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

Thirteenth Meeting
Montreal, 25-27 July 1994

PROJECT PROPOSALS: INDIA

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

UNEP

- Indian Halon Management and Banking system.

UNIDO

- Conversion of electronic cleaning processes from ODS solvents to aqueous cleaning at ITI Mankapur.

World Bank

- Replacement of CFC-11 blowing agent in polyurethane (PU) foam systems with low and non-ODS materials at Expanded Incorporation;

- Conversion of process for manufacture of disposable syringes from EO/CFC-12 to EO/Co_2 sterilisation and direct siliconisation at Hindustan Syringes and Medical Devices Pvt. Ltd.;

- Conversion from Halon 1211 to ABC-DCP portable extinguisher manufacturing at Real Value Appliances Limited.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India	
PROJECT TITLE:	Indian Halon Management and Banking System	
BUDGET:	Phase I (1994-1995) Phase II (1995-1998)	US $230,000 US $455,000
INCREMENTAL COSTS:	US $685,000	
ODS PHASE-OUT:	N/A	
COST EFFECTIVENESS:	N/A	
PROJECT DURATION:	4 years	
IMPLEMENTING AGENCY:	UNEP / DIFR	
NATIONAL COORDINATING AGENCY:	Ministry of Environment and Forests	
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _	

SECRETARIAT'S COMMENTS

1. The project proposes to develop a plan for managing existing stocks of halons in India (estimated as 2,500 and 700 metric tonnes of halons 1211 and 1301, respectively).

2. The plan seeks to accomplish the following:

   (a) Facilitate the transfer of available halons among users for essential use purposes;

   (b) International cooperation to share surplus halons, especially halon 1301;

   (c) Evolve a method for international trade in recycled halons through national halon banks;

   (d) Identification of essential uses in India and determination of present and future requirements; and

   (e) Setting up of halon management and banking in India.

3. The project will be implemented by the Defence Institute of Fire Research.

4. The project will be implemented in two phases. Phase I (October 1994-September 1995) includes the preparatory work for establishing the infrastructure of a halon banking system as well as developing a halon clearing house. It also includes identification and registration of halons, estimates of future halon needs, and the financial viability of the halon bank. Implementation and operation of the halon bank and the halon clearing house will be undertaken during Phase II of the project (October 1995-September 1998).

5. The cost of Phase I is estimated at US $230,000 to cover salaries, software, recycling machines, laboratory equipment, domestic and international travel and workshops.

6. Phase II is costed at US $455,000 to cover salaries, handling and storage of halons and purchase of ABC powder extinguishers. Although there are many applications where the use of halon 1211 is desirable there are very few essential uses. Therefore, there is no reason to remove halon 1211 from portable extinguishers to utilize the halon elsewhere.

7. Ten metric tonnes of halon 1211 would be banked in the first year of the bank's operation.

8. The Executive Committee will consider a project submitted by UNDP which would demonstrate alternative fire fighting systems and develop a sectoral strategy for the phase-out of halons in India. The strategy will be ready by end-1997.

9. India is a producer of halon 1211. India's consumption of halons is expected to rise until end of 1995, according to the country programme of India.

10. At present there is no regulation and regulatory authority in the country for halon uses.

10. Decision IV/26 of the Fourth Meeting of the Parties states, <u>inter alia</u>, "To request the Industry and Environment Programme Activity Centre of the United Nations Environment Programme to function as a clearing-house for information relevant to international halon bank management and further request the Centre to liaise with and coordinate its activities with the implementing agencies designated under the Financial Mechanism to encourage Parties to provide pertinent information to the above-mentioned clearing-house;" As per this decision, the role of UNEP as the implementing agency of the project is questionable.

SECRETARIAT'S RECOMMENDATION

11. The Secretariat recommends that the project should be deferred, until a national halon phase out strategy is developed. The Secretariat also recommends to request UNDP to address the needs of establishing a halon bank system while developing the national strategy.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India
PROJECT TITLE:	Conversion of Electronic Cleaning Processes from ODS Solvents to Aqueous Cleaning at ITI-Mankapur
PROJECT COST:	Incremental capital cost US $1,159,000 Incremental operational saving US $(383,846) Project preparation cost US $ 24,000
INCREMENTAL COST:	US $799,154
ODS PHASE-OUT:	36.9 tonnes of CFC-113 in 1992 4.5 tonnes of CFC-12 2.0 tonnes of Carbontetrachloride 23.0 tonnes of Trichloroethane (Total ODP = 38.5 tons)
COST EFFECTIVENESS:	US $20.8 per kg ODP saved
PROJECT DURATION:	One year and six months
IMPLEMENTING AGENCY:	UNIDO
NATIONAL COORDINATING AGENCY:	Ministry of Environment and Forest
TECHNICAL REVIEW COMPLETED:	YES _X_ NO _

SECRETARIAT'S COMMENTS

1. This project was given permission to proceed at the 12th Meeting of the Executive Committee. Under this project, the company will eliminate the use of ODSs being used for cleaning of digital switches and printed circuit boards by converting to an aqueous cleaning system.

2. After the 12th Meeting, UNIDO had further developed this project and submitted a revised document. The new proposal requests two additional cleaning systems to phase-out 20 tonnes of trichloroethylene (TCE) and 47 tonnes of methylene chloride (DCM). TCE and DCM are not substances that are controlled by the Montreal Protocol. The cost of these two systems is therefore not eligible for funding. Consequently, operational savings generated by not using

TCE and DCM could be deducted from the total incremental operational savings (US $383,846).

3. Although a "study tour" is being included to enable management to choose a technology, the project is costed based on a pre-determined technology and this cost (US $32,000) should not be approved.

4. Since the project preparation costs of US $24,000 are covered by the US $74,000, which was approved