposed aqueous systems
Component assembly	3	300x450x350	300x400x400
Hybrid circuits	1	460x320x350	300x450x350

The environmental, quality and safety considerations mentioned above are still requirements, however, and equipment design must include these components as needed. There are ranges of quality and construction materials in this equipment category; for this project, it is estimated that each cleaner will cost in the region of US$ 60,000. Two water recycling systems will be installed; one for the CMB Division and the other for hybrid circuit manufacturing. The total cost of the two systems is estimated at US$ 40,000.

Purchase of an additional exposure unit to process aqueous processed dry-film photoresist

Presently, ODS-solvent processed dry-film photoreist (DFPR is used to transfer circuit patterns on copper-clad circuit boards. The proposed aqueous processed DFPR is less efficient than the present system. As it is shown in the table below, it requires 25-30 per cent more time, that is there will be a 25-30 per cent reduction in productivity. Considering the actual annual production output of 26,000 m^2, an additional DFPR exposure/developing station with a cpacity of around 8,000 m^2 (which is slightly more than 30 per cent of the installed capacity) will be required to raise the output capacity of the non-ODS process to that of the ODS-solvent using process. The estimated cost of an automatic developer with an annual output capacity of around 8,000 m^2 is US$ 200,000.

	Process name	ODS-solvent process	Aqueous process
1	Exposure time	Setting 7-9 for clear copper	Setting 8-10 for clear copper
2	Development time	30% of break point	50% of break point

Site preparation and installation of machinery

The project includes funding to prepare the sites for the equipment installation. This funding is for electrical supply and plumbing to ensure safe installation of the equipment. Modifications are necessary to the cleaning areas so that the process flow of the new equipment is uninterrupted in times of high volume cleaning. Technical staff of the equipment manufacturer will help in the installation work.

Operator training

Operators and maintenance personnel will be trained in the proper operation and maintenance of the new equipment. Personnel will also be trained to measure important process changes in the cleaning effectiveness of the high-volume aqueous cleaner. The training programme will be designed by C-MET in cooperation with the equipment manufacturer and ITI-Mankapur. This programme will be the basis of systematic training of personnel in the following projects.

5. JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

In the solvents sector, especially in the case of electronics cleaning, there are many options to the use of ozone depleting solvents. Usually the choice of the alternative cleaning process is dependent upon the type of market served by the solvent user. Most commercial applications have more flexibility in the use of new technology, because of the inherent need for commercial entities to maintain their competitiveness in the world market. However, many organizations build products known for their high degree of reliability for use in military aircraft, satellites or other difficult professional (industrial and commercial) operations. These organizations spare no cost to ensure that products made by their organizations are dependable and reliable. Considering the high reliability requirements of ITI-Mankapur products, the migration to non-ODS cleaning should be planned and evaluated extremely carefully.

Switching from CFC or MCF cleaning applications to the use of aqueous based processes is the most practical for organizations that prefer to eliminate organic solvents from their cleaning process. The use of aqueous cleaning processes requires the availability of ample quantities of water and the ability to treat the effluent so that the waste from the cleaning process does not contribute to environmental damage. Changing to aqueous based processes also requires that the materials used in the production of the product are not damaged by water or aqueous based residue.

In this project, the use of aqueous based processes is chosen because the efficient use of water as a solvent will not damage the environment and because water is a plentiful and inexpensive resource in Mankapur. Other alternatives require that the cleaning by-product, whether it is contaminated water or an organic solvent, be further processed before the cleaner can be reused or returned to the environment. However, the use of photoresist development and stripping processes will require treatment of waste stream.

7. PROJECT COSTS

(Unless otherwise noted, all costs in this section are economic, rather than financial costs.)

The incremental recurring costs are included in this project. Incremental costs are offset by the reduction in cost for the ODS solvents and cost of waste disposal. The costs of utilities and of solvents may differ between this project and other projects in India. These costs were evidenced by receipts from each of the companies.

Finally, the cost of acquiring the necessary environmental permits is included as part of the project.

Total project costs:

As described below and presented in detail in the relevant annexes (Annexes 1,2 and 3), the total project cost is US$ 1,039,365. Because there are no non-ODS investment costs associated with this project, the total project cost equals the ODS reduction portion of the overall project. The total project incremental cost of US$ 1,020,000 was calculated as the economic capital costs plus the net incremental recurrent savings for four years discounted at 10 per cent minus the project preparation costs..

Investment (capital) cost (see Annex 1)

As detailed in Annex 1, the total investment cost is US$ 1,067,400. Major components of this cost include the purchase and installation of one continuous operation aqueous cleaning system (US$ 310,000), four batch processing aqueous cleaners (US$ 240,000), three water recycling systems (US$ 90,000), one DFPR exposure and development unit (US$ 200,000), as well as other related costs.

Incremental operating costs/savings (see Annex 2)

If the project was not undertaken, the annual operating cost, exclusive of tax, would be US$ 232,844. If the project is implemented, the annual operating cost will be US$ 224,000, resulting in an annual incremental operating savings of US$ 8,844. Given an equipment lifetime of 10 years and a discount rate of 10 per cent, the net present value of the first four years of incremental operating saving is US$ 28,035. A more detailed breakdown of operating costs is provided in Annex 2.

Revenues:

This project will not provide ITI-Mankapur with any incremental revenues.

Local ownership ratio:

Local ownership fraction of 100 per cent was considered to determine the amount of eligible MF grant financing. since the total project incremental cost should be multiplied by the fraction of local ownership to determine the proposed grant amount, total proposed MF financing is equal to total project incremental cost, i.e., US$ 1,020,000.

Contingencies:

A 10 per cent contingency has been included in all calculations.

Breakdown of total project costs:

Description of cost	Full-life of project		First four-years	
	Local, US$	Foreign, US$	Local, US$	Foreign, US$
Investment (capital) costs		1,067,400		1,067,400
NPV of incremental operating costs/savings		(54,343)		(28,035)
NPV of incremental operating revenues		0		0
Total costs		1,013,057		1,039,365

Unit Abatement Cost (UAC) (see Annex 4)

As shown in Annex 4, the UAC for this project is US$ 3.40 per ODP-weighted kilogram of ODS phased out per year. This number is derived from an annualized incremental cost of capital of US$ 173,829, first year incremental annual operating savings of US$ 8,844, and phasing out of 48.4 MT (ODP-weighted) of ODS per year.

Proposed MF Grant

The proposed MF grant for this project is US$ 1,020,000 and was calculated as follows: First, the total investment cost of US$ 1,067,400 was added to the net present value of the incremental operating savings over the first four years of the project, which is US$ (-)28,035. From the resulting total of US$ 1,039,365, project preparation costs of US$ 19,365 was deducted to find the total costs US$ 1,020,000. This sum was then multiplied by the 100 per cent Indian ownership ratio of ITI-Mankapur to yield the the same grant amount of US$ 1,020,000.

8. FINANCIAL AND ECONOMIC ANALYSIS

Economic Rate of Return (ERR)

Because the project entails an initial investment followed by a net annual incremental operating cost, there will be a net outflow of cash each year for the project's entire economic life. The ERR for the project is thus undefined.

Financial Rate of Return (FRR)

Because the project entails an initial investment followed by a net annual incremental operating cost, there will be a net outflow of cash each year for the project's entire economic life. The FRR for the project is thus undefined.

9. FINANCIAL STATUS OF ENTERPRISE

Provide sufficient information to demonstrate financial viability of the enterprise. Financial indicators such as debt service coverage and cash flow over the project life could be used.

10. FINANCING PLAN

MF funding is a grant and is limited to the incremental cost as calculated above. Any costs not covered by the MF funding as calculated above must be financed by other sources. A financing plan to cover all project costs will be included giving terms and conditions of other loans.

11. PROJECT IMPLEMENTATION

Management

The Ministry of Environment and Forest (MOEF) will oversee the successful implementation of this project. The project will be carried out at the ITI-Mankapur in cooperation with C-MET of the Department of Electronics. UNIDO will also provide technical assistance to the project during its implementation.

Procurement

Project procurement will comply with the UNIDO procurement procedures. These are described in the related UNIDO documents.

Disbursements

Fund disbursements will comply with UNIDO financial procedures. These guidelines are described in the related UNIDO documents. The schedule for disbursements will be decided upon at the beginning of project implementation.

Audits

For auditing, UNIDO's project evaluation and review procedures and project financial management data will be used.

Schedule of activities (PROJECT ROADMAP)

	Activity	Description	Responsible	Timing
1	Sign the project, receive funding		MOEF, UNIDO, Multilateral Fund	1 Q
2	Make a detailed project work plan		C-MET, ITI-Mankapur, UNIDO	1 Q
3	Arrange the study-tour		UNIDO	1 Q
4	Technical discussions	Discuss cleaning technology & equipment specifications with manufacturers and other end-users as per the technical proposal based on the study tour	C-MET, ITI-Mankapur, UNIDO	1 Q
5	Carry out reliability and materials compatibility tests	Evaluate the effectiveness of different non-ODS cleaning techniques	C-MET, ITI-Mankapur, UNIDO	2 Q
6	Select technology	Finalize the optimum cleaning technology & prepare the list and specifications of equipment and materials	C-MET, ITI-Mankapur	2 Q
7	Commercial negotiations	Hold commercial negotiations based on the selected technology and equipment and sign the contract(s)	C-MET, ITI-Mankapur, UNIDO	3 Q
8	Design modifications of the site and facilities	Engineering design of utilities (water, electricity and gas), piping and civil engineering.	ITI-Mankapur	3 Q
9	Prepare facilities	Construction	ITI-Mankapur	4 Q
10	Preparation/procurement of local equipment and machinery	Procure or make in-house the locally supplied equipment and machinery	ITI-Mankapur	4 Q
11	Technical training	Send staff abroad for technical training/design and run local training programmes	ITI-Mankapur, UNIDO	4 Q
12	Acceptance test, installation and commissioning of equipment		C-MET, ITI-Mankapur	5 Q
13	Start utilizing new cleaning processes		ITI-Mankapur	5 Q
14	Evaluate the processes		C-MET, ITI-Mankapur	5 Q
15	Evaluate the project		C-MET, ITI-Mankapur, UNIDO	6 Q
16	Promotion of phasing out of ODSs in the Indian electronics industry		MOEF, C-MET, UNIDO	6 Q

12. REQUIRED REGULATORY ACTIONS

No regulatory actions, other than routine permitting, are required to implement this project. Under the existing agreement with the UNDP, equipment and machinery imported as part of this project will be exempt from import duties levied by the Government of India.

13. RESULTS

Direct Project Impacts

The project will eliminate annually 48.4 MT of ODSs (ODP-weighted) at the ITI-Mankapur Factory.

Indirect Project Impacts

As far as the indirect effect such as the transfer of technology to other enterprises in following projects is concerned, this project will have a big impact. The project design has been made to maximize this impact. Particularly, the involvement of C-MET of DOE will ensure the successful repetition of phasing out projects in the Indian electronics industry.

Otherwise, assuming a successful transition to aqueous cleaning in ITT-Mankapur, the quality and performance of ITT-Mankapur products will remain unchanged. Assuming that a grant is provided to cover the incremental costs, there is unlikely to be any impact on product price. Absent a change in quality or price, consumer demand and production levels are expected to be unaffected by the project. The environmental impacts associated with this project are discussed in Annex 5.

14. ENTERPRISE COMMITMENT

This section should be a statement from the C-MET and ITI-Mankapur managements indicating that the enterprise will undertake the activities described in the proposal following the proposed schedule provided that grant funds are approved and available as scheduled.

OVERVIEW OF ANNEXES

Annex 1: Breakdown of investment (capital) costs.

Annex 2: Breakdown of incremental recurring costs/savings.

Annex 3: Breakdown of incremental revenues (benefits).

Annex 4: Calculation of unit abatement cost (UAC).

Annex 5: Environmental impact assessment (EPA)

ANNEX 1

BREAKDOWN OF INVESTMENT (CAPITAL) COSTS

	Description of cost item	Unit	Unit cost, US$	Qty	Total cost, US$
1	Training and engineering				
1.1	Material compatibility and process development (LOCAL)	week	400	24	9,600
1.2	Reliability testing (LOCAL)	week	400	32	12,800
1.3	Study-tour	week	4,000	8	32,000
1.4	Equipment operator training (LOCAL)	week	100	30	3,000
1.5	Consultants: material compatibility studies, installation assistance, follow up, etc. (INTERNATIONAL)	week	10,000	2	20,000
1.6	Supplier installation assistance	week	10,000	1	10,000
1.7	Project monitoring missions	week	5,000	3	15,000
2	Continuous aqueous cleaning system				
2.1	In-line aqueous cleaning machines	nos	250,000	1	250,000
2.2	Conveyor work-piece transport set-up	nos	60,000	1	60,000
2.3	Water filtration and recycling equipment	nos	50,000	1	50,000
2.4	Installation costs (electrical, piping, etc.)	nos	25,000	1	25,000
3	Batch processing aqueous cleaning systems				0
3.1	Aqueous cleaning machines	nos	60,000	4	240,000
3.2	Installation costs (electrical, piping, etc.)	nos	5,000	4	20,000
3.3	Water filtration and recycling equipment	nos	20,000	2	40,000
4	Aqueous photoresist exposure and development system				
4.1	Aqueous DFPR exposure and development equipment	set	200,000	1	200,000
5	Miscellaneous				
5.1	Waste treatment	set	30,000	1	30,000
5.2	Transportation: shipping and insurance	set	50,000	1	50,000
	TOTAL INVESTMENT COSTS				1,067,400

ANNEX 2

BREAKDOWN OF INCREMENTAL OPERATING COSTS/SAVINGS

	Description	Unit	Unit cost, US$	Qty	Pre-project total cost, US$	Post-project total cost, US$
A.	Solvent/media costs per year					
A.1	CFC-113/Methanol	kg	2.5	39,000	97,500	0
A2	CFC-12	kg	2.5	5,000	12,500	0
A3	CTC	kg	1	2,000	2,000	0
A4	MCF	kg	1.5	23,000	34,500	0
A5	TCE	kg	1	20,000	20,000	20,000
A6	DCM	kg	1	47,000	47,000	47,000
A7	Water @ 80% recycling	m3	0.1	30,000	0	3,000
	Sub-total				213,500	70,000
B.	Electricity costs per year					
B1	Current systems (29 kW, 16 hr/day, 300 days/year) (29 kW, 16 hr/day, 300 d/year)	kWh	0.07	139,200	9,744	0
B2	Aqueous cleaning systems (400 kW, 16 hr/day, 300 d/year)	kWh	0.07	1,920,000	0	134,400
	Sub-total				9,744	134,400
C.	Water treatment costs per year					
C1	Recycling costs		10000	1	0	10,000
C2	Labour costs (processes using ODS's)	w/m	400	24	9,600	0
C3	Labour costs (non-ODS processes)	w/m	400	24	0	9,600
	Sub-total				9,600	19,600
TOTAL PRE-PROJECT COSTS/YEAR					232,844	0
TOTAL POST-PROJECT COSTS/YEAR					0	224,000
TOTAL INCREMENTAL SAVINGS/YEAR						(8,844)

ANNEX 3

BREAKDOWN OF INCREMENTAL BENEFITS

For this project, there is no incremental benefit.

ANNEX 4

CALCULATION OF UNIT ABATEMENT COST

A.	ODS phase out		
A1	Average use of CFC-113 based solvent per year	MT	36.9
A2	ODP of CFC-113		1.07
A3	ODP-weighted CFC-113 phase out (A1*A2)	MT	39.48
A4	Average use of CFC-12 based solvent per year	MT	4.5
A5	ODP of CFC-12		1
A6	ODP-weighted CFC-12 phase out (A4*A5)	MT	4.5
A7	Average use of CTC based solvent per year	MT	2
A8	ODP of CFC-12		1.1
A9	ODP-weighted CTC phase out (A7*A8)	MT	2.2
A10	Average use of MCF based solvent per year	MT	23
A11	ODP of MCF		0.1
A12	ODP-weighted MCF phase out (A10*A11)	MT	2.3
A13	Total ODP-weighted phase out		48.48
B.	Annualized capital cost		
B1	Total investment cost from Annex 1	US$	1,067.400
B2	Equipment life	Year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	173,666
C.	Annual incremental operating savings from Annex 2	US$	(8,844)
D.	Unit abatement cost		
D1	Annualized capital cost per kg ODS phased out (B4/A13*1000)	US$/kg	3.58
D2	Annual incremental operating savings per kg ODS phased out (C/A13*1000)	US$/kg	-0.18
D3	Unit abatement cost (D1+D2)	US$/kg	3.40

ANNEX 5

ENVIRONMENTAL ASSESSMENT

In the proposed aqueous cleaning systems, deionized water will be used to clean electronic parts without the aid of additional cleaning agents. Therefore, this method of cleaning does not pose an environmental hazard. The waste water effluent from both the aqueous system and the wet-media blasting system will be filtered and deionized by a wastewater recycling system. The solid waste generated during resin column and filter maintenance will be treated or disposed of properly off-site.

It is unlikely that the project will have an adverse environmental impact. ITI-Mankapur will have to obtain permits from the necessary authorities prior to installation of the cleaning equipment.

TECHNICAL REVIEW - UNIDO INDIA PROJECT

(1) Technology

(a) The chosen approach, aqueous cleaning is as safe as, or safer than other alternatives such as semiaqueous, terpenes, hydrocarbons, isopropyl alcohol, etc. While semi aqueous technology is mentioned, all cost estimates are based on aqueous technology.

(b) If the right technology is chosen, it should be appropriate throughout the operating lifetime of the equipment. The ten (10) year life time used in cost estimate is short if the equipment is properly maintained.

(c) Feasibility of transfer to India.

(i) Since this is a government project, any import authorization, licensing agreement, permit or any other regulatory approval, should not be an obstacle.

(ii) Insufficient information.

(iii) The Indian Government appears to have settled on aqueous cleaning technology. No information is provided on how it reached this determination. Was a no clean option considered such as low solid fluxes for circuit boards? Are water based fluxes to be utilized?

(iv) No comparative cost data is provided. India should have ruled out the modification and use of existing cleaning equipment before proposing replacement with new processes. Existing conveyor systems should be suitable for incorporation into any in line automated system.

(2) Environmental Impact

(a) The proposed substitute processes to be considered have no ozone depleting potential. The potential for generating global warming gases from additives (surfactants, builders, rinse agents) or from semiaqueous cleaners is possible but minimal. Perflorocarbon rinse agents should be ruled out due to high GWP and cost.

(b) Health and safety considerations were not directly addressed. Considering the hazardous nature of solvents used in current cleaning operations, methylene chloride, carbon tetrachloride, etc., this omission may be understandable. Depending on the cleaner chosen, some additives have potential health impacts, such as the surfactant glycol ether. Some semiaqueous cleaners also have safety and health considerations that must be addressed if such cleaners are ultimately proposed.

(3) Project Cost

(a) Since no specific product, manufacturer, unit capacity, performance specification, or other supporting documentation is provided, no in-depth review of cost estimates can be made. Such justification should be provided before project costs are approved. The proposal estimated costs are more than adequate to convert the manufacturing processes identified to alternative cleaners, strippers and related equipment.

(b) Yes. While this review is not made based on an on-site knowledge of the manufacturing facility described, knowledge of similar facilities would indicate the presence of existing equipment, conveyors and utilities that could be incorporated into this project. The proposal appears to be based on the decision that all equipment and modifications are necessary and cannot utilize existing equipment and utilities. Do the manufacturers of the existing equipment already have retrofit design packages? Many do and this option should be ruled out before new equipment is authorized.

(c) Cost of equipment

(i) No. The evaluator is not familiar with the level of justification required at this point in the funding process. The cost estimates appear inflated to take care of any unforseen contingency or other objective of the grant requestor. Approval of any grant funds should be predicated on more detailed justification and supporting documentation to include reasons for choosing a specific manufacturer's product.

(ii) The potential for utilizing existing equipment has not been adequately addressed. For example, has the potential for using some of the new HCFC blends been considered as drop in replacements for CFC's in the existing in-line degreaser? If not, why not?

(iii) The grant request appears to provide adequate funds for any foreseen or unforseen contingency.

(iv) Previously discussed.

(v) No. Disposal or reutilization of existing equipment is not addressed.

(vii) Depending on the equipment model chosen, the potential for increased manufacturing capacity could occur despite claims that only existing capacity will be maintained.

(d) Since this is an Indian Government project, any training of the technical staff that cannot be conducted on-site by the equipment manufacturer, should be at the expense of India. The World Tours (1.3 Study-Tour) proposed to orient, evaluate, and select the appropriate technology should be more than adequate to satisfy any out-of-country training required. Expenses related to on-site training should be a specification of the equipment purchase package, not a separate line item.

(e)

(i) Operating costs for energy, power consumption, and raw materials are estimated to be significantly higher than existing uses. The magnitude of the difference needs scrutiny.

(ii) Not addressed

(iii) Yes. The cost savings by switching to aqueous or semiaqueous cleaners is not adequately addressed. The current costs of hazardous waste disposal is not addressed. The current raw material cost of chlorinated solvents is significantly less than the cost of such materials in Europe or North America. Much greater savings have accrued to comparative changes in this country. U. S. companies report a pay back on investment in the 1-3 year time frame. By India's estimate, the only benefit to be derived is the elimination of the use of huge quantities of ozone depleting substances.

(4) Yes. The goal to eliminate the use of chlorinated solvents by the year 2000 is not in keeping with goals of the Montreal Protocol.

(5) Recommendations

(a) This obviously is a needed project. Since great benefits will accrue to India by making the proposed changes, more of the cost should be borne by India. The estimated costs of capital equipment appears high. Any project approval (equipment purchase) should only be approved after a cost effective evaluation of competing processes has been completed.

(b) Other line item costs proposed should be explained. Line item 1.2 is to be accomplished by government employees and, therefore, should not be an additional charge. Line items 1.4 and 1.6 should be part of the equipment purchase price. Line item 1.7 would appear to fund additional international travel. Is this necessary?

THE MONTREAL PROTOCOL ON
SUBSTANCES THAT DEPLETE THE OZONE LAYER
REVISED PROJECT COVER SHEET

COUNTRY	India
SECTOR COVERED	Rigid and Flexible Moulded Foams
ODS CONSUMPTION IN AFFECTED SECTOR	1,280 Tons CFC-11 (1991)
PROJECT TITLE	Conversion of CFC-11/Polyol Systems to low/non-ODS formulations
PROJECT DURATION	Phase I : Part A 1 years Phase I : Part B 2 years
PROJECT IMPACT	490 tons per year ODS by 1995
PROJECT BUDGET	Incremental Capital Cost $579,600 Incremental Operating Cost $100,000 Financial Agent fee $ 20,400 Total Project Cost $700,000
PROPOSED OTF GRANT	$700,000[1] (Phase I only)
IMPLEMENTING ENTERPRISE	MANALI PETROCHEMICAL LTD., MADRAS
IMPLEMENTING AGENCY	The World Bank/IDBI
NATIONAL COORDINATING AGENCY	Ministry of Environment and Forests (MOEF)

PROJECT SUMMARY

This project will enable replacement of CFC-11 as foam blowing agent in polyurethane (PU) systems manufactured at Manali Petrochemicals Ltd. (MPL) plant near Madras. These systems have end-uses in rigid insulation and flexible moulded foam manufactured products. Commercially proven technology for PU systems containing low-ODP foam blowing agents would be adapted to suit Indian customer specific end-use requirements with modifications to MPL's existing infrastructure. Technology for PU systems would be obtained from ARCO (US) and Mitsui (Japan) under transfer agreements currently being negotiated. This project would provide local source of essential materials and technology with which industry would reduce CFC-11 usage in India by about 1,200 MT per year by 1996. Project scope and cost have been revised taking into account comments from MPEC in November, 1993. The project is part of GOI strategy in foam sector to support competitive role of three or more existing private sector polyol/foam systems suppliers to the many diverse foam industries throughout India and to deliver foam formulations at cost effective prices and lower overall sector incremental costs.

TECHNICAL ASSESSMENT: The revised subproject has been reviewed and supported by the OORG technical reviewer, M. Jeffs. His comments are attached.

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[1] A $219,000 OTF grant was approved at the November 1993 meeting of the ECMF to finance technology transfer,consultancy and training costs for this project.

PROJECT OBJECTIVES. The objective of this project is to establish proven and useful technology for use of polyurethane foam blowing agents which have low and zero ozone depletion potentials (ODP) in India with optimum availability of technology and materials from local enterprises. The objective will be accomplished in two phases as follows:

Phase I. Formulation development mainly using indigenous material and small quantities of imported material with emphasis on formulations using low or zero-ODP substitutes such as HCFC-22, HCFC-141b, HCFC-142b, HFC-134a, and hydrocarbons. Since a single solution is unlikely in the foreseeable future, the study should include at least 2 of the aforementioned chemicals.

Phase II.[2] Manufacture and supply of commercial quantities of alternative systems for replacement of CFC-11 in flexible moulded and rigid polyurethane formulations.

SECTOR BACKGROUND

Table-1
ODS Consumption in Foams, 1991 (metric tons)

Category	CFC-11	CFC-12	CFC-113
Polyurethane Foams (PUF)			
Flexible Moulded	160		
Flexible Slabstock Foams	40		
Rigid PUF			
Refrigerator Insulation	500		
General Insulation	240		
Thermoware	220		
Integral Skin Foams	20		
Phenolic Foams	20		20
Thermoplastic Foams	70	280	
Misc.	10		
Total	1,280	280	20

Unconstrained demand would lead to an expected ODS use of about ten times current consumption in 2010. The sector consists of about 235 enterprises. About 20% of these companies are large or medium sized and have relatively sophisticated manufacturing equipment. The remaining enterprises operate small scale units and are technically and chemically unsophisticated. The support of the three chemical suppliers would be crucial in reaching and enabling this latter group of enterprises to develop cost effective ODS phase out projects.

Three or more existing private sector firms (Manali, UB Products and Expanded) supply most of the foam formulations and materials to the foam industry, in a highly competitive market with rapidly changing technology. Government strategy in the foam sector is to support the ability of these firms to maintain their market presence in the transition to non ODS foam systems and support the ability of these foam systems suppliers to service the many diverse foam industries throughout India, including small scale sector who are not well served by imported suppliers. Competitive supply from the three firms is essential to reach this market and to keep foam formulations and materials at competitive

[2] The engineering scope and estimated project cost for Phase II will be determined during Phase I. A second project proposal will be prepared for Phase II activities and will be presented to the ECMP for approval upon completion of this Phase I project.

prices, and overall to reduce incremental costs for the foam sector. The Government considers that all three polyol foam formulation projects are essential to implementation of a cost effective and timely phase out action program in the foam sector.

Manali Petrochemical Ltd. has a market share of 45% for flexible moulded subsector and around 50% for the rigid subsector.

Flexible Moulded Foams (Automotive Sector)

There are 8 major and 24 smaller foam manufacturers operating in the moulded foam subsector. All are suppliers to the automotive industry. In 1991, all enterprises produced about 2,900 MT of foam using CFC-11-based indigenous formulations including 160 MT of CFC-11. The largest manufacturer, Bharat Seats, produces nearly 50% of country's requirement of seats using CFC-11 based imported polyol formulations containing an additional 80 tons of CFC-11. Bharat now is changing to CFC-free systems. One more large enterprise for manufacture of seats is expected to go into production by 1994. By 1994, the requirement of unconstrained consumption of polyol & isocyanate systems in automotive sector is expected to be of the order of 4600 MT, which would lead to consumption of 210 MT of CFC-11.

Rigid foam sector (Refrigeration)

The domestic refrigerator industry of India consumed about 575 MT of CFC-11 in polyurethane foaming operations in 1992. Production of refrigerators and freezers has increased significantly in the past three years with two new companies entering the field. In 1992 production was about 1.4 million refrigerators and it is expected to increase to 2.3 million refrigerators by 1995. Domestic refrigerators are relatively small (about 165 liters). Each refrigerator uses about 3 kg. of foam, which requires about 0.45 kg of CFC-11 for foam production. Recently large refrigerators, using approximately 5.5 kg. of foam per refrigerator, have also entered the market. It is expected that by 1995, the refrigerator sector will consume approximately 8,000 MT of foam, which will require nearly 875 MT of CFC-11. Availability of alternative polyol/blowing agent combinations from local sources as soon as possible will have a direct impact on these large, rapidly growing CFC consuming sectors.

ENTERPRISE BACKGROUND. Manali Petrochemical Limited (MPL) is located in Madras, India. It is a 100% Indian owned company and employs about 350 people. The revenues in 1991, the first year of operation, were approximately $16 million. Revenues grew in 1992 to $22 million due to penetration of the import market and new sales in flexible moulded and rigid insulation foams. MPL began polyol production at its Madras plant in December 1990. Technology was purchased from ARCO (USA) on a one-time technology transfer agreement covering a broad range of polyether and polyester polyol formulations. A $219,000 OTF grant for a new technology transfer agreement, consultancy services and training costs related to CFC-free systems was approved by the Executive Committee of the Multilateral Fund (ECMF) at their November 1993 meeting.

Annual production capacity for polyols by MPL is 7,500 MT in two plants at the Madras site. Capacity utilization is about 25% but expected to reach 65-70% by 1996. Raw materials for manufacture of polyols, i.e. propylene and propylene oxide are also produced at the same location. Small quantities of polyol systems are exported to Middle East and to Asian Countries. MPL's domestic market share in the foam sector is 45-50%.

PROJECT DESCRIPTION. The project scope and costs have been revised downward by the enterprise to the bare minimum that the enterprise believes can be supported to effect CFC phase out in its customers' foam formulations. New formulations require more sophisticated and higher pressure evaluation techniques compared to CFC formulations. The enterprise considers some of the dropped equipment essential and may provide from its own sources to effect commercial adaptation of non CFC formulations on a timely basis. The enterprise's arguments to support the revised project scope are attached as annex C.

This project would source commercially proven technology for polyurethane foam systems containing low/non-ODP blowing agents. The technology would be adapted at MPL to suit Indian customer needs and specific end-use requirements with modifications to MPL's existing manufacturing infrastructure. Phase I of the project has been subdivided into two parts based on foam type. Part A is for flexible moulded foams and Part B is for rigid foams. Phase II activities are to be determined upon completion of Phase I.

Phase I - Part A (Flexible Moulded Foams)

In this part of the project, the company would develop technology leading to production of CFC free polyurethane foams for flexible moulded applications. Currently MPL manufactures polyol formulations based on conventional technology. Current CFC consumption rate is approximately 60 tonnes annually. MPL proposes to manufacture polyol formulations for flexible moulded foams which would eliminate the need for CFC-11 with water-blown systems. These formulations would eliminate around 94 MT in 1994 and 140 MT in 1995 of CFC-11 in MPL sales to the automotive market. For this purpose, the MPL proposes the following action:

a) Acquire the technology at an estimated cost of about $97,000 from ARCO Inc. of USA through their application center at Singapore.

b) Training of MPL chemists at Singapore, (20 man-days).

c) ARCO Staff would work at MPL's application center to perfect foam formulations.

d) Carry out field trials at foam manufacturers to gain acceptance and feed-back.

e) Define the scope and estimate of a Phase II project for MPL to complete their transition to non-ODS blowing agents in the flexible foam sector.

Phase I Part B: (Rigid Foams)

Part B concerns reduction/phase out of CFC-11 in production of polyurethane foams in the refrigeration and PU foam insulation sector. The main thrust of Part B is application development of Polyol formulations for insulation foam. In this part of the sub-project, MPL proposes to develop formulations to immediately achieve 50% CFC-11 reduction. This action is not expected to need any significant redesign or capital expenditure. MPL further proposes to support the Indian customers with formulations containing alternatives to CFCs, such as HCFC-22, HCFC-141b, and ultimately achieve 100% CFC-free systems with candidates such as HFC-134a and/or cyclopentane. These formulations would eliminate around 350 MT in 1995 of CFC-11. To achieve this objective, the MPL proposes the following actions.

a) Enter into a technical consultancy agreement with Mitsui of Japan to provide the technical guidance in development of rigid formulations. A quotation from Mitsui of Japan is awaited. Estimated cost is about $122,000.

b) Purchase required catalysts, chemicals and alternative blowing agents to carry out the experiments.

c) Buy additional high pressure dispensing equipment and large life size moulds to simulate operating conditions of refrigerator manufacturer.

d) Define the scope and estimate of a Phase II project for MPL to complete their transition to non-ODS blowing agents in the rigid foam sector.

The development of new formulations requires special foam testing equipment. Major properties need to be monitored and to be kept within precise acceptable limits. The technology development also requires the visit of foreign technology experts i.e. Mitsui of Japan. MPL expects to develop the formulations within a period of twelve months, carry out laboratory trials and then field trials to gain acceptance with the refrigerator manufacturers. After successful development of rigid formulations, MPL would be in a position to supply formulations for use by the refrigerator manufacturers prior to commencement of commercial production. The incremental investment costs for manufacturing and supplying these formulations would be presented in project for Phase II activities.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY:

PHASE-I: PART-A

Flexible moulded foams are produced either cold-cured based totally on MDI or hot-cured or semi-hot cured with TDI or a mixture of MDI and TDI. Developed countries mainly use MDI/catalyst/water combinations to replace CFC-11 in flexible moulded foams. Since insulation performance is not a factor, such a system is both acceptable and lower cost. This technology is not applicable to rigid insulation foams, as resultant insulation values are poor. In the Indian context, the polyol industry is in its infancy and would require significant expert technical guidance and training to keep abreast developments in the rest of the world. Since large users of flexible moulded formulations in India have already started specifying CFC-11 free foams, MPL must equip itself with technology to produce the CFC-free polyol formulations needed to domestically produce these foams.

MPL currently export polyol formulations to Middle East and Asia. Consequently, a technology tie up with a renowned technology supplier is necessary (i.e. ARCO-USA) to sustain these exports. MPL requires not only technical guidance in development of formulations but also requires new equipment in addition to that which they already have for foam testing. The major proposed expenditure is for purchase of a bench dispensing machine and larger size moulds to check system flow characteristics which result from an increase in polyol viscosity following elimination of CFC diluent.

PHASE-I : PART-B

In the rigid foam sector, the options available to the company are as follows:

a) Development of 50% CFC-11 free formulations.

b) Development of CFC-free formulations with HCFC-22, HFC-141b, HCFC-134a, and/or cyclopentane, whichever the market demands.

By world standards, most refrigerators manufactured in India are small (165 liters) and moulds are not intricate. MPL believes that by use of suitably enhancing surfactants and blends of low viscosity polyols, it would be possible to use water blowing techniques to phase out 50% of CFC-11 used in appliance foam insulation. However, this activity would require technical guidance from external sources who have already developed such technology. Critical foam properties are thermal conductivity, closed cell content, compression strength, dimensional stability, flowability, filling characteristics, flammability and adhesion to refrigerator liners. New formulations must closely replicate properties of CFC-11 blown foams to be acceptable to appliance manufacturers. On this basis, MPL must have equipment equivalent to that in use by appliance manufacturers in order to conduct appropriate tests prior to plant testing of new formulations.

The thermal conductivity of non-CFC foams is generally higher than CFC foams due to the increased use of thermally conductive carbon dioxide (CO_2). The increased CO_2 is also likely to cause a reduction in compression strength and reduce the closed cell content, both of which would detract from foam properties desired by appliance makers. MPL will need the capability to test these factors under customer conditions if successful marketing of the non-CFC formulations is to be achieved. Existing equipment at MPL is fully committed for routinely testing production of polyol systems and cannot be spared for carrying out concentrated development work.

PROJECT COST. Total Project financing is $700,000 for Phase 1 activities, including capital costs for phase 1 of US$579,600, including 10% contingency; incremental operating costs of US$ 100,000; and financial agent fee of US$ 20,400 as shown below:

INCREMENTAL CAPITAL COST. As detailed in Annex A, the total capital cost for this project for phase 1 part A and phase 1 part B, is $579,600 including a 10% contingency of $52,700 to cover costs due to price escalation and engineering changes which may result as project scope becomes firm and binding quotations are received. (10% contingency was used, instead of 15%, since technology costs are firm and most equipment costs are firm.)

INCREMENTAL OPERATING COST. The project envisages development of systems for use of special chemicals, catalysts and blowing agents in laboratory and field trials. Hence, incremental operating costs for materials used in the development program would be incurred and have been included in the project. Incremental manpower and energy costs are also to be expected during the period of development and have been included in the incremental operating cost estimate. The Net Present Value (NPV) of incremental operating costs is estimated to be $100,000 and is equally divided between Part A and B of Phase I. Incremental operating costs for Phase II are to be determined later and included in a subsequent project.

FINANCIAL AGENT FEE. A 3% financial agent fee (US$ 20,400) has been added.

PROPOSED OTF GRANT. The proposed OTF grant requested equals 100% of incremental capital cost, 100% of incremental operating costs plus the financial agent fee of US$20,400 or a total of <u>US$700,000</u>. However, $219,000 OTF grant approved at the November 1993, meeting of the ECMF to finance technology transfer, etc would be deducted from this amount to arrive at proposed OTF funding for this project submission of US$481,000.

UNIT ABATEMENT COST (UAC). The project will enable Manali customers to phase out 490 MT of CFC annually. The Unit Abatement Cost (UAC) will be calculated for the user industries when those projects are funded to prevent double counting.

FINANCIAL AND ECONOMICAL ANALYSIS:

Economic Rate of Return (ERR). The project is 100% funded by grant and ERR of the project is undefined.

Financial Rate of Return (FRR). The project is 100% funded by grant and FRR is undefined.

Financial status of enterprise. To be completed at appraisal by IDBI.

Financing plan. To be completed at appraisal by IDBI.

PROJECT IMPLEMENTATION. The project will be executed by Manali. Detailed implementation plan will be included in IDBI appraisal report. The project implementation schedule is presented in Annex B.

Changes in Project Scope and Costs Due to OORG Comments and MPEC Comments

Technology supply arrangements have been defined and project scope and costs were reduced substantially after a series of OORG reviews of the project during 1993 and MPEC comments during November, 1993. Consideration will be given to zero-ODP (e.g. hydrocarbon) blowing agents in the development program. Attention will also be given to reducing emphasis on reduced CFC foams where lower ODP options are possible, consistent with India's CP.

Annex A

PROJECT COST SUMMARY
Manali Petrochemical Ltd.

	US$
CAPITAL COSTS	
Phase I - Part A	
Technology Transfer, Consultancy and Training	97,000
Testing Equipment	45,200
Freight/Insurance	4,300
SUB-TOTAL	146,500
Phase I - Part B	
Technology Transfer, Consultation and Training	122,000
High Pressure foaming Equipment	232,400
Freight/Insurance	26,000
SUB-TOTAL	380,400
Contingency (10%)	52,700
PHASE I - TOTAL CAPITAL COSTS	579,600
OPERATING COSTS (NPV)	
Phase I - Part A	50,000
Part B	50,000
TOTAL OPERATING COSTS	100,000
TOTAL PROJECT COST[3]	679,600
FINANCIAL AGENT FEE, 3%	20,400
TOTAL PROJECT FINANCING	700,000

[3] Duties and taxes have been excluded from all project costs.

Annex B

IMPLEMENTATION SCHEDULE[4]

	From	To
Phase I - Part A - Flexible Moulded Formulations		
Technical assistance and visits	1Q-'94	2H-'94
Procurement	1Q-'94	2H-'94
Bench trials and testing	1Q-'94	3Q-'94
Demonstration at MPL Lab. and at customer location	2Q-'94	4Q-'94
Ready for commercial production	2H-'94	-
Part B-1 - 50% CFC Foam Formulations		
Technical assistance and visits	1Q-'94	2H-'94
Construction and procurement	1Q-'94	2H-'94
Bench trials and Testing	3Q-'94	1Q-'95
Demo at MPL and customers	1Q-'94	2Q-'95
Commercial production	3Q-'95	-
Part B-2 - 100% CFC-11 Free Formlations		
DEM discussions to define needs	1Q-'94	2Q-'94
Technical Assistance and visits	1Q-'94	4Q-'94
Bench trials and testing	3Q-'94	3Q-'95
Demo at MP Lab of new technology	3Q-'95	4Q-'95
Commercial production	4Q-'95	-

4 Project schedule assumes ECMP approval of project during 1Q94.

MANALI PETROCHEMICAL LTD. MADRAS, INDIA

Scope

The project under review covers the development of technology suitable for the Indian market in the fields of:

a) CFC-free systems for flexible moulded foams for the automotive sector.

b) CFC 11 reduced and CFC-free systems for rigid insulation foams for the domestic refrigerator sector.

It is the reviewer's understanding that other actions in which MANALI is engaged in, such as flexible slabstock, integral skin, general insulation (building) and structural foams, are outside the scope of this project.

Recommendation

The project is supported. As discussed in the section on "technical soundness" the time of phasing in HCFC/HFC technology for the rigid application and the choice of technology post "reduced CFC" will have to be decided as the project develops.

Relevancy and Adequacy of information

This is the most comprehensive and best prepared project that this reviewer has seen.

Technical soundness

Technology and technical support for this project is to be obtained from two (Arco Chemical and Mitsui) of the world leaders in the field.
For the flexible moulded application the proposed route is understood to be based on MDI/water blown technology, in line with general world trends.
For the rigid refrigerator application the project envisages the development of 50% reduced CFC 11 formulations followed by CFC-free formulations. The project plan calls for the market introduction of the CFC-free formulations only six months after the 50% reduced formulations. Because of the rapid implementation of CFC-free formulations in other markets, The Bank will be reviewing policy on the technologies to be supported during 1993 and this project should take note of any conclusions reached. The only way to progress towards ODS elimination during a period of technological change is cover several bases and constantly review technological choices as time passes. Twenty-twenty vision will be evident in hindsight.
It is noted that equipment capable of handling low boiling blowing agents such as HCFC 22 and HCF 134a is included in the quotations.

./2..

The reviewer repeats earlier comments that HCFC 22 alone is considered to be unsuitable for this application because of rapid loss of insulation value through diffusion out of the foam. There is an increasing interest in cyclopentane technology in the refrigerator sector and further equipment and procedures would be necessary to handle this flammable blowing agent.

Lesson from experience

This project shows the benefit of interchange between the project developers and reviewer during the earlier stages of project development.

Environmental Issues

The execution of the project should consider the time scale over which 50% reduced CFC 11 formulations are used when proven technology will be available in the short term for complete CFC replacement by either HCFC or zero ODP technology.
The centre of zero ODP rigid foam technology is currently Europe and other technology partners might be required for this stage.

Safety Issues

The issues raised at an earlier stage appear to be adequately addressed in Appendix III. It is recommended that these are incorporated in the main project and referred to under "training".

Cost Effectiveness

The project's effectiveness can be expressed as 1.7 $/kg of ODS phased out although this analysis does not take into account additional costs incurred at the production at MANALI or at the downstream production stage (foam or refrigerator factor). The figure expressed above is highly effective compared with the bulk of foam projects.

Other

No additional comments.

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER REVISED PROJECT COVER SHEET

COUNTRY	India
SECTORS COVERED	Rigid and Flexible Moulded Foams
ODS CONSUMPTION IN AFFECTED SECTOR	1,280 tons of CFC-11 (1991)
PROJECT TITLE	Conversion of CFC-11/polyol systems to low/non-ODS formulations.
PROJECT DURATION	Phase I: 1 year (1994/95) Phase II: 2 years (1995- 97)
PROJECT IMPACT	705 MT ODS in the period 1995-97
PROPOSED BUDGET	Incremental Capital Cost $572,300 Incremental Operation Cost $ 35,000 Financial Agent Fee $ 17,200 Total Project Cost $651,000
PROPOSED OTF GRANT	$589,500[1]
IMPLEMENTING ENTERPRISE	UB Petroproducts Ltd.
IMPLEMENTING AGENCY	The World Bank/IDBI
NATIONAL COORDINATING AGENCY	Ministry of Environment and Forests (MOEF)

PROJECT SUMMARY

This project will replace CFC-11 as the blowing agent in polyurethane rigid insulation and flexible moulded foams with low/zero ODS alternatives. UB Petroproducts manufacture polyurethane chemical systems for these foam applications. The project would be implemented in two phases. Phase I involves: a) sourcing of appropriate technology, b) establishment of test facilities which include high pressure foaming equipment, and c) evaluation of non-CFC alternates for each end-use. Phase II includes: a) customer trials/testing/training of non-CFC systems, and b) commercial production of formulated polyols. Technology would be obtained from Enichem (Italy) for systems based on low ODP CFC-alternates and adapted to suit Indian customer specific end-use requirements. The project would permit phasing out 705 MT of CFC-11 in manufacturing polyurethane foams during 1995-97. The project would provide local source of essential materials and technology with which industry would reduce CFC-11 usage in India by about 1,200 MT per year by 1997. Project scope and cost have been revised taking into account comments from MPEC in November, 1993. The project is part of GOI strategy in foam sector to support competitive role of three or more existing private sector polyol/foam systems suppliers to the many diverse foam industries throughout India.

TECHNICAL ASSESSMENT: The revised project is supported by OORG technical reviewer, M. Jeffs. His comments are attached.

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[1] **A $200,000 OTF grant was approved at the November 1993 meeting of the ECMF to finance a technology transfer agreement included in this project.**

PROJECT OBJECTIVES. The objective of this project is to provide polyols needed for replacement of CFC-11 as blowing agent with low ODP alternates by: i) modifying the chemical system i.e., polyol + catalyst + isocynate and testing it extensively to make it suitable for use with CFC-alternate; and ii) providing on-site demonstration capability to encourage a more rapid conversion to non-CFC blowing agents.

SECTOR BACKGROUND. The Indian foam industry consumed 1,280 tons of CFC-11 in 1991.

Table-1
(metric tons)
ODS Consumption in Foams, 1991

Category	CFC-11	CFC-12	CFC-113
Polyurethane Foams (PUF)			
Flexible Moulded	160		
Flexible Slabstock Foams	40		
Rigid PUF			
Refrigerator Insulation	500		
General Insulation	240		
Thermoware	220		
Integral Skin Foams	20		
Phenolic Foams	20		20
Thermoplastic Foams	70	280	
Misc.	10		
Total	1,280	280	20

Three or more existing private sector firms (Manali, UB Products and Expanded) supply most of the foam formulations and materials to the foam industry, in a highly competitive market with rapidly changing technology. Government strategy in the foam sector is to support the ability of these firms to maintain their market presence in the transition to non ODS foam systems and support the ability of these foam systems suppliers to service the many diverse foam industries throughout India, including small scale sector who are not well served by imported suppliers. Competitive supply from the three firms is essential to reach this market and to keep foam formulations and materials at competitive prices. The Government considers that all three polyol foam formulation projects are essential to implementation of a cost effective and timely phase out action program in the foam sector.

Unconstrained demand would lead to an expected ODS use of about ten times the current consumption in year 2010. The sector consists of about 235 enterprises. About 20% of these companies are large or medium sized and have relatively sophisticated manufacturing equipment. The remaining enterprises operate small scale units and are technically and chemically unsophisticated. The support of the chemical suppliers would be crucial in reaching and educating this group.

UB Petroproducts Ltd. had about 14% share of foam sector market in 1992.

ENTERPRISE BACKGROUND. UB Petroproducts Limited currently manufactures polyurethane chemical systems (Polyol + Isocyanate) with and without CFC-11 for the following end-uses:

1) Insulated thermoware;
2) General Insulation applications: Sprays, slabs, pipe-sections, etc;
3) Flexible moulded foams for automotive and furniture applications; and
4) Integral skin foams.

It also supplies systems for domestic refrigerator insulation. However, these systems are supplied without blowing agent - the addition of which is done by the refrigerator manufacturer at their works. UB Petroproducts commenced manufacture of CFC-11 based products in 1992. Previously, local demand was being met by imports.

Production Capacity

For Polyols : 8,000 MT/Annum
(Note: Only Polyols are manufactured locally, isocyanate component being imported and then supplied to end-users).

Current (1993) capacity utilization is at about 25% since the enterprise is still virtually in a start-up mode. Capacity utilization is expected to increase to about 55 to 60% in 5 years - mostly at the expense of imports. Corresponding to production of formulated polyols, consumption of ODS is expected to be:

ANNUAL ODS CONSUMPTION (MT CFC-11)
(Current/Projected)

	1992	1993	1994	1995	1996	1997
DIRECT	57	250	335	413	463	511
INDIRECT	106	214	282	340	391	438

Technology Source

Existing technology for conventional CFC-11 based polyurethane systems has been procured from Enichem, Italy.

Ownership

90% - Indian (UB Group, Tamil Nadu Govt., Public); 10% - Italy (Enichem)

PROJECT DESCRIPTION. The project scope and costs have been revised downward by the enterprise to the bare minimum that the enterprise believes can be supported to effect CFC phase out in its customers' foam formulations. New formulations require more sophisticated and higher pressure evaluation techniques compared to CFC formulations. The enterprise considers some of the dropped equipment essential and may provide from its own sources to effect commercial adoption of non-CFC formulations on a timely basis. The enterprise's arguments to support the revised project scope are attached as annex C.

The project would aim at developing polyurethane foam systems (Formulated Polyol + Isocyanate) that can be used with CFC-alternate blowing agents with low ODP's. This would, in turn, enable the reduction in usage of CFC-11 for polyurethane foam blowing. Part of the reduction would be in consumption of CFC-11 at UB Petroproducts itself (direct) and partly, by reduction at customers' works (indirect).

Phase I (1994/95) of the project envisages the following steps:

1) From Enichem (Italy), transfer commercially proven technologies for CFC-alternate based systems. These would apply to rigid insulation foams and to CO_2/water systems for flexible moulded foams;

2) Establish high pressure foam machinery & test facilities;

3) Evaluation of these alternate technologies and choice of appropriate blowing agents for each end-use application; and

4) Production of suitable base polyols, testing/characterization at the enterprise and at customer locations, and adaptation of systems to specific customer needs.

In view of the diversity of applications that use UB's products, it is considered necessary to have a range of different systems to choose from. However, they need to be thoroughly evaluated with various blowing agent candidates.

Phase II (1995-97) of the project would consist of:

1) Trials/testing at customers end; adaptation of low-ODP blowing agent technology to specific customer needs/requirements;
2) Training of customer's technicians and provision of assistance in equipment modification;
3) Commercial production of formulated polyols.

JUSTIFICATION FOR SOURCE OF TECHNOLOGY. The proposed source of technology is Enichem (Italy). They have provided conventional CFC-based system technology for the current range of UB Petroproducts products, and as such are familiar with their product range and Indian manufacturing conditions. They are amongst the world leaders in PU systems/intermediates and have ongoing active research programs on CFC-replacements in foam blowing applications. Many of their CFC-reduced systems are being used successfully in Western Europe. UB Petroproducts would, on sourcing technology from Enichem, have the benefit of the latest and most appropriate technology for low ODP blowing agents when the actual transfer of the technology takes place.

JUSTIFICATION FOR TECHNOLOGY SELECTION:

Flexible Moulded Foams

Proven CFC-free technologies based on TDI-isocyanates are currently used in W. Europe without any significant compromise on densities or performance. This would be the first area of concentration for UB Petroproducts - constitutes about 50% of the market - for adopting technology under Indian conditions. MDI based water systems would be tested and introduced next. All approaches are cost-effective, being approximately the same as current systems. The rationale for selection of technologies is outlined below:

Rigid Foam Systems

Seven alternate routes are being considered for evaluation:

1) Reduced (50%) CFC-11 systems have been widely used and proven in Western Europe and developed countries for the last three years. The key benefits are the minimal engineering changes required for the conversion. This would enable an immediate reduction in CFC-11 usage, thus providing some time for implementing more lasting solutions. It is, however, at best, only a stop-gap measure on the path to zero-ODP technologies.

2) HCFC-22 based systems - HCFC-22 is commercially available in India and promises some price stability. The factors would enable quick introduction/changeover from CFC-11 for certain applications such as steel faced panels.

3) HCFC-22/142 blends - Systems based on these blends have displayed properties that are superior to HCFC-22 based systems - both in terms of processing and foam properties. HCFC-22/142b based systems require high pressure technology, and as such can be viewed as an intermediate step to

using zero-ODP options such as HFC-134a or hydrocarbons (which also require high pressure technology).

4) HCFC-141b - use of HCFC-141b as a drop-in replacement to CFC-11 must consider flammability and the possible need for changes in auxiliary materials (e.g. liners) used in domestic refrigerator applications. It has merit as an interim CFC-11 replacement and for applications where use of high pressure technology is precluded.

5) HCFC-123 - Toxicity is a primary issue. HCFC-123 only has potential as a drop-in replacement for CFC-11 where human exposure can be controlled as the occupation exposure limit is only 5 ppm. To date, few such applications have been identified.

6) CO_2 - This technology has potential for applications where K values and dimensions are not the constraining factors.

7) Cyclopentane - Indian appliance manufacturers are considering cyclopentane as an alternative to other low/non-ODP blowing agents in rigid foam applications. This option would be evaluated with due consideration of safety.

PROJECT COST. The total project incremental costs for Phase I were calculated at US$651,000 as shown below and in annex A, including contingency and financial agent fee. Since there are no non-ODS investment costs associated with this project and no offsetting change in revenue, total project cost is also equal to incremental cost.

INCREMENTAL CAPITAL COSTS. Incremental capital costs for the project total US$ 597,000 and include a 15% contingency of $ 78,000.

INCREMENTAL OPERATING COST. Incremental operating costs are only included for Phase I and would vary from year to year based on changes in proportions and prices of blowing agents, polyol and isocyanate. Given a discount rate of 10%, the net present value of incremental operating costs for the first four years is estimated to be US$ 105,000. <u>However, the enterprise has reduced the request for funding of operating cost to US$ 35,000.</u> Only systems which involve direct usage of CFC-11 at UB Petroproducts have been considered in these calculations.

Financial agent fee. A 3% financial agent fee has been added of US$ 19,000.

PROPOSED OTF FUNDING. The proposal requests US$589,500 as a grant from the Ozone Projects Trust Fund. The US$200,000 approved by MPEC in November 1993 would be deducted from this amount to arrive at proposed OTF funding for this project submission of US$389,500.

FINANCIAL AND ECONOMIC ANALYSIS. Economic Rate of Return (ERR): Since the project involves 100% funding for one time capital cost and recurring operating cost, the ERR is undefined. Financial Rate of Return (FRR): Since the project involves 100% funding for one time capital cost and recurring operating cost, the FRR is undefined.

UNIT ABATEMENT COSTS. To be determined. Unit abatement costs will be calculated for the foam customers of UB when they prepare their projects, to avoid double counting.

REQUIRED REGULATORY ACTIONS. The general comments on taxes and duties apply to this project. The enterprise has requested that the Government grant full exemption for taxes due to the non commercial nature of the investment and because the enterprise will incur some expenses for items not covered by the OTF grant.

Changes in Project Scope and Costs Due to OORG Comments and MPEC Comments

Costs were reduced substantially as a result of review by the OORG expert during 1993 and in response to MPEC comments in November, 1993. The enterprise has given a better explanation of market position and technology employed. UB has an established technology agreement with Enichem and this would continue as long as the company thinks it is appropriate. Competition would be provided from other sources. The schedule for phasing in rigid foam applications can not be given until, the refrigeration sector phase out plan is better developed. These latter points would be reviewed during subproject appraisal.

Annex A

PROJECT COST SUMMARY
UB Petroproducts Ltd.

	US$
CAPITAL COSTS	
Phase I	
Technology Transfer Fee	200,000
Testing and Control Equip.	34,000
Blending and Mixing	209,000
Moulds and Jigs	20,000
Spray/pourin-place Machine	25,000
SUB-TOTAL	488,000
Training	31,000
SUB-TOTAL	519,000
Contingency (15%)	78,000
TOTAL CAPITAL COSTS	597,000
90% of capital costs[2]	537,300
TOTAL OPERATING COSTS	35,000
	573,300
TOTAL PROJECT COST[3]	573,300
Financial Agent Fee	17,200
	589,500

[2] Euqal to local ownership fraction of 90%.

[3] Duties and taxes have been excluded from all project costs.

Annex B

IMPLEMENTATION SCHEDULE
UB Petroproducts Ltd.

	From	To
Phase I		
Technology Transfer Agreement	1Q-94	2Q-94
Procurement	2Q-94	4Q-94
Bench trials and testing	3Q-94	1Q-95
Demonstrations at Expanded Lab and at customer location	2Q-95	4Q-97
Pilot Production	4Q-94	2Q-95
Phase II		
Plant Modification	2Q-95	2Q-97
Commercial production of modified polyols	4Q-95	4Q-97

UB PETROPRODUCTS, MADRAS, INDIA

SCOPE

The project under review covers the development of technology for CFC 11 reduction and elimination in the polyurethane rigid insulating foam and flexible moulded foam. The first phase under review covers the steps up to and including proving trials at customers' facilities.

RECOMMENDATION

The project is supported. As in other projects now undergoing the review process - the choice and timing of technologies to be implemented for rigid insulating foams need to be determined at a later stage in the project. These should be in line with guidelines to be developed by The Bank.

RELEVANCY AND ADEQUACY OF INFORMATION

Information is comprehensive and well set out to the high standard which should now be the norm. There should be some further technology exemplification as noted in the next section.

TECHNICAL SOUNDNESS

The technology and technical support is provided by Enichem, one of the leaders in the field. However, it would be beneficial to UB Petroproducts if they were exposed to technology from competitive suppliers.

For flexible moulded foams CFC-free technology is not fully explained for the TDI-based systems. There are several technologies which the enterprise could use.

The choice for MDI-based flexible foam systems is given.

For rigid foams several technologies are listed, including reduced CFC 11 systems. The proposed timetable for phasing in the various technologies should be given. Because of the rapid implementation of CFC-free technologies in other markets, The Bank will be reviewing policy on the technologies to be supported for refrigerator insulation during 1993 and the project should take note of the guidelines to be developed. The review may also be extended to other sectors.

The project envisages the evaluation of several options and this is a sound way to progress at a time of rapid technological change.

The following comments are offered on some of the technologies listed :

- HCFC 22 technology is not considered suitable except in those applications, such as steel-faced panels, where protection against rapid thermal conductivity ageing is provided. Plastic panels (liners), as in refrigerators, are not suitable.
- The project description should clarify exactly that pressurised blowing agent addition facilities (eg. Easy Froth) are required for blowing agents which boil at low temperatures.
- The reviewer considers that the toxicology issues which related to HCFC 141b are now resolved.
- HCFC 123 should not be considered since its OEL (occupational exposure limit) is considered to be 5 ppm by several potential suppliers - this should constitute an unnecessary health risk as other, cheaper, alternatives are available.

LESSON FROM EXPERIENCE

The project shows progress along the learning curve.

ENVIRONMENTAL ISSUES

As noted, the project in its execution phase should follow a rapid path to low or zero ODS technologies, always provided that there are proven technologies. Reduced CFC 11 is, at best, a short term stop-gap measure.

SAFETY ISSUES

The portable use of cyclopentane is noted and there must be adequate training if this option is followed through. Further capital expenditure should be required in addition. The sum involved would not be trivial.

COST EFFECTIVENESS

It is noted that additional expenditure is required over and above the technology fee for foreign experts, presumably from Enichem, to visit India. Nevertheless, the project is cost effective at $ 1.2/kg of ODS phased out. This figure depends on the growth rates being achieved which include the capture of market share by the enterprise and does not include production costs at UB Petroproducts or its down stream customers.

OTHERS

None.

10/8/93

PROJECT COVER SHEET

COUNTRY	India
SECTOR COVERED	Fire Protection / Halon
ODS USE IN SECTOR	550 tons Halon 1211, 200 tons Halon 1301 and 135 tons CFC 12 in 1991
PROJECT TITLE	ABC-DCP manufacturing facility
PROJECT DURATION	1 year
PROJECT IMPACT	Phase-out 480 tons Halon 1211 and 120 tons CFC 12 in first year of operation (1995/96) and 800 tons Halon 1211 and 200 tons CFC 12 in 2001/02) at full capacity.
UNIT ABATEMENT COST	
PROPOSED BUDGET	Incremental capital costs US$ 630,800 Incremental operating benefit US$ 28,000 Financial Agent Fee US$ 18,100
PROPOSED OTF GRANT	US$ 620,900
IMPLEMENTING ENTERPRISE	Real Value Appliances Limited
IMPLEMENTING AGENCY	The World Bank/IDBI
NATIONAL COORDINATING AGENCY	Ministry of Environment & Forests

PROJECT SUMMARY

This project will produce ABC dry chemical powder (DCP) that would be used as an alternative to halons in portable extinguishers. By using ABC-DCP in portable extinguishers, the present Halon 1211 and CFC 12 consumption could be phased-out. This project will produce 1000 tons of ABC-DCP annually when the line is in full operation. This amount corresponds to an equivalent phase-out of 800 tons of Halon 1211 and 200 tons of CFC 12.

This project will involve a technology transfer agreement with ABC-DCP manufacturers in the developed countries. This project has been identified as one of high priority and has been included in the Country Program.

TECHNICAL ASSESSMENT. The project has been reviewed and supported by the OORG reviewer, P. Di Nenno. His comments are attached.

PROJECT OBJECTIVES

The aim of this project is to produce ABC-DCP and thereby make available this halon-alternative for the enterprise's own consumption and to supply to other manufacturers of portable extinguishers in the country.

SECTOR BACKGROUND

For purposes of fire protection, the ozone-depleting substances Halon 1211 and Halon 1301 are used as extinguishing agents in portable extinguishers and fixed systems respectively. In portable halon extinguishers, a small quantity of CFC 12 is also used as a propellant. The present and future demand of the three ODS along with their ODP has been estimated in Table 1.

Table 1

(tons)

Type	Units	1991	1996	2002	2005	2010
Halon 1211	ODS	550	1050	1500	1750	2100
	ODP	1650	3150	4500	5250	6300
Halon 1301	ODS	200	340	600	800	1000
	ODP	2000	3400	6000	8000	10000
CFC 12	ODS	135	262	375	437	525
	ODP	135	262	375	437	525

ENTERPRISE BACKGROUND

Real Value Appliances Limited was incorporated as a private limited company in July 1989 and subsequently became a public limited company in May 1992. The enterprise is 100 % locally owned and had a turnover of US$ 0.44 million or Rs. 14 million for a 16-month period in the year 1992-93 and employs around 150 people. The manufacturing unit is located in Bhor in Maharashtra (Western India) with its head office in Bombay. It has about 20 branches all over the country to support the aggressive marketing strategies in promoting its portable extinguisher as a user-friendly product.

It commenced operations in September 1989 with manufacture of Halon 1211 portable fire extinguishers and soon became the largest consumer of halons in India. In about three years, the enterprise sold over 800,000 units of 500 gm Halon 1211 portable extinguisher. The enterprise imported Halon 1211 from

ICI-UK and quantity of halons consumed from time of commencement of production till date is given in Table 2.

Table 2

Year	Consumption (tons)
1989-90	70.2
1990-91	142.0
1991-92	39.0
1992-93	24.8

note: Indian fiscal year ends on March 31 and split year designations refer to fiscal years.

Since at that time, the enterprise was dependent on import of halons, it had to formulate its strategies with regard to halon phase-out based on international trends. With the assistance of the overseas halon supplier, ICI-UK, the enterprise determined that ABC-DCP was the appropriate alternative. Given that its line of business was critically dependent on availability of halons and being one of the largest consumers of halons, the enterprise is adversely affected due to the Montreal Protocol and is therefore most suited to promote this project to manufacture ABC-DCP so as to be in a position to supply to its needs and to that of the industry in a larger context. Since that time, halon production has started in India, and the enterprise would have switched to local supply of halon except for this project and the parallel project to convert its cylinder operation from halon to ABC powder. In 1992/93 the enterprise also started production of ABC powder cylinders on a trial basis. In early 1993/94, halon filled cylinder production was stopped.

PROJECT DESCRIPTION

This project is to establish a new facility for the manufacture of 1,000 tons per year of ABC-DCP, which would replace use of halons in portable fire extinguishers. A non ODS gas would be used to replace CFC as the propellant. For this project, the enterprise will enter into a technology transfer agreement with one of the manufacturers of the ABC-DCP in the developed countries after the approval of this proposal is obtained. It is only the know-how which is required to be transferred, all the capital equipment are to be sourced and fabricated indigenously. This project will be established by Indian engineering consultants on a turnkey basis in collaboration with the technology suppliers.

The enterprise is one of the largest manufacturers of ABC-DCP portable extinguishers in the country. (See parallel project for ABC powder cylinder production.) Being critically dependent on ABC-DCP as raw material, the enterprise is motivated towards establishing its own facility for the manufacture.

JUSTIFICATION FOR SELECTION OF ALTERNATIVE TECHNOLOGY

ABC-DCP is an accepted alternative to Halon 1211 for portable extinguishers. ABC-DCP is a recognized alternative by the UNEP Technical Options Committee (Halon sector) and has been included in India Country Program. In terms of effectiveness in fire protection, ABC-DCP is substantially equal to Halon 1211, but within India there is a perception within the market that Halon is superior and great attention is needed to product quality.

PROJECT COST:

The capital costs excluding taxes/duties is US$ 630,800. Being a new project, the capital cost is incremental to the enterprise. The project has net incremental recurring benefits during the operational life of the project and this revenue stream has been deducted from the incremental capital cost in order to calculate the eligible OTF grant for this project.

Incremental capital costs. The incremental capital costs excluding taxes/duties is US$ 630,800. (Annex A)

Incremental operating costs. These costs include the cost of raw materials, salaries and wages, insurance premium, repairs and maintenance, power cost and miscellaneous expenses. Four years of operating costs discounted to present value equals US$ 3,573,710.

Incremental operating benefits. This project envisages incremental recurring benefits through sale of ABC-DCP from first year of operation. Four years of operating benefits discounted to present value equals US$ 3,601,730. Thus net recurring benefits equals US$ 28,000.

TOTAL INCREMENTAL COSTS OF THE PROJECT

Net Incremental Project Costs: US$ 630,800-28,000=US$ 602,800

Financial Agent Fee: 3% or US$ 18,100

PROPOSED OTF GRANT US$ 620,900

Local Ownership. The enterprise is 100% locally owned.

Unit abatement cost. The unit abatement costs or the annual cost required to phase-out one kilogram of ODP ton is given as

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

In this case, C, the capital cost is US 630,800 and the recurring cost at full operation is US 1.64 million and recurring benefit is US 1.65 million. The ODS that will be phased out at full operating capacity is 800 tons of Halon 1211 and 200 tons of CFC 12. Therefore, W - the annual ODS reduction at the first year of full operation expressed in ODP units - is 2600 tons. C(F) is evaluated as US$ 139,000 where F is the capital recovery factor. The unit abatement costs is therefore evaluated as 0.04 US$ per kg. However, note that UAC for this project and the parallel project represent the same ODS phase out and the costs for both should be combined to determine a single UAC index.

FINANCIAL AND ECONOMIC ANALYSIS

Economic rate of return (ERR). to be determined in appraisal
Financial rate of return (FRR). to be determined in appraisal

FINANCIAL HEALTH OF ENTERPRISE

The enterprise has had a healthy financial performance from the time of its inception. A comparison of the last four years financial performance as it appears in the enterprise's annual report is provided in Table 3.

Table 3

(Rs. million)

Particulars	1989-90	1990-91	1991-92 (8months)	1992-93 (16months)
Equity Base	1.55	2.40	2.40	76.50
Share premium	-	-	-	112.70
Turnover	3.36	7.57	3.43	142.50
Profit after tax	1.65	4.86	5.81	30.50
Gross Block	1.02	9.73	17.17	90.00

note change of fiscal year in 1991

This project has net incremental recurring benefits from the first year of operation. Hence it is expected to have a healthy financial performance.

FINANCING PLAN

The OTF grant is equal to 95% of project capital costs excluding duties. The balance - US$28,000 will be raised by the enterprise from internally accrued funds.

PROJECT IMPLEMENTATION

The expected time period for the different activities is 1 year and the detailed break-up is given below:

1. Negotiations to finale technology transfer agreements	12 weeks
2. Procurement of land	8 weeks
3. Placing order for machinery and delivery	20 weeks
4. Erection of machinery	6 weeks
5. Pre-commissioning and start-up	6 weeks
Total	52 weeks

REQUIRED REGULATORY ACTIONS

It would be required for the Government of India to waive duties/taxes for all equipment supplied for this project as these are transfer payments rather than true economic costs.

RESULTS

Direct Project Impacts. This project has no direct impact since it will be suppliers of ABC-DCP for its own consumption and to other portable extinguisher manufacturers. **Indirect Project Impacts**. In the first year of operation (1995-96), this project will phase-out 480 tons of Halon 1211 and 120 tons of CFC 12. On achieving full capacity operation (2001-2002), the project will phase-out 800 tons of Halon 1211 and 200 tons of CFC 12.

ENVIRONMENTAL IMPACT ASSESSMENT. Being a powder, the alternative ABC-DCP will not reach up to the atmosphere and hence will not damage the ozone layer. The powder will also not cause any pollution at the surface level.

SUMMARY OF PROJECT COSTS

Particulars	Costs Excl.Taxes/Duties US$ 000	Costs Excl.Taxes/Duties Rs. Million	Taxes/Duties US$ 000	Taxes/Duties Rs. Million
1. Capital Equipment				
Primary Equipment	69.70	2.20	6.27	0.20
Auxiliary Equipment	77.22	2.43	6.69	0.21
Spare Parts	39.11	1.23	3.52	0.11
Quality Control Equipment	9.81	0.31	0.88	0.03
Miscellaneous Equipment	23.73	0.75	2.14	0.07
2.Installation/Start Up	147.58	4.65	0.00	0.00
3.Technology Transfer Fees	175.00	5.51	0.00	0.00
4.Expenses in Project Management	6.35	0.20	0.00	0.00
subtotal	548.5	17.28	19.50	0.61
Contingency, 15% of subtotal	82.3			
Total Project costs	630.8			

Technical Opinion
ABC-DCP Manufacturing Facility
India

Recommendation:

The project is supported.

Relevance and Adequacy of Information:

The project appears well founded in principle. It is not possible to judge the cost figures. The DCP technology transfer fees are uncertain. Since the DCP technology source is not identified, it is not possible to assess this vital component of the proposal.

Technical Soundness:

Conversion from 1211 to DCP for portable extinguisher use makes sense for many applications. The excess DCP technology to be used is an optimization issue. Provided the DCP technology source is sound, the project is appropriate with minimum risk, and no unexpected problems.

Environmental Issues: None

Safety Issues: No unique problems

Cost Effectiveness:

Based upon my own experience and knowledge, conversion from 1211 to DCP should be cost effective. The costs of this particular project are largely driven by local conditions. The technology licensing cost should be further defined. It is not clear why this conversion involves an annual cost relative to 1211. DCP conversion should result in much lower costs.

Hughes Associates, Inc.

203/2.

WWF World Wide Fund For Nature-India
विश्व प्रकृति निधि, भारत

WWF-INDIA
Secretariat (Delhi)
P.O. Box 3058
172-B, Lodi Estate
New Delhi-110 003

9 February 1994.

Mr. Don Brown,
World Bank,
Headquarters,
Washington D.C.
USA.

Dear Mr. Brown:

Please find the information on the Real Value Appliances projects that you wanted when we met yesterday at your New Delhi office. I have also attempted to provide specific answers to the comments / queries raised in Mr. Omar El Arni's fax of 7 February 1994 with a view that it may be useful to you. Please note that all the italicized portions refer to the original versions of the proposals.

ABC-DCP Manufacture

1. **Table 1:**

The figures of Halon 1211 and Halon 1301 consumption has been obtained from the Halon Sectoral reports, which were prepared while compiling the India Country Programme. The figures for CFC consumption is taken as one-fourth of the Halon 1211 consumption since it is the proportion in which Halon 1211 and CFC 12 are mixed in halon-based portable extinguishers.

2. **Table 2 and ABC powder production build-up:**

Table 2

Year	Halon Consumption (tons)	ABC-DCP Consumption (tons)
1989-90	70.2	nil
1990-91	142.0	nil
1991-92	39.0	nil
1992-93	24.8	125

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172-B, Lodi Estate, Max Mueller Marg, New Delhi-110 003 Tel.: 4627586, 616532, 693744 Fax: 462 6837 Grams: PANDAFUND DELHI

253/3

From the current year, i.e. 1993-94 onwards, there will be no consumption of halon by Real Value, while the consumption of ABC-DCP will be available only at the end of the financial year, 31 March 1994. Real Value did not have any consumption of BC powder.

The text following Table 2 need not be changed and matches with the additional data provided.

3. **Comment on 800 ton halon / 200 ton CFC 12:**

The ABC-DCP manufacture project is expected to produce 600 tons in the first year of operation (1995-96) and 1000 tons when operating in full capacity (the seventh year or 2001-02). The full capacity operation would be replacing 800 tons of Halon 1211 and 200 tons of CFC 12.

4. **Capital costs details:**

Detailed break-up of the capital cost is in the original proposal - Annex 1A & 1B (Pgs. 8-13).

<u>ABC-DCP cylinder</u>

1. **Table 1:**

Same as for the ABC-DCP manufacture project.

2. **Table 2 ABC-DCP production build-up:**

Same as for the ABC-DCP manufacture project. Note that the first year of phase-out needs to be reverted to 1992-93 as the first year of phase out of Halon 1211 from 1994-95.

Annex 2 / Breakdown of incremental recurring costs (pgs.11-15) of the proposal commences from 1992-93 onwards, the year of the partial changeover from Halon 1211 to ABC-DCP. In this Annex, the halon consumption for 1992-93 is given as 100 tons, which is the estimated halon consumption if the phase-out where not necessary. This is different from the actual consumption of 24.8 tons (given in Table 2 above) based on a partial changeover scenario.

3. **Comment on 800 tons halon / 200 tons CFC :**

The conversion project has phased-out 100 tons of Halon 1211 and 25 tons of CFC 12 in the first year (1992-93). When operating in full capacity (1999-2000), the project would be replacing 800 tons of Halon 1211 and 200 tons of CFC 12.

In the original proposal at full operation the phase-out was 768 tons of Halon 1211 and 192 tons of CFC 12 to indicate that full capacity of the filling machine would have reached at the above tonnage. Keeping these figures would also imply that a certain portion of the ABC-DCP supplied by the ABC-DCP manufacture project would have to sold to outside buyers

253/4

and this has been mentioned in the ABC-DCP original proposal.

4. **Capital costs details**

Detailed break-up of the capital cost is in the original proposal - Annex 1 (Pg. 8).

Other points

1. **Tallying the prices of ABC-DCP between the two projects:**

As stated in the ABC-DCP cylinder proposal, the selling price of ABC-DCP by the ABC-DCP manufacture project and the buying price of ABC-DCP by the ABC-DCP cylinder project are the same from the fourth year of operation of the ABC-DCP cylinder project, i.e. 1995-96. The price is Rs. 52 per kg.

2. **Prices of ABC-DCP and Halon 1211:**

As stated in the ABC-DCP cylinder proposal, Halon 1211 would cost Rs. 281.25 per kg (imported price). The selling price of a Halon 1211 500 gm portable extinguisher is Rs. 278.50. The net revenue (selling price - cost price) per Halon 1211 500 gm extinguisher is Rs. 22.40 in the first year of operation.

The cost of imported ABC-DCP is Rs. 58.00 per kg. and the cost of ABC-DCP to be produced by the ABC-DCP manufacture project is Rs. 52.00 per kg. The selling price of a ABC-DCP 500 gm portable extinguisher is Rs. 245.50. The net revenue (selling price - cost price) per ABC-DCP 500 gm extinguisher is Rs. 10.50 in the first year of operation.

Specific comments on the points raised in Mr. Omar E. El-Arni's fax

1. Halon chemical manufacturers have not yet shown interest in putting forward any proposals for the manufacture of ABC-DCP. Since the manufacture of ABC-DCP is a much smaller operation vis-a-vis halon manufacture with a requirement for a completely different production process, it may not interest the halon manufacturer to put forward a project for ABC-DCP manufacture at any stage. In a sense this project is similar to a HAP facility being established by a non-CFC manufacturer and being supported by the Multilateral Fund. In fact, this case is stronger since the project proposer is the largest consumer of Halon 1211 and is establishing this project primarily to cater to its own requirement.

   Since the MEF / India Ozone cell have forwarded this project, it is indicative of their support to the above analysis.

2.

(i) Real Value was importing Halon 1211 since local Halon was not available. The reduction in the consumption in 1991-92 and 1992-93 was because of a steep increase in the international prices of Halon 1211. The rise in the international price of halons was primarily caused because of the Montreal Protocol and so Real Value was forced to reduce its consumption. Therefore, the unconstrained scenario for Real Value cannot be based on figures of 1991-92 and 1992-93 but need to be based on 1990-91 when there was an upward trend in the consumption (double of the previous year). Given the above, phasing-out 800 tons of Halon 1211 and 200 tons of CFC 12 in the year 2000-01 is realistic.

(ii) In the last four (not three as earlier noted) years, Real Value has produced around 550,000 units of Halon 1211 portable extinguishers and about 250, 000 units of ABC-DCP portable extinguishers (in 1992-93). Therefore, in total, Real Value has produced 800,000 units in the last four years.

(iii) Details on capital cost

Detailed break-up of the capital cost is in the original proposal - Annex 1A & 1B (Pgs. 8-13).

(iv) Details of incremental operating costs/savings

Detailed break-up of the incremental operating costs /savings is in the original proposal - Annex 2 & 3 (Pgs. 14-18).

I hope I have provided all the information that you want. If you need any further information, please do get in touch. I will be away at the WWF International Headquarters in Gland, Switzerland, between 12th and 17th of February and I could be reached c/o Mr. Peter Hurst, fax No. 00 41 22 364 5829 during that period.

While it is a pleasure to associate with you in finalising these proposals, it is indeed disheartening to note that there are ever so many hurdles to cross before a proposal is accepted by the Executive Committee of the Multilateral Fund. I have communicated the negative response in Mr. Omar E. El-Arni's fax to the management of Real Value Appliances and consulted with them in the formulating the above information.

Awaiting your response.

Thank you.

Yours sincerely,

S. VAIDEESWARAN

c.c. Mr. C.K. Marfatia,
Real Value Appliances Limited

THE MONTREAL PROTOCOL ON
SUBSTANCES THAT DEPLETE THE OZONE LAYER
REVISED PROJECT COVER SHEET

COUNTRY	India
SECTOR COVERED	Fire protection / Halon
ODS USE IN SECTOR	550 tons Halon 1211, 200 tons Halon 1301, and 135 tons CFC 12 in 1991
PROJECT TITLE	Conversion from Halon 1211 to ABC-DCP in portableextinguisher manufacturing
PROJECT DURATION	1 year and 6 months
PROJECT IMPACT	Phase-out 100 tons Halon 1211 and 25 tons CFC 12 in first year (1994-95) and 800 tons Halon 1211 and 200 tons CFC 12 in 1999-2000 at full capacity.
UNIT ABATEMENT COST	
TOTAL PROJECT COST	Incremental capital costs US$571,500 Incremental operating costs US$724,000 Financial Agent Fee US$ 17,100
PROPOSED OTF GRANT	US$588,600 (operating costs not claimed)
IMPLEMENTING ENTERPRISE	Real Value Appliances Limited
NATIONAL COORDINATING AGENCY	Ministry of Environment & Forests
IMPLEMENTING AGENCY	World Bank/IDBI

PROJECT SUMMARY

This project will phase-out Halon 1211 consumption in production of portable extinguishers by converting existing halon cylinder production line to suit alternative ABC-DCP. In case of Halon 1211, components of portable extinguisher were externally sourced but with ABC-DCP it will be necessary to manufacture components in-house due to cost and quality considerations. There are no requirements for imported technology for this conversion project and all expertise required is available within the enterprise. This project will result in reduction of 800 tons of Halon 1211 annually when the production line is operating at full capacity. India's Country Program has identified this as a high priority project. This project is currently under implementation. It was launched in October 1992, soon after India became party to the Montreal Protocol.

TECHNICAL ASSESSMENT: This project has been reviewed and supported by OORG reviewer, P. Di Nenno. His comments are attached. Confirmation of project design and rationale for including value manufacture are discussed herein.

PROJECT OBJECTIVES. The aim of this project is to redesign the portable extinguisher production unit to suit use of ABC-DCP and to convert production line for manufacture of ABC-DCP portable extinguishers.

SECTOR BACKGROUND. For purposes of fire protection, ozone-depleting substances Halon 1211 and Halon 1301 are used as extinguishing agents in portable extinguishers and fixed systems respectively. In portable extinguishers, a small quantity of CFC 12 is also used as a propellant. Present and future demand of the three ODS along with their ODP has been estimated in Table 1.

TABLE 1

(tons)

Type	Units	1991	1996	2002	2005	2010
Halon 1211	ODS	550	1,050	1,500	1,750	2,100
	ODP	1,650	3,150	4,500	5,250	6,300
Halon 1301	CDS	200	340	600	800	1,000
	ODP	2,000	3,400	6,000	8,000	10,000
CFC-12	ODS	135	262	375	437	525
	ODP	135	262	375	437	525

ENTERPRISE BACKGROUND. Real Value Appliances Limited was incorporated as a private limited company in July 1989 and became a public limited company in May 1992. The enterprise is 100% locally owned and had a turnover of US$440,000 or Rs. 14 million for a 16-month period in 1992-93 and employs around 150 people. Manufacturing unit is located in Bhor in Maharashtra (Western India) with head office in Bombay. It has about 20 branches all over the country to support the aggressive marketing strategies in promoting its portable extinguisher as a user-friendly product.

It commenced operations in September 1989 with manufacture of Halon 1211 portable fire extinguishers and soon became the largest consumer of halons in India. In about three years, the enterprise sold over 800,000 units of 500 gm Halon 1211 portable extinguisher. The enterprise imported Halon 1211 from ICI-UK and quantity of halons consumed from commencement of production till date is given in Table 2. The decrease in halon consumption in 1991/92 was primary due to a steep rise in international price. In 1992/93, the enterprise began use of ABC (from imports) on trial basis and halon use went correspondingly.

TABLE 2

(tons)

Year	Consumption	
	Halon	ABC
1989-90	70.23	Nil
1990-91	142.00	Nil
1991-92	39.00	Nil
1992-93	24.80	125

note: Indian fiscal year ends on March, 31 and split year designations refer to fiscal years.

Since the enterprise was dependent on the import of halons, it had to formulate its strategies with regard to halon phase-out based on international trends. With assistance of overseas halon supplier, ICI-UK, the enterprise identified that ABC-DCP was the appropriate alternative. Given that its line of business was critically dependent on availability of halons, the enterprise launched its phase-out project soon after India became a party to the Protocol.

PROJECT DESCRIPTION. In this project, the enterprise will convert from use of Halon 1211 to ABC-DCP in their portable extinguisher manufacturing facility. With Halon 1211, most components of portable extinguisher are imported or sourced locally. It is only the assembling and filling operations which were carried out by the enterprise. However, the same method cannot be adopted in case of ABC-DCP. Importing components such as valve and cans for ABC-DCP portable extinguisher is not possible since this will make the product prohibitively expensive, while sourcing components locally does not give required quality standards. Hence it is required to establish a production line for manufacture of components in addition to assembling and filling operations which are to be adapted to ABC-DCP in lieu of Halon 1211. Note: The Government's technical review committee and Steering Committee have confirmed that inclusion of valve manufacture is appropriate since quality of valves from existing halon use does not meet satisfactory quality standards to ensure market acceptance of halon substitute.

Since expertise for manufacture of components was not readily available within the enterprise, in the first phase of this project only design of components was done by the enterprise while the components was sub-contracted locally. This ensured that the enterprise was aware of problems associated with components manufacture, especially with regard to achieving quality standards, and to decide on equipment specifications that will be required to manufacture components within the enterprise. During this phase, the enterprise installed a trial (relatively-inexpensive and locally-sourced) powder filling machine to determine exact specifications of machine that will be required for full-fledged commercial operation.

On completion of this phase of the project, investments on an imported powder filling machine and for the manufacturing facility for the other components was undertaken. Certain components such as pressure gauge will have to continue to be imported. This is because the present German suppliers of the pressure gauge offer both the best quality and price, and it will not be possible to manufacture these gauges at the enterprise's volume levels at a price lower than the imported price. In installing the powder filling machine and in the manufacturing facility, the enterprise will not require technology from the developed countries.

Halon 1211 extinguisher production line has a maximum capacity of around 2 million unit per annum (taking a capacity utilization of 85 %). This translates to around 800 tons of Halon 1211 annually at full operation. Therefore the above ABC-DCP facility has been designed to be able to phase-out the same tonnage of Halon 1211. Since this is an on-going project, at least 100 tons of Halon 1211 and 25 tons of CFC 12 will phased out in first year after commissioning in March 1994.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION. ABC-DCP is an accepted alternative internationally to Halon 1211 for portable extinguishers. ABC-DCP is a recognized alternative by the UNEP Technical Options Committee (Halon sector) and has been included in the Country Program. In terms of effectiveness in fire protection, ABC-DCP is substantially equal to Halon 1211, but within India, there is a perception within the market that Halon is superior.

PROJECT COST

Incremental capital costs. The incremental capital costs for this conversion project comprises capital costs, expenses on overseas tours for alternative identification and expenses in project management during implementation. The incremental capital costs works out to be US$571,500 (Annex A)

Incremental Operating costs. This project involves a significant loss in revenue, which is an incremental recurring costs to the enterprise. However, the enterprise is requesting only incremental capital cost component as an OTF grant. In calculation of incremental recurring costs, operation with Halon 1211 is used as baseline and compared with ABC-DCP operation. Since revenue margin in Halon 1211 operation is significantly higher than ABC-DCP operation, there is a net incremental recurring cost to the enterprise due to changeover. Revenue during Halon 1211 operation is compared with that of ABC-DCP operation and the net

incremental recurring cost due to changeover is tabulated for economic life of project, i.e. 10 years. (Annex 2) Incremental operating costs are US$724,000. However, this is shown for information purposes only, since no compensation is being requested.
Incremental Operating benefits. There are no incremental benefits to this project.

TOTAL INCREMENTAL COSTS OF THE PROJECT. Total incremental cost of the project is the sum of incremental capital cost and net present value of incremental recurring cost for a four-year period. This works out to be US$1.30 million. However, the enterprise is only requesting incremental capital cost portion of US$571,500 be given as OTF grant. The enterprise is not requesting that its loss of revenue (even for four years) due to the switchover be included in the OTF grant. In the incremental capital cost calculations, the can processing and valve manufacturing plant have been included. As per OTF guidelines, these items do not, a priori, appear to qualify as incremental costs. However, the enterprise was forced to enter into can processing and valve manufacturing because current suppliers of valves and cans could not meet satisfactory quality standards for market acceptance of the new product ABC-DCP, imported supplies would be much more expensive, and therefore these costs are incremental for the enterprise and should be included in the OTF grant.

Financial Agent Fee. (3%) US$17,100

OTF Grant: The proposed grant is equal to the project capital costs (US$571,500) plus the financial agent fee of US$17,100) or a total OTF grant of US$588,600

LOCAL OWNERSHIP FRACTION. The enterprise is 100 % locally owned.

UNIT ABATEMENT COST. (note that ODS phase out for this project is the same as for Real Value project for ABC powder production. The ODS phase out amounts should not be counted twice.)

The unit abatement costs or the annual cost required to phase-out one kilogram of ODP ton is given as

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

In this case, C, the capital cost is US$571,500. Since the OTF grant does not include the incremental recurring costs, the recurring costs/savings and the recurring cost and savings are not considered in the calculation of the unit abatement cost. The ODS phased out at full operating capacity is 800 tons of Halon 1211 and 200 tons of CFC 12. Therefore, W - the annual ODS reduction at the first year of full operation expressed in ODP units - is 2600 tons. C(F) is evaluated as US$93,000 where F is the capital recovery factor. The unit abatement costs is therefore evaluated as 0.037 US$ per kg.

FINANCIAL HEALTH OF ENTERPRISE:

This project commenced in October 1992 and is expected to be completed in March, 1994. Although, the enterprise was put to a great deal of inconvenience due to the conversion from Halon 1211 to ABC-DCP, the management ensured that a healthy financial performance was maintained. A comparison of the last four years financial performance as it appears in the enterprise's annual report is provided in Table 3.

TABLE 3

(Rs. million)

Particulars	1989-90	1990-91	1991-92 (8 months)	1992-93 (16 months)
Equity Base	1.55	2.40	2.40	76.50
Share premium	-	-	-	112.70
Turnover	3.36	7.57	3.43	142.50
Profit after tax	1.65	4.86	5.81	30.50
Gross Block	1.02	9.73	17.17	90.00

note: change of fiscal year in 1991

FINANCING PLAN. The project will be financed 100% by grant for direct capital costs on a retroactive basis. Being an on-going project, the capital investment already made has been financed through lease/hire purchase scheme and from internally accrued funds. Additional capital investment that is to be made by March 1994 will be financed from funds raised through public issue of shares in November 1992 and by way of long term loans from mutual funds and other Indian financial institutions. The funds obtained as an OTF grant will be used to repay loans and for settlements of lease/hire purchases of equipment.

PROJECT IMPLEMENTATION. This on-going project commenced in October 1992 and is expected to be completed in March 1994, with a total duration of eighteen months. Implementation schedule is given below:

Phase I (October '92 - September '93)

1.	Developing new valve design	10 weeks
2.	Redesigning and adapting cans to new screw-on valves	12 Weeks
3.	Moulds for powder release assembly	12 weeks
4.	Sourcing and installation of trial powder filling machine	10 weeks
5.	Designing can and finalizing process (pressure testing, welding & powder coating)	12 weeks

Phase II (October '93 - March '94)

6.	Sourcing and installation of can processing plant	15 weeks
7.	Sourcing and installation of valve manufacturing plant	15 weeks
8.	Installation of the imported powder filling machine	15 weeks

REQUIRED REGULATORY ACTIONS. It would be required for the Government of India to waive duties/taxes for all equipment supplied for this project as these are transfer payments rather than true economic costs.

RESULTS. In the first year of operation after commissioning in March 1994, this project will phase-out at least 100 tons of Halon 1211 and 25 tons of CFC 12. On achieving full capacity operation (1999-2000), the project will phase-out 800 tons of Halon 1211 and 200 tons of CFC 12.

ENVIRONMENTAL IMPACT ASSESSMENT. Being a powder, the alternative ABC-DCP will not reach up to the atmosphere and hence will not damage the ozone layer. The powder will also not cause any pollution at the surface level.

CHANGES IN PROJECT DESIGN AND COSTS DUE TO OORG COMMENTS. The only OORG comment was why the existing local value manufactured for halon was not suitable for ABC powder use. The enterprise has confirmed that the current local valve does not meet quality standards for use in powder applications. Given the market resistance to use of ABC compared to Halon, and after technical review of the project, the Government has supported that decision. (Also note that the enterprise is <u>not</u> asking for compensation for operating costs that would be a substantially larger amount, that appear to be eligible as incremental costs.) On balance, the inclusion for local valve manufacture should be supported.)

Annex A

SUMMARY OF PROJECT COSTS

Particulars	Costs Excl. Taxes/Duties US$ 000	Costs Excl. Taxes/Duties Rs. Mill.	Taxes/Duties US$ 000	Taxes/Duties Rs.Mill.
1. Capital Equipment				
Powder Filling Plant	79.27	2.50	27.74	0.87
Value Manufacturing Plant	93.14	2.93	6.63	0.21
Can Processing Plant	297.78	9.38	55.37	1.74
Miscellaneous	84.13	2.65		
Total	554.30	17.46	89.74	2.83
2. Expenses on overseas Tours for Alternative Identification				
Visit to UK for two people	10.8	0.34		
Total	10.8	0.34		
3. Expenses in Project Management	6.4	0.20		
4. Total	571.50	18.00	89.74	2.83
Financial Agent Fee	17.10			
Total OTF Grant	588.60			

NB: No contingency is required since the project is to be physically completed by March 1994

Technical Opinion

Conversion from HALON 1211 to ABC-DCP in Portable Extinguisher Manufacturing India

Recommendation:

This project is not supported.

The project involves the development of a valve manufacturing facility for DCP extinguishers. Since currently valves for HALON 1211 extinguishers are purchased, it is not clear why conversion to DCP requires any change. The valves could be of identical design and manufacture.

It may be the case that the valve assembly currently used for 1211 extinguishers is unsuitable for DCP, in which case this opinion might be modified. However, there is no reason in general that a valve used for 1211 could not be used for DCP. They are, in fact, often identical. Given this need was not sufficiently motivated, it was not possible to support the project at this time.

Adequacy of Information Provided:

The major gap in information provided is the motivation for a change in valve manufacture. There is no technical justification provided for the need to change the valve design and have the need to alter current methods.

Technical Soundness:

Conversion from 1211 to DCP in portable extinguishers is a good idea in principle. Weaknesses in the technical basis of this proposal are associated with the need to convert valve component procurement and/or assembly. There are no other special technical problems associated with this approach.

Environmental/Safety Issues: None

Hughes Associates, Inc.

Cost Effectiveness:

If one can produce HALON 1211 portable extinguishers cost effectively with local and imported valve components, the same should apply to DCP extinguishers. The valve assembly should be neutral in the incremental cost/benefit comparison. It is possible that the current 1211 valve assembly is unsuited for DCP, in which case, the cost effectiveness may be impacted.

**THE MONTREAL PROTOCOL ON
SUBSTANCES THAT DEPLETE OZONE LAYER
PROJECT COVER SHEET**

COUNTRY	INDIA
PROJECT TITLE	ODS phaseout in sterlisation and siliconisation of disposable syringes and needles. Phase I - Conversion of sterilisers to CO_2-EO Phase II - Phaseout of ODS in siliconisation of needles This project covers Phase I
SECTOR COVERED	Solvents - Sterilisation
ODS CONSUMPTION IN AFFECTED SECTOR	19 mt CFC-113 (1991) and 100 mt CFC-12 (1991)
PROJECT IMPACT	Phase I Phaseout of 50 mt/y of CFC-12 (1992-93 basis)
Unit Abatement Cost (UAC)	$3.89 per kg. ODP/Year
PROJECT DURATION	Phase I 1 year Phase II Separate Project report will be submitted
PROJECT ECONOMIC LIFE	7 years
TOTAL PROJECT COST	Phase I: Incremental Capital Cost $358,600 Incremental Operating Cost $434,200 **Total Project Cost $792,800** Financial Agent Fee $ 23,800
PROPOSED OTF GRANT	$816,600[1]
IMPLEMENTING ENTERPRISE	Hindustan Syringes & Medical Devices Private Ltd., Ballabhgarh (Haryana)
IMPLEMENTING AGENCY	The World Bank/IDBI
NATIONAL COORDINATING AGENCY	Ministry of Environment and Forests (MOEF)

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

PROJECT SUMMARY

Phase I of the project will phase out CFC-12 currently used in the 88-12 mixture of CFC-12 and ethylene oxide (EO). The mixture is used for sterilization of disposable syringes, needles and other medical devices manufactured by the enterprise. Replacement of the current system will be carried out by switching over to an ODS-free mixture of carbon dioxide (CO_2) and EO. This subproject will result in phasing out 50 mt/y of CFC-12.

In Phase II, use of CFC-113 as a carrier medium for siliconisation of syringe barrels and plungers will be replaced by resorting to direct spraying of a modified silicon oil via specially designed spray system. Alternative methods for application of silicon, currently diluted with CFC-113 for siliconisation of needle points, will be explored. Phase II of the project will result in phasing out of 6 mt/y of CFC-113. This project report seeks funding for Phase I only.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by OORG technical reviewer Mr, Fitzgerald. His comments are attached.

PROJECT OBJECTIVE. The objective of present project is to install carbon dioxide (CO_2)-ehylene oxide (EO) sterilisers to replace the current CFC-EO system and seek alternative to siliconisation of needles by a medium other than CFC-113.

SECTOR BACKGROUND. India's various disposable medical device manufacturers are consuming about 19 MT CFC-113 per year for the purpose of siliconisation and block testing of needles and siliconisation of disposable syringes. CFC-113 is used as a delivery agent for silicon. This quantity will continue to grow unless new facilities which do not use CFC-113 are installed. In 1995, CFC-113 consumption is expected to reach 40 tons for these applications at a growth rate of 20% per annum. The sector also consumes approximately 100 mt/y of CFC-12 in CFC-EO mixture for sterilisation. CFC-12 is used as a dilutant primarily to reduce the explosion risks involved with the use of EO.

ENTERPRISE BACKGROUND. Hindustan Syringes Ltd. has been in the field of medical devices since 1957. The enterprise capacity for devices is 90 million syringes, 135 million needles and 3 million IV cannulas. The utilization of plant capacity is around 100%. The company products cater to approximately 55% of the market share in India. The technology employed at the company's facility originates from South Korea, Japan, Taiwan and Germany. The export market accounts for roughly 20% of the turnover. The exports are to the developed countries. The company is 100% Indian.

PROJECT DESCRIPTION. In Phase I, the enterprise will replace existing sterilisation equipment which is incompatible with the pressure fluctuation demands necessitated by the CO_2-EO technology. Sterilisers using CO_2-EO mixtures are available in the World market and the technology is well proven. The main capital equipment consists of three imported sterilisers.

JUSTIFICATION FOR TECHNOLOGY SELECTION. The enterprise has examined various technologies. The alternative opted for sterilisation technology has been found to be the most cost-effective and well tried. The chosen technology is in commercial use with manufacturers of similar products in the developed countries.

PROJECT COST. The Phase I project incremental cost of $816,600 has been calculated as the economic capital cost plus the net incremental recurrent costs for 4 years discounted at 10%, plus 15% contingency on capital cost, plus 3% financial agent fee on project costs.

CAPITAL COSTS. Capital cost is US$358,600 including handling and installation charges and excluding duties (see Annex 1A), and including 15% contingency..

INCREMENTAL RECURRENT COSTS. Net incremental operating cost of US$126,250 per year discounted at 10% for four years amounts to US$434,200 (see Annex 1B).

BENEFITS. There will be no benefits to the enterprise by changing the existing CFC-EO steriliser.

Financial agent fee of 3% project costs equals $23,800.

Total incremental cost equals $816,600.

LOCAL OWNERSHIP. Local ownership of 100% was considered to determine the amount of eligible OTF grant financing.

UNIT ABATEMENT COST. US$ 3.890 per Kg. ODP/Year

FINANCIAL AND ECONOMIC ANALYSIS. Since there will be no savings to the enterprise, financial internal rate of return and economic rate of return are not applicable.

PROJECT IMPLEMENTATION. The implementation of the project is scheduled as follows:

Phase I

1.	Conceptualisation and inviting quotations	March 1994
2.	Order booking	April-June 1994[2]
3.	Shipment	July-September 1994
4.	Installation on site	October-December 1994
5.	Commissioning	January-March 1995
6.	Commercial use	April 1995

Phase II

Comparative study of alternative technologies	July-December 1993

Direct Project Impact. This project will phase out 50 mt of CFC-12 annually after one year from the date of order. It will also pave the way for additional phase out of 6 mt of CFC-113 which would eventually be covered under Phase II of the project.

Indirect Project Impact. The enterprise can export its products to developed countries where restrictions have been imposed on products that contain ODS or are manufactured with ODS.

Changes in Project Scope and Costs Due to OORG Comments. Enterprise has agreed to investigate use of HCFC solvents as part of the technology selection process being undertaken by in phase II of the project.

[2] Subject to financial commitment by MPF by March 1994

PROJECT COST ESTIMATE

		US$
1.	CIF cost of imported equipment and handling charges of 5% (includes installation) (rounded) (see Annex 1A)	311,850
2.	Contingency - 15% of 1	46,750
	Sub total	358,600
3.	Recurrent incremental cost	
	4 years capitalised increased operating cost (rounded) (see Annex 1B)	434,200
	Project costs (excluding taxes)	782,800
	Financial Agent Fee (3% of Project Costs)	23,800
	Total Incremental Cost	816,600

ANNEX-IA

Item No.	Description of Machinery	(1) CIF Cost of replace-ment US $	(2) Taxes & duties %age	(3) Taxes & Duties in US $	(4) Post-Landing Costs 5% of CIF US $	(5) Justification for selection
	INCREASED CAPITAL COST					
	EXISTING					
1	a) 5 Cu.Mt. Steriliser a) 4.96 Cu.Mt. Steriliser a) 5 Cu.Mt. Steriliser					The sterilisers presently in use with us, for CFC-12+EO mixture have steam feeding, evaporators, humidity transmitters and evaporators. The equipment in use is valid at 0.69 Kg./Sq.Cm. working pressure. No local manufacturer makes sterilisers fit for use with CO2+EO, which requires a working pressure of 1.4 Kg./Sq.Cm. We have received quotation from M/S M.F.Marketing (KOTWAL), which is valid for working pressure of 1.36 Kg./Sq.Cm. and is not specified for use, only with CO2+EO mixture. Since we are not aware of any disposable device manufacturer, using these sterilisers, costing US $ 68,250 each for 5 Cu Mts. (equivalent capacity of 20 Cu.Mt. costing US $ 273,000), we would prefer to go in for 3 imported sterilisers, at US $ 99,000 each, of 6 Cu.Mt. capacity (equivalent capacity of 18 Cu.Mt. costing 297,000). The increase in cubic capacity from 15 cu.mt. to 18 cu.mt. would be necessitated by reduction in EO concentration from 12% used with CFC to 10% used with CO2.
	TO BE REPLACED BY 3 Nos. Sterilisers, each of 6 Cu.Mts. capacity, complete with : (i) Steam Feeding System (ii) Humidity Transmitter (iii) Automatic Aeration	297000	35	103950	14850	
		297000		103950	14850	
1.	Total increased capital cost (Col.1+ Col.4)	311850				
~~2.~~	~~Increased cost of Working (Annex IB)~~	~~434174~~				
~~3.~~	~~Capital Cost~~	~~746024~~				
~~4.~~	~~Incremental Cost Phase-II, Part-2A~~	~~20000~~				
	~~Total Project Cost (3+4 above)~~	~~766024~~				
~~5.~~	~~taxes and duties (Col.3.)~~	~~103950~~		~~For MPF Grant~~ ~~Enterprise's Investment~~		

ANNEX.-19

NOTE ON INCREMENTAL RECURRING COSTS

The equivalent sterilisation proposed of 18 Cu.Mts. of CO_2+EO mixture, vis a vis 15 Cu.Mts. of CFC-12+EO mixture has the following cost implications :-

	PRESENT	PROPOSED
Rate per Kg.	CFC+EO (88%+12%) Rs.98/- per Kg.	CO_2+EO (90%+10%) **Rs.70 per Kg.**
Consumption at equal pressure	56.82 Mt. of mixture per year	58.62*18/15=68.18 M.T.per year of mixture, after adjusting for volume(read concentration)
Consumption at adjusted pressure	56.82 m.t. at 0.70 Kg./Sq.Cm.	68.18 M.T.*1.4/0.70 adjusted for pressure of 1.40 Kg./Sq.Cm.
Cost per year	Rs.5.57 Million (US $ 176,770) per year	Rs.9.55 Million (US $ 303,020) per year
Difference		US $ 126,250 per year

4 Year's incremental cost

Ist. Year	126,250
IInd.Year	113,625
IIIrd.Year	102,263
IVth.Year	92,036
Total Incremental Cost in 4 Years	434,174

ANNEX. II
UNIT ABATEMENT COST

Hindustan Syringes & Medical Devices P.Ltd.

ODS Reduction Investment Cost (C)	331850
Capital Recovery Factor (F)	0.2055
Annual Incremental Operating Costs (OC)	126250
Ozone Depleting Potential (ODP)	50 Mt/Year
Unit Abatement Cost C(F)+OC/(ODP) Say	3.890

Hindustan Syringes

Scope

Hindustan Syringes produces various medical devices and uses CFC-12 in combination with ethylene oxide to sterilize needles and syringes, and CFC-113 as a carrier of silicon for their lubrication. This project proposes to convert the CFC-12 using process to a process that uses carbon dioxide in combination with the ethylene oxide. The project also proposes a small study to find alternatives to CFC-113 in the lubrication of the needles and syringes.

Recommendation

The proposal to convert the sterilization process to carbon dioxide rather than CFC-12 is supported. The Phase 2A, exploration of alternatives to CFC-113 in siliconisation of needles and syringes is also supported, however it is recommended that this study also include a review of the application of bridging chemicals such as HCFC solvents (see comments in **Technical soundness** below).

Relevance and adequacy of information provided

Information is adequate to provide a fundamental understanding of the manufacturing processes, especially when combined with knowledge of similar manufacturing processes elsewhere that the reviewer has.

Technical soundness

A mixture of gasses is needed in the sterilisation process to reduce the potential of explosions from ethylene oxide – carbon dioxide should serve this purpose. It is understood that Hindustan will proceed with direct siliconisation of the syringe barrels but that an alternative carrier solvent is required to siliconise the syringes and that the study proposed in Phase II, Part IIA would identify the most appropriate alternative. The reviewer is aware that at least one North American manufacturer of syringes and needles has opted for an HCFC solvent as an interim means of providing the carrier for the silicon. Moreover, a representative of DuPont has indicated that hydrocarbon based solvent blends are in advanced development stages which may offer an appropriate long term alternative to the CFC-113 that is currently in use.

Lessons from experience

The approach proposed is logical and will see an early phase out of 50 tonnes of CFC-12 using technology that has little risk of failure. Given the availability of HCFC solvents and the developments that appear to be taking place in the chemical industry, the proposed Phase IIA study for an alternative carrier solvent in the siliconisation process is a sound approach that should lead to selection of the most appropriate technology.

Environmental issues

There do not appear to be any significant environmental issues associated with the switch to carbon dioxide as the explosion suppressant in the sterilisation process.

Safety issues

Appropriate engineered controls will be required for the carbon dioxide-ethylene oxide system.

Cost effectiveness

The cost of converting to the alternative sterilisation process is based on quotations for the needed equipment. Requested money includes incremental operating costs reflecting the differences in gas requirements. Unit abatement costs, at USD 3.89/kilogramme, appear reasonable.

Other

No additional comments.

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER PROJECT COVER SHEET

COUNTRY	India
SECTORS COVERED	Solvent (Pharmaceutical)
ODS CONSUMPTION IN AFFECTED SECTOR	19 M tons (1993)
PROJECT TITLE	Syringe and hypodermic needle manufacturer using CFC-113/Silicone replacement
PROJECT DURATION	1 Year
PROJECT IMPACT	8-9 MT ODS (1993)
Unit Abatement Cost (UAC)	$16.80 per kg. ODP/Year
PROPOSED BUDGET	Incremental Capital Cost $625,700 Incremental Operating Cost $ 64,700 Total Project Cost $690,400 Financial Agent Fee $ 20,700
PROPOSED OTF GRANT	$711,100[1]
IMPLEMENTING ENTERPRISE	ALBERT DAVID LTD., BHOPAL
IMPLEMENTING AGENCY	THE WORLD BANK/IDBI
NATIONAL COORDINATING AGENCY	MINISTRY OF ENVIRONMENT AND FORESTS (MOEF)

PROJECT SUMMARY

This project will phase out CFC-113 consumption completely in the process of manufacturing of hypodermic needles at Albert David Ltd., Bhopal, by converting the existing hypodermic needle assembly Line. The enterprise have negotiated with Herbert Eccard GMBH for supply of a new assembly line which will not use CFC-113 in the process. This project will result in phasing out 8 MT CFC-113 annually. The project will use commercially proven and available technology from Germany.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by OORG technical reviewer Mr. Fitzgerald. His comments are attached.

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

PROJECT OBJECTIVES. The objective of this project is to convert Albert David's existing needle assembly line to a CFC-113 free non-ODS production line.

SECTOR BACKGROUND. India's various establishments manufacturing disposable syringes and hypodermic needles consume about 19 MT per year of CFC-113 for the purpose of Siliconisation and block-testing of needles and sterilization of disposable syringes as well as needles. This quantity will continue to grow unless new facilities which don't use CFC-113 are installed. In 1996 CFC-113 consumption is expected to reach 40 tons for industrial applications at a growth rate of 20% per annum. Current (1993) use of the enterprise is approximately 8-9 mt/year.

ENTERPRISE BACKGROUND. Albert David Limited has been in pharmaceuticals since 1934. The company has three manufacturing plants at its Mandideep facility near Bhopal. Hypodermic syringes and needles are manufactured at the facility and the plant holds a Good Manufacturing Practice (GMP) certificate issued by World Health Organization (WHO). The company's plant is the only one in India holding a GMP certificate for syringes and needles. In the process of siliconization and block testing of needles ODS are being used at present.

Annual ODS consumption	:	8.0 tons CFC-113
Production capacity	:	30 million syringes/100 million needles
Actual production (design)	:	24 million syringes/120 million needles
Market share in sector	:	About 20%
Source of existing technology	:	Imported from Korea
Product market	:	Local
Ownership	:	100% Indian

PROJECT DESCRIPTION. For this project the enterprise will work with a foreign supplier of technology in Germany (Herbert Eccard GMBH) for redesigning/supplying new system machine which will eliminate use of CFC-113 in the production line. The enterprise will also work with mould manufacturers for design of new kind of moulds required for the new production line. The enterprises will import new technology from Germany and the supplier has agreed to transfer technology along with machine free of additional charge.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION. The enterprise has examined various kinds of indigenous and foreign technologies and where possible, chosen qualified indigenous technology from a cost effective point of view. The enterprise has also rationalized, by process oriented good housekeeping measures, use of CFC-113. The measures have enabled reduction of its CFC-113 consumption by approximately 50 percent. This has been accomplished by supplementing CFC as a carrier with a compatible hydrocarbon. Furthermore, the enterprise has also carried out in-house investigations for complete replacement of CFC with a number of hydrocarbons. These attempts have been unsuccessful for a total phase-out of CFC. The enterprise has then evaluated a number of alternative processes abroad and located one system that qualified. This alternative necessitates import of new technology and machinery which will resort to mechanical application and vacuum drying and completely eliminates use of CFC-113. The new machine has a lower capacity than the existing one. The machine is more compact and complex than the existing unit. Where the existing machine enabled the operator to manually supervise alignment and quality control inspection routines, the alternative technology design requires a more skilled operator and an automated system for alignment of the needles and quality control. The alternative system also necessitates a modified arrangement for insertion of the cannula to the hub of the needle. Accordingly a new sets of moulds are required. Here the indigenous manufacturers of mould have offered a more cost effective alternative which has been opted for in this proposal.

PROJECT COST. The total project incremental cost of US$711,100 has been calculated as the economic capital cost plus the net incremental recurrent costs for 4 years discounted at 10%, plus 15% contingency on capital cost, plus 3% financial agent fee on total project costs.

CAPITAL COSTS. Capital cost is US$625,700 including capital investment in needle assembly machine, cost of new set of moulds, training, installation cost and trial run and trial production cost (Annex A).

INCREMENTAL RECURRENT COSTS. The net incremental operating cost, US$19,015 per annum, discounted at 10% for four years, is US$64,700 (Annex B).

BENEFITS. There will be no benefits to the enterprise by changing the existing needle assembly line.

Financial agent fee of 3% on project costs equals $20,700.
Total incremental costs equals $711,100.

OWNERSHIP. Local ownership of 100% was considered to determine the amount of eligible ODS grant financing.

UNIT ABATEMENT COST. US$16.80 per kg. ODP/Year

FINANCIAL AND ECONOMIC ANALYSIS. Since there will be no savings to the enterprise, financial and economic internal rates of return are not applicable.

FINANCIAL INDICATORS OF ENTERPRISE. For the financial year ended 31st March 1992: (Rs. million)

Debt service coverage	:	1.4 times.
Cash flow	:	24
Gross Profit ratio	:	6.9%
Net profit Ratio	:	1.1%
Paid up Share capital	:	35.9
Reserves & Surplus	:	52.5
Net Fixed Assets	:	110.1

FINANCING PLAN. To be financed by OTF grant which include/covers project cost as well as incremental cost.

PROJECT IMPLEMENTATION. IDBI will oversee the implementation of this project. The project will be carried out by the enterprise.

REQUIRED REGULATORY ACTIONS. None

Direct Project Impact. Completion of the project will phase out 8-9 MT CFC-113 annually. There will be no temporary phase out program but the complete phase out of CFC-113 will start by the end of 1994.

Indirect Project Impact. The enterprise can export its products to developed countries where CFC-113 is either already banned or will be banned by 1994.

ENTERPRISE COMMITMENT. The enterprise will submit a statement from the Chief Executive Officer that the enterprise will undertake the activities described in the proposal following the proposed schedule provided grants funds are approved.

Changes in Project Scope and Costs Due to OORG Comments. The company has made an extensive search for suitable technology over the past two years. HCFC solvents have been ruled out as not suitable or not available in India. The search for technology concluded that the German technology, although expensive, was the best approach available at present and essential to keep WHO good manufacturing practices rating and maintain exports. Detailed response from the enterprise is attached to the OORG comments.

FINANCING PLAN

To be financed by OTF grant which include/covers project cost as well as incremental cost.

PROJECT IMPLEMENTATION

IDBI will oversee the implementation of this project. The project will be carried out by the enterprise.

REQUIRED REGULATORY ACTIONS

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

1. The enterprise will submit order on suppliers and open a line of credit for purchase of new machine and mould.

2. Control and coordination of the enterprise by the Ministry of Environment and Forests.

RESULTS

Direct Project Impact

Completion of the project will phase out 8-9 MT CFC-113 annually. There will be no temporary phase out program but the complete phase out of CFC-113 will start by the end of 1994.

Indirect Project Impact

The enterprise can export its products to developed countries where CFC-113 is either already banned or will be banned by 1994.

ENTERPRISE COMMITMENT

The enterprise will submit a statement from the Chief Executive Officer that the enterprise will undertake the activities described in the proposal following the proposed schedule provided grants funds are approved.

Annex A

Breakdown of Project Cost

Sl. No.	Items Imported (Annex 1-A)	Price US$
1.	EC Bonding and Assembly systems for medical disposable cannulas including caps. range 24 gauge to 26 gauge	253,840
2.	Replacement magazines required for processing the various needle sizes (each magazine accommodates only two sizes) so extra two sets of magazines required	10,260
3.	Control unit for monitoring whether the needle is in the right position in the assembly machine	37,400
4.	Handling charges	16,060
5.	Hot manifold and nozzles for Hub Mould	8,000
6.	Temp. controller for Hub mould	7,500
7.	Hot manifold and nozzles for hub protector mould	8,000
8.	Temp. controller for hub protector mould	7,500
9.	Insurance and freight charges	17,780
	Sub Total	366,340
Sl. No.	**Indigenous Items (Annex 1-B)**	**Price(US$)**
1.	48 impression, two plate type semi hot runner injection mould HUB with 21 HWG pins	47,620
2.	Other gauge pin set for processing other gauges: a) 22 SWG Rs. 3.40 b) 23 SWG Rs. 3.55 c) 24 SWG Rs. 3.70 d) 25 SWG Rs. 3.85 e) 26 SWG Rs. 4.00	58,730
3.	48 Impression, three plate type, semi hot runner injection mould for hub protector	50,000
4.	Installation, training, trial runs start up cost	21,430
	Sub Total	177,780
	Total Capital Cost (w/o contingency)	544,100
	Continency 15%	81,620
	Capital Costs (rounded)	625,700
	Incremental Operating Cost (Annex 2) (4 yrs increased operating cost, discounted at 10% p.a.)	64,700
	Project Costs	690,400
	Financial Agent Fee (3% of project costs)	20,700
	Total Incremental Costs	**711,100**

Annex B

BREAKUP OF INCREMENTAL COST PER ANNUM

No.	Existing System	Amount (Rs.)	Proposed system	Cost/Savings (Rs.)		US $
1.	Electricity - 300 units per day for 300 days @ 2.50/unit	2.25	Electricity - 300 units per day for 300 days @ 2.50/unit	2.25	--	--
2.	Labors - 2 semiskilled workers per shift for 3 shifts @ Rs. 1,000 per month per worker	0.72	Engineer 1 per shift for 3 shifts @ Rs. 7,000 per month.	2.52	1.80	5714
3.	Raw materials: (At production level ________ of 75 million needles) (i) Silicon Oil 2 kg per million @ Rs. 200/kg (ii) CFC-8000 kg @ Rs. 200/kg (iii) n-Hexane - 8000 kg @ Rs. 23/kg (iv) Epoxy - 8 kg/million @ US$30	0.30 16.00 1.84 5.67	Raw materials: (At production level ________ of 75 million needles) (i) Silicon Oil (AK-150) @ 25 Ltr/million @ DM 30) (ii) Nil (iii) Nil (iv) Epoxy 18 lt/million @ DM 43/lt	11.25 -- -- 11.61	10.95 (16.00) (1.84) 5.94	34762 (50794) (5841) 18857
4.	Maintenance Cost @ Rs. 5000 p.m.	0.60	Maintenance cost @ DM 28700 p.a.	5.74	5.14	16317
	TOTAL	27.38		35.89	8.51	19015

Note: 1. Import duty, excise duty and taxes have not been considered while computing cost.
2. Exchange rate- 1 DM = Rs. 20; 1 US$ = Rs. 31.50

northern telecom

Northern Telecom
Limited
3 Robert Speck Parkway,
Mississauga, Ontario, Canada
L4Z 3C8

Feb. 7, 1994

Mr. Tom Waltz
The World Bank -- OORG
Fax 202-522-3258

Re: Albert David Company

Dear Tom

I have reviewed the comments that were returned by Albert David Company. I am satisfied that the Company has carefully considered the issues that I raised and it can proceed.

The response has further informed me of the practical situation regarding the lack of availability of alternative chemicals which then requires that they proceed with the alternatives that they have chosen.

Sincerely,

A.D. FitzGerald
OORG Solvent Reviewer

Albert David Ltd.

Scope

Albert David is a manufacturer of syringes and hypodermic needles, located in India. The proposal is for the purchase of new manufacturing equipment that would eliminate the use of CFC-113 solvents that are used as a carrier for the silicones that lubricate the syringes and needles. The conversion would eliminate the use of eight tonnes of CFC-113 annually.

Recommendation

It is recommended that additional comment be provided on whether HCFC solvents were considered as a bridging technology, and the extent of discussions with chemical suppliers on developments of new hydrocarbon solvent formulations, before the proposal can be supported.

Relevance and adequacy of information provided

The information provided describes the existing process and the proposed German manufactured alternative equipment. Additional information as described above would be helpful to the review process.

Technical soundness

Based on the information provided, it is assumed that the German manufactured technology will perform as designed and will result in the elimination of CFC-113 solvent.

Lessons from experience

It would appear that at least one North American manufacturer of hypodermic needles and syringes has converted its facilities to use HCFC solvents until an alternative solvent is available to act as the carrier in the siliconisation process. Recent discussions with a representative of DuPont have indicated also that hydrocarbon based solvent formulations to displace CFC-113 solvents in the manufacture of hypodermic needles are in advanced development stage. They may provide a replacement for the CFC-113. This approach merits consideration by Albert David Ltd., if it has not already done so.

Environmental issues

The information provided on the new technology does not suggest environmental issues of concern.

Safety issues

Machine operating procedures should reflect appropriate safety considerations.

Cost effectiveness

The unit abatement costs of USD 16.80 are somewhat high compared to the costs of other solvent conversion technologies which may reflect a uniqueness of technology that is required to make the conversion in this specialized manufacturing process. The proposed technology appears to include modifications to steps in the manufacturing process that are integral with the equipment and that are not directly related to the elimination of CFC-113. These appear to be necessary if the mechanical process is the preferred option. These extra costs could, perhaps, be reduced or avoided if an alternative solvent based process was shown to be available (conversion now to an HCFC solvent followed by later introduction of a new hydrocarbon solvent).

Other

No other comments.

Prepared by:
A.D. FitzGerald
OORG Solvents Sector

Feb.7

THE MONTREAL PROTOCOL ON
SUBSTANCES THAT DEPLETE THE OZONE LAYER
PROJECT COVER SHEET

COUNTRY	India
SECTORS COVERED	Refrigeration and Air Conditioning
ODS CONSUMPTION IN AFFECTED SECTOR	1800 MT
PROJECT TITLE:	Conversion of compressor designs for refrigerators and appliances from CFC-12 to HFC-134a.
PROJECT DURATION	Phase I - 4 years Phase II - 2 years
PROJECT IMPACT	125 MT ODS in 1998
Unit Abatement Cost (UAC)	To be determined in Phase III
PROJECT COST (excluding operating cost)	Project Capital Cost $1,183,000
PROPOSED OTF GRANT	Incremental Capital Cost $ 603,300 Incremental Operating Cost $ 29,600 TOTAL OTF GRANT $ 651,900 [1]
IMPLEMENTING ENTERPRISE	Kirloskar Copeland Ltd.
IMPLEMENTING AGENCY	The World Bank/IDBI
NATIONAL COORDINATING AGENCY:	Ministry of Environment & Forests (MOEF)

PROJECT SUMMARY

This OTF request is for the first two phase of a three phase project which will facilitate the phaseout of CFC-12 by converting the hermetic compressor production at Kirloskar Copeland Ltd. (KCL), India from CFC-12 to HFC-134a designs. In Phases I/II, engineering development, prototype manufacturing and testing of compressors for HFC-134a will be conducted based on technology purchased from Copeland US for 15 different models. Phases I/II will also establish the project requirements for retooling, training, and other activities needed to complete the conversion to HFC-134a designs and provide substantial (small scale) customer training in use of new compressors. KCL primarily manufactures compressors to supply about 60% of market for small commercial refrigeration manufacturers in India. Phase III is the subsequent commercial manufacturing. KCL will calculate the incremental cost for Phase III during implementation of Phase I/II and submit for OTF funding at a later time. Current KCL estimates of Phase III eligible incremental costs are about US$2.7 million (51% local ownership). The KCL project is a key part of Government strategy to reach small scale unorganized sector firms in India's ODS phase out program.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Mr. Kuijpers. His comments are attached.

[1] Includes US$19,000 as financial agent fee.

3 (

PROJECT OBJECTIVE

The objective of the project is to eliminate the use of CFC-12 in India (to the extent of KCL share) by making available compressors for HFC-134a to appliance manufacturers, including a wide range of types of refrigeration uses.

SECTOR BACKGROUND

The refrigeration sector in India accounts for approximately 1800 MT of the country's consumption of CFC-12 which includes the manufacture and servicing of both domestic and commercial refrigeration appliances. Out of the 1800 MT CFC-12:

i) 500 MT is used for manufacturing new appliances; and
ii) 1300 MT is used for recharging and servicing appliances.

The refrigeration sector includes manufacturers of domestic and commercial refrigeration appliances. These appliances use CFC-12 as the refrigerant e.g. domestic refrigerators, water coolers, deep freezers, bottle coolers, display cabinets, walk-in coolers and cold storage, dehumidifiers etc. The demand for these appliances has been growing annually at the rate of fifteen percent. (Other appliances such as window and package air conditioners use HCFC-22 as refrigerant, and large centrifugal air conditioning plants use CFC-11 and hence are not addressed in this project).

All domestic and commercial refrigeration appliances use Indian made compressors only. The appliance manufacturers produce a portion of their compressors and buy their supplemental requirements from two compressor manufacturers in India-Kirloskar Copeland Ltd., and Shriram Refrigeration Industries.

ENTERPRISE BACKGROUND

Kirloskar Brothers Ltd. has been manufacturing hermetic compressors since 1966. In 1991-92, KCL sold 56,800 compressors comprising 15 different models. KCL also repaired 24,100 compressors. In April, 1993 the hermetic compressor division of Kirloskar Brothers Ltd. was converted to a joint venture company with Copeland Corporation, US and named Kirloskar Copeland Ltd. In this joint venture company, Kirloskar Brothers Ltd. owns 51% share and Copeland Corporation 49%. KCL has entered in a technology transfer agreement with Copeland Corporation. Copeland Corporation will, transfer technology for manufacture of compressors for HFC-134a and other ozone-friendly refrigerants to KCL. KCL enjoys the confidence of its customers for quality and reliability of compressors. It is the only company in India to have obtained ISO 9001 certification for Quality Management Systems for manufacture of hermetic compressors.

KCL manufactures compressors for CFC-12 in the 76 kcal/hr to 1058 kcal/hr cooling capacity range for Low Back Pressure applications such as refrigerators and freezers; and in 305 kcal/hr to 1991 kcal/hr range for High Back Pressure applications such as water coolers, bottle coolers etc. In addition to CFC-12 models, KCL also manufactures HCFC-22 compressors for air conditioners, which are not addressed in this report.

PROJECT DESCRIPTION

The project will be implemented in two phases that overlap:

Phase I: Engineering development, prototype manufacturing and testing of compressors for HFC-134a; and customer training in use of HFC-134a compressors; and

Phase II: Establishment of manufacturing facilities for HFC-134a, and preparation of feasibility report for Phase III (commercial manufacturing).

PHASE - I

The first phase will cover engineering development, prototype manufacture, testing of compressors on calorimeter, testing of compressors on appliances and field trials of HFC-134a designs. HFC-134a has different thermodynamic properties compared to CFC-12. Many of the materials used in CFC-12 compressors are not compatible with HFC-134a. Therefore, a change over from CFC-12 to HFC-134a as the working medium of a compressor will necessitate many changes in compressor, some of which are given below:

* Bore and stroke
* Gasket material
* Valve reed
* Valve plate design
* Insulating material for motor
* Motor design
* Mufflers and other gas passages
* Lubricating oil
* Material/components incompatible with HFC-134a and its lubricant..

In addition, many changes will be required in production processes and processing equipment such as lubricants and chemicals used in the processes, oil reclamation and changing equipment etc.

KCL does not have the above mentioned know-how and hence will be dependant on Copeland for this technology. Copeland will furnish detailed information on changes required in the above mentioned parameters to make the models suitable for HFC-134a. The detailed information will be used by KCL in order to:

. Prepare drawings.
. Build prototypes.
. Test on calorimeter and on appliances.
. Improve the design to make it suitable for ambient and voltage conditions in India.
. Conduct life tests.
. Build a trial lot for field tests.

The funding requested will cover:

a. *Test facility to test the new compressors:* Since tests on calorimeter, on appliances and on life test rigs are an inherent and important requirement of the development process the first phase will cover the expenses to set up necessary test facilities compatible with HFC-134a.

b. *Oil reclaimer and charger:* HFC-134a needs a different lubricating oil. The first phase will cover the expenses for a separate oil processing and charging equipment, since the present equipment cannot be used due to contamination possibilities. The equipment selected will be suitable for Phase-II also.

c. *Training:* HFC-134a systems are extremely sensitive to contamination. Hence the first phase will cover the training of engineers and operators involved in manufacture and testing of prototypes. Copeland agreed to impart training to KCL's employee at Copeland's plant as well as at KCL's plant. This training will help KCL to build prototypes smoothly and effectively.

d. *Traveling:* The expenses will also cover travelling of personnel as well as communication for the purpose of various activities mentioned here.

e. *Transition team:* Funding requested in this proposal will finance the cost of compensation for 4 KCL engineers and related support staff. This refrigerant transition team will undertake all the activities described above. The level of funding requested also reflects the cost of testing, data collection and other necessary activities to ensure cost-effective implementation of HFC-134a use into KCL's product line.

f. *Recovery and recycling:* An additional component of phase-I is the use of refrigerant recovery and recycling equipment for testing of compressors that are being tested on appliances. Such equipment will enable KCL to reduce emission losses by up to 60%.

g. Customer training: Many KCL customers are small scale, unorganized sector firms scattered throughout India and with virtually no inhouse engineering capability and ability to absorb new technology. KCL will conduct considerable support and technical assistance to these firms. KCL will conduct about 22 training workshops during phase I/II at different locations, including additional TA follow-up with individual customers to ensure successful switch to use of HFC-134a compressors. The Government considers that this intensive training is an essential step in ODS phase out in refrigeration sector and reaching the many small firms.

PHASE II

The second phase will cover the change over of KCL's production line from CFC-12 compressors to HFC-134a compressors. Since it is not possible to totally shut down production of CFC-12 compressors during the changeover, it will be necessary to lay down an additional production line to produce HCFC-134a compressors. <u>CFC-12 compressor production will stop once HFC-134a compressor production commences</u>. The second phase will also involve training of all personnel involved in production and testing of the new compressors.

HFC-134a and its compatible lubricant oil are very sensitive to contamination. The second phase will therefore cover expenses on training the KCL's customers for proper use and correct application of HFC-134a compressors. Many of KCL's customers are in the unorganized (small scale) sector and such training would otherwise be out of their reach.

Funding will be requested for training of operators on production lines, limited retooling necessary for production and incremental operating cost. Since HFC-134a and its lubricant (polyol ester) are very sensitive to moisture and contaminants, it will be necessary to carefully select the compressor assembly and processing equipment to avoid hydration. The changes in compressor design would mean changes in some of the tooling.

KCL will prepare a separate project proposal for Phase-III commercial operation during implementation of Phase I/II.

JUSTIFICATION FOR SELECTION OF ALTERNATE TECHNOLOGY

HFC-134a has been accepted world-wide as the most suitable alternative refrigerant. Also HFC-134a properties shows that it can be used in a wide variety of appliances to replace CFC-12. Furthermore, HFC-134a has good thermodynamic properties, zero ODP and no flammability. It is therefore selected by KCL as the most appropriate alternate refrigerant as a long term solution. It will also help KCL to keep pace with other countries and ensure that KCL can continue to export compressors to World markets.

TOTAL PROJECT COST

The total project cost of Phase-I/II is US$651,900 including eligible incremental capital costs and incremental operating cost (training, contingencies and financial agent fee) as shown in Annex A. Because there is no Non-ODS investment cost associated with this project the total project cost equals the ODS reduction portion of the overall project. This project will not provide Kirloskar Copeland Ltd. with any incremental revenue.

Investment Cost

The total investment cost for the Phase-I/II of this project is US$1,183,000 of which 51% is eligible for OTF funding.

Operating Cost

The operating cost of Phase-I/II of this project is US$59,200 to cover product development and testing. The incremental operating costs for Phase-III have not been included as a part of this project. Incremental Operating Cost for Phase-III will be estimated at a later date and a separate proposal will be submitted after having more accurate data. The eligible operating cost is 51% of US$59,200 or US$29,600.

UNIT ABATEMENT COST (UAC)

UAC is not calculated since this project proposal is only for Phase-I/II.

PROPOSED OTF GRANT

KCL is an independent company with equity held by Kirloskar Brothers Ltd. (51%) and Copeland Corporation (49%). Neither company will fund any expenses that the KCL needs for the development of HFC compressors. Therefore the whole burden of development of compressors for ozone friendly refrigerant comes to KCL. The requested OTF grant for Kirloskar Copeland Ltd. is US$603,300 (plus FA fee of $18,100 to equal to US$621,400).

Economical Rate of Return (ERR)

The ERR for the project is to be determined during project appraisal.

Financial Rate of Return (FRR)

The FRR for the project is to be determined during project appraisal.

IMPLEMENTATION SCHEDULE

Task	1993	1994	1995	1996	1997	1998	1999
PHASE-I							
Consultancy.	X	XXXX	XXXX	XXXX	XXXX		
Training	X	XXXX	X				
Procurement		XXXX					
Development		XXXX	XXXX	XX			
Field trials.			XXXX	XXXX	X		
PHASE-II							
Production				XXXX	XXXX		

FINANCING PLAN

Total project cost is US$1,183,000 of which OTF grant of US$603,300 is being proposed and the balance of US$579,700 will be provided by the enterprise. Details of financing plan will be given during project appraisal.

REQUIRED REGULATORY ACTION

At present, the custom duty is at a rate of 35% to 150% depending upon the equipment to be imported. In addition to duty there are also taxes such as excise, sales, etc. that are charged on equipment purchased from Indian manufacturers. Because duties and taxes are considered transfer payments between organizations rather than true economical costs, the MP Multilateral Fund does not consider such cost as incremental. KCL will not realize any profit from implementing the project. Hence to reduce the total costs incurred by KCL it is requested that the Government to waive import duties and taxes for all equipment supplied for this project.

A significant portion of CFC-12 consumption is for servicing of appliances. In order to eliminate it, the compressor repairs will have to incorporate suitable changes in the compressors as and when required while repairing and make them suitable for ozone friendly gases. The Government should not consider these changes as fresh manufacture and should not therefore charge fresh excise and other duties.

DIRECT PROJECT IMPACT

As KCL is not consuming CFCs directly the impact of the project is difficult to estimate. KCL has manufactured 56,800 compressors and repaired 24,225 compressors in 1991-92. The use of CFC-12 with KCL's compressors was approximately 57 MT (11.5%) for new appliances and 23 MT with repaired compressors. The market share of KCL is more than 60 per cent in the commercial refrigeration field. By making compressors available with alternate refrigerant the use of 57 MT CFC-12 for new application and 23MT with repaired compressors will be eliminated based on 1991/92 data. In 1998, at full production, an estimated 125 MT of CFC-12 will be removed from KCL's customers' operations.

INDIRECT PROJECT IMPACT

While designing the product, KCL will ensure that the product quality and performance of compressors manufactured by KCL will not be affected. Since operating costs for Phase-III have not been considered in this proposal, the impact on product price will be known after knowing the operating cost in Phase-III of this project.

ENVIRONMENTAL ASSESSMENT

The project will not result in any additional emission effluent or wastes being produced at Kirloskar Copeland's plant. The proposed project will meet all applicable environmental, health, and safety regulations of Government of India and will not require a revised certificate of compliance. This will be verified at the time of project appraisal.

ANNEX A

BREAK DOWN OF INCREMENTAL CAPITAL COST.
PHASE-I - COMPRESSORS FOR HFC-134a

		US$
A.	EQUIPMENT COST	486,400
	a. Controlled ambient test room	25,180
	b. Data acquisition system	8,580
	c. Calorimeter	200,000
	d. Leak detector (2)	880
	e. Recovery and reclaimer	5,270
	f. Life test equipment	4,760
	g. Appliances	2,400
	h. Oil reclaimer charger	144,840
	i. Limited retooling	81,900
	j. Evacuation system (2)	8,590
	k. Installation cost	4,000
B.	TECHNOLOGY KNOW-HOW AND INFORMATION COST	300,000
C.	PROTOTYPE MANUFACTURING, TESTING AND DRAWING COSTS	27,900
	a. Prototype mfg.	
	b. Prototype testing	5,250
	c. One time drawing cost	15,000
	d. Laboratory testing cost	2,650
		5,000
D.	FIELD TRIALS	23,300
E.	TRAINING, TRAVELLING AND COMMUNICATION	29,000
	a. Training cost	4,000
	b. Travelling & communication	25,000
F.	Equipment Modification	79,400
	CAPITAL COST	946,000
	Contingency 15% (except B)	97,000
	Customer Training	140,000
	Project Costs	1,183,000
	OTF grant (51%)	603,300
	Financial agent fee (3%)	19,000
	Total Project OTF Funding	622,300

NB: 1) Calorimeter budget limited to $200,000, compared with KCL request (quote) of $247,010. KCL will obtain three bids and award to lowest acceptable.

2) Customer training limited to $140,000 (22 workshops at $6,350 each, compared to KCL request for 30 workshops. If more than 22 are needed, then they would be included in phase III).

India

REVIEW OF A HFC-134a CONVERSION PROJECT

Manufacture of HFC-134a Compressors at Kirloskar/ KCL Ltd

Project Proposal by The World Bank, July 1993

RTU-UNWB-LK-93211 -lk

Scope

The project under review covers the first phase of the conversion of CFC-12 compressors to HFC-134a, the transfer of HFC-134a technology, the development of in-house technology, the testing of HFC-134a compressors, and the repairs/ retrofits of CFC-12 compressors.
Apart from the latter, it is in agreement with the phased approach recommended by the OORG.

Recommendation

Due to a number of investments of a certain type, the costs for conversion to HFC-134a will never be linear with the quantity of compressors produced. The cost level as indicated here can be considered applicable to the HFC-134a conversion process.

The project is supported, however, under the conditions

- that the retrofit part of the project has to be either more detailed or taken out, and
- that it should be investigated what would be the investment in calorimeters in case two calorimeters each with a smaller capacity variation -and higher accuracy- are chosen.

(since half of the costs involved are due to the investment in a calorimeter (extremely expensive since it has to cover a broad range of capacities) and an oil reclaimer)

Relevancy and Adequacy of Information

It is mentioned that Kirloskar manufactured 56,779 compressors in 1991/92; It is not clear whether this is an average figure for these years or whether it is the production during these two years. It is also not clear whether the larger part of the compressors produced is in the small capacity range (for refrigerators or freezers), or whether it is in the larger capacity range. For this reason it is difficult to calculate to which ODS reduction the project will lead (see also below, ODS consumption for repairs).
As to the conversion, the information presented is adequate and gives a good overview of what the funding requested will cover.
It is stated that many changes may be needed in production processes and processing equipment; this aspect could be dealt with somewhat more elaborately (see below). Part of the project deals with retrofits; this is not consistent with the main part of the proposal that addresses the conversion of the manufacturing process.

Technical Soundness

The technology and technical support is provided by Copeland to Kirloskar. Copeland can be considered as one of the leading companies in the manufacturing of middle sized compressors. It is stated that Kirloskar was converted to a joint venture by April 1, 1993; this will guarantee technology transfer at the short term.
Under "Required Regulatory Action" the proposal mentions that "a significant portion of the CFC-12 consumption is for servicing of appliances. Therefore, compressor repairs will have to incorporate suitable changes in the compressors in order to make them suitable for ozone friendly gases". However, the question of how and when to retrofit compressors from CFC-12 to HFC-134a is a quite different one and should not be addressed here in this way. Furthermore, the retrofit of a compressor will not guarantee the reliable functioning of an appliance on non-ODS gases. The retrofit procedure also applies to the procedures involved in the appliances.

The following observations do apply:

The conversion of compressors from CFC-12 to HFC-134a may necessitate design changes in the compressors, as specified in the proposal. However, most of these changes have also been common for the design of new CFC-12 compressors in the past. Technology transfer from Copeland will automatically cover these design changes.

It is stated that the design has to be improved to make it suitable for ambient and voltage conditions in India. Of course, the design of the motor transferred to Kirloskar by Copeland has to be adapted to the above conditions. However, this has been a normal procedure for all compressors produced for CFC-12 in the past.

The proposal mentions that many changes may be required in production processes and processing equipment such as lubricants and chemicals used in the process, oil reclamation and changing equipment etc. In case the uncertainties which arise from the application of chemicals in the process can be addressed within the framework of technology transfer by Copeland, there is no problem. However, it is not clear from the budget whether the limited funds allocated to consultancy will cover this aspect. This part of the proposal should give more detailed information. For a certain part this appears to be covered by the training component, where KCL engineers are trained at a Copeland plant. However, production surroundings and cvhemicals applied may be quite different in the case of Kirloskar.

Lessons from experience

The project proposal is consistent with other proposals that relate to the conversion of compressor manufacturing to HFC-134a.

Environmental Issues

The use of HFC-134a is a rapid way to come to the application of non-ODS chemicals. The use of a recover and recycle machine, and also the use of a sophisticated oil reclaimer is positive from the environmental point of view.

Safety Issues

Not directly involved.

Cost Effectiveness

The costs for technology and information transfer are moderate. High costs are involved due to the investment in a calorimeter and an oil reclaimer (it may be possible to reduce these costs).
It is mentioned that implementation of the project will lead to an ODS reduction of 80 MT/year. However, this includes the repair/ retrofits of CFC-12 compressors, where still considerable uncertainties are present, and where this part of the project is not very well specified and, in fact, it should not be taken into account.
Assuming that 30-40 MT are involved in the production of new compressors, the cost per kg of CFC-12 phased out would be in the order of 20-30 USD, in line with many other proposals of the same kind (although one should bear in mind that additional funding would be required to convert the appliances from CFC-12 to HFC-134a).

Others

None.

Kuijpers, 93 08 13

Appendix (Kirloskar)

India

Manufacture of HFC-134a Compressors at Kirloskar/ KCL Ltd

Further information by The World Bank, 30 august 1993

RTU-UNWB-LK-93229 -lk

Scope

The project under review covers the first phase of the conversion of CFC-12 compressors to HFC-134a, the transfer of HFC-134a technology, the development of in-house technology, the testing of HFC-134a compressors, and the repairs/ retrofits of CFC-12 compressors. Apart from the latter, it is in agreement with the phased approach recommended by the OORG.

Recommendation

In the original review the project was supported under the conditions
- that the retrofit part of the project has to be either more detailed or taken out, and
- that it should be investigated what would be the investment in calorimeters in case two calorimeters each with a smaller capacity variation -and higher accuracy- are chosen (since half of the costs of the projectinvolved are due to the investment in a calorimeter).

Further information, given by Kirloskar, takes away the above concerns for the larger part. Kirloskar will investigate the investment in two smaller capacity range calorimeters.

Assuming that this different calorimeter set-up will result in cost reductions, the project is supported.

Eindhoven, 9 September 1993

Kuijpers, L.J.M. (OORG)

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER PROJECT COVER SHEET

COUNTRY	India
SECTORS COVERED	Refrigeration and Air Conditioning (Automotive Air Conditioning)
ODS CONSUMPTION IN AFFECTED SECTOR	282 MT in 1992
PROJECT TITLE	Modification of CFC-12 Mobile Air Conditioning Manufacturing for HFC-134a
PROJECT DURATION	2 years
PROJECT IMPACT	84 MT ODS
Unit Abatement Cost (UAC)	$4.3 per ODP weighted kg. of CFC-12
PROPOSED BUDGET	Incremental Capital Cost $2,010,740 Incremental Operating Cost $ 302,860 Total Project Cost $2,313,600
PROPOSED OTF GRANT	$2,025,000[1]
IMPLEMENTING ENTERPRISE	Subros Limited
IMPLEMENTING AGENCY	The World Bank/IDBI
NATIONAL COORDINATING AGENCY	Ministry of Environment and Forests (MOEF)

PROJECT SUMMARY

This Project will phase out chlorofluorocarbons (CFC-12) used in Automotive Air Conditioning Systems. In Phase I of this project, Subros will modify its production capability enough to supply its export market with HFC-134a compressors. This Phase will therefore require changes in production equipment as well as compressor design modifications. The incremental capital cost for these items is the subject of this proposal. Phase II will be devoted to phase-out of CFC-12 from all compressors for the domestic market. The schedule has been planned to accommodate the phase-out envisaged in the India Country Program. Many of the costs involved in the Phase I proposal will also provide for some of the Phase II activities. A separate proposal will be submitted for Phase II.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by the OORG technical reviewer, Mr. S. Oulouhojian. His comments are attached.

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[1] Includes 15% contingency and 3% fee for financial agent. US$1.71 million approved at 11th meeting of the EC.

PROJECT OBJECTIVE. The project objective is to facilitate the phase out of CFC-12 used as refrigerant in the Automotive Air Conditioning Systems by producing compressor designed for use of HFC-134a in coordination with model changes by car manufacturers.

SECTOR BACKGROUND (modified as per draft India Country Programmme - July 1993)

The Automobile Industry in India underwent major growth in the early 1980's with the start-up of manufacturing facilities for late model cars. To provide Automotive Air Conditioning Systems for these cars, SUBROS LIMITED, India started production with foreign collaboration. India has a tropical climate coupled with heavy traffic and pollution conditions in the metropolitan cities and also poor rural road conditions. All these result in a lot of discomfort while travelling, due to high temperature, humidity, dust and pollution etc. It is estimated that during the year 1993-94 a total of approx. 105,000 Air Conditioning units shall be installed in India (including vehicles manufactured for export) and another 176,000 units may require fresh refrigerant charging. The total consumption of CFC-12 during 1993-94 is estimated to be 281 MT at one kg. per vehicle.

ENTERPRISE BACKGROUND. Subros Limited, India, is manufacturing Automotive Air Conditioning Systems in technical collaboration with M/s. Nippondenso Company Limited, Japan. Total Capital Investment of the Company is about US$7 million and expected turnover during the financial year 1993-94 is likely to be US$40 millions. Subros employs 400 people, is the largest manufacturer of Automotive Air Conditioning Systems in India and is the original equipment supplier to:

1) M/s. Maruti Udyog Limited (Subsidiary of M/s Suzuki Motor Company, Japan) - for their total requirement for domestic and export markets; and

2) Other leading manufacturers like M/s. Engg. & Locomotive Co. Limited and M/s. Premier Automobiles Limited.

Subros has a modern manufacturing facility located at Noida (30 Kms. from New Delhi). All the critical manufacturing equipment, instruments and tooling etc. have been imported from M/s. Nippondenso Company, Japan, who have trained Subros engineers. Some of their engineers are based at Subros to provide day to day input for making their products of international quality standards. Keeping in-line with the Montreal Protocol Agreement, of which Japan also is a signatory, M/s. Nippondenso Company, after extensive research and tests, developed the technology for use of alternate refrigerant HFC-134a. Subros plans to phase out the use of CFC-12 with technology available from M/s. Nippondenso Company, Japan and adopt HFC-134a based technology.

Subros manufactured 31,000 units during FY 1992-93. During the year 1993-94, it is expected that Subros shall manufacture and supply 50,000 Air Conditioning Systems both for domestic and export market. Considering the quantity of refrigerant required is one kg. per vehicle, approx. 50 MT of CFC-12 shall be consumed for Automotive Air Conditioning Systems supplied by Subros. Approximately 35 MT is used for recharging. In the years 1994-1999 an average of 100 MT/year is expected to be consumed. Subros is the original equipment supplier of Automotive Air Conditioning Systems to M/s. Maruti Udyog Limited (MUL), both for their domestic and export markets. At present M/s Maruti Udyog Limited is exporting their existing model of 800 CC (LHD) cars to various countries for which Air Conditioning Systems are supplied by Subros. During mid 1993, M/s. Maruti Udyog Limited shall be launching a new model of car primarily designed for export market. It is expected that during 1994-95, MUL shall require a total of 12,000 units for export market. M/s. Nippondenso, Japan has projected a demand for supply of 11,000 retrofit Compressors (for use with HFC-134a) per annum from 1994-95 onwards for export market to their various subsidiary companies.

PROJECT DESCRIPTION. The project involves:

(a) Transfer of Technology from M/s. Nippondenso Company Limited, Japan;

(b) Setting up infrastructure required for new production lines;

(c) Procurement of imported and indigenous equipment, toolings, instruments etc. for new production lines and modification of existing production lines; and

(d) Training of Subros manpower at Nippondenso, for changeover implementation and subsequent production.

The project will result in phasing out a total of 100 MT CFC-12 used for the initial charge and service.

JUSTIFICATION FOR SELECTION OF ALTERNATE TECHNOLOGY. Alternate technology based on refrigerant HFC-134a is being adopted for the following reasons:

(I) HFC-134a has been accepted world wide as replacement for CFC-12 for use in refrigeration and air conditioning applications including Automotive Air Conditioning Systems because of its good thermodynamic properties, zero ODP and non-flammability. Also, refrigerant HFC-134a has been recognised world-wide as the refrigerant of choice.

(II) M/s. Nippondenso Company, Japan, Subros collaborators, have carried out extensive research and testing using HFC-134a and have accordingly developed the technology. M/s. Nippondenso have agreed to transfer the technology free of charge.

PROJECT COSTS. Unless otherwise noted, all costs in this section are economic rather than financial costs.

Total Sub-Project Cost: The total capital cost is US$2,010,740. Since there are no non-ODS capital costs associated with this project, the total project cost equals ODS reduction portion of the overall project. This project will not provide Subros with any additional revenue. Major components included in the capital cost are, costs for infrastructure, additional production and testing lines, transfer of technology, training etc.

Operating Costs: The incremental operating costs for this project are estimated to be US$302,860.

Unit Abatement Cost (UAC). The UAC for Phase-I of the project is US$4.3 per ODP weighted kilogram of CFC-12. This number is derived from annualised incremental capital cost of US$2,64,360 first year incremental operating cost of US$95,544 and savings of 83.6 MT (weighted) of CFC-12 per annum.

Proposed OTF Grant. The proposed OTF grant of US$1.71 millions for Subros is calculated by multiplying the total ODS reduction project cost of US$2,313,600 by the percentage of ownership of the company by Indian owners (i.e. 74%).

FINANCIAL AND ECONOMIC ANALYSIS

Economic Rate of Return (ERR). Since the project entails initial capital and incremental operating cost only, the ERR is undefined and is not calculated.

Financial Rate of Return. (FRR). Since total incremental cost over 15 years is estimated to be US$302,860. Assuming that Subros receives a grant of US$1.71 million and since the enterprise has a cash flow in the first year followed by recurring cost, the project is equivalent to borrowing money rather than making an investment. Thus, as there is only a net recurring cash out flow every year, FRR is not calculated.

Implementation Schedule :

SL NO	Activity	1993				1994			
		Quarter				Quarter			
		I	II	III	IV	I	II	III	IV
01.zz	Technology Transfer	..	--<----->--						
02.	Fund receiving				<-->				
03.	Infrastructure Provision								
04.	Equipment Ordering		<------->						
05.	Training				<-->				
06.	Setting up production Lines						<->		
07.	Trial Production								.. ..
08.	Mass Production			(As per the country policy to be announced)					
09.	Supply of Domestic Market								

REQUIRED REGULATORY ACTIONS. No regulatory actions other than routine permission, are required to implement this project.

Direct Project Impacts. This project will phase out 85 MT per year of CFC-12 (1992 basis) equivalent to ODP weighted savings of 85 MT.

Indirect Project Impacts. This project will have no impact on performance or quality. However, since the cost for Phase-II has not been included in this project and shall be worked out separately, it is not possible to furnish the impact on price of Automotive Air Conditioning Systems for domestic market.

ENVIRONMENTAL IMPACT. This project is not expected to have any adverse Environmental impact at the factory level.

Changes in Project Scope and Costs Due to OORG Comments. Project costs was reduced as a result of earlier OORG review. Enterprise will make the maximum use of Japanese engineers already at site due to other work. However, this factor was already taken into account to determine training and technical assistance level required. All equipment wil be procured internationally to optimize costs.

Project Cost Estimate

Capital cost	**US$**
Compressor Assembly	512,484
Tube liquid	396,027
Hoses	159,181
Task Receiver	113,472
Condenser Evaporator	351,984
Compressor parts machinery	497,708
Training	38,258
Technology	9,590
Consultancy	6,000
Total cost	2,034,706
Less residual value	23,966
Capital cost	2,010,740

TO: NAIMEH HADJITARKHANI

②

SIMONE MANAGEMENT INC.

7425 West Chester Pike
Upper Darby, PA 19082
(215) 352-4600

DATE: August 9. 1993

TO: Don Brown
Project Manager

World Bank
Washington, D.C. 20433
Asia Information Center
Fax# 202-477-6619

FROM: Simon Oulouhojian
OORG Reviewer

Fax# 215-352-1345

SUBJECT: India - Review of Mobile Air Conditioning Project Proposal
Sub-Project Proposal For The Use Of Non-Ods Technology At Subros Limited, India
File # 1-2R.PRJ

MESSAGE: Modification of CFC12 Mobile Air Conditioning systems manufacturing and compressors to HFC134A, a non-ozone depleting refrigerant.
Two phase project over a period of two years.
Impact is 84 metric tons of ozone depleting substances.
Project cost $2313600.00
Grant OTF $17100.00 $1,712,000

RECOMMENDATIONS: On the whole, I support this proposal. The bank should look at the possibility of reducing costs in both travel and additional support to bring in engineers through the utilization of the on site quality control engineers that Nippondenso has there. There may be a rotation of these personnel, who could be trained and retrain the staff at Subros Limited.
Based on the information in the proposal, Subros has a modern plant and qualified employees that could easily and quickly make the necessary changes for transition to non-ozone depleting HFC134A refrigerant in systems and compressor production.
This grant would accelerate the use of HFC134A compressors into the region as Subros also exports systems and parts.
The climate and temperature in India indicates a growth market for mobile air conditioning systems, by their own projections well over 110000 units in the next few years.
This project will provide cash flow the first year. This proposal should be beneficial to all parties and should be a model program as it comes to fruition.

③

SIMONE MANAGEMENT INC.

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Nippondenso certainly has a fine reputation in the air conditioning industry maintaining a leadership position for its research and development programs, highest quality products and engineering. They should be commended for offering this technology for transfer.

ENVIRONMENTAL IMPACT: Phasing out 84 metric tons of CFC through accelerated transition to 134A in systems and compressors manufactured by Subros. I see nothing in this proposal with adverse environmental impact. I am sure proper material safety data information will accompany technology transfer; for example, proper handling of synthetic lubricants to avoid skin contact.

Simon Oulouhojian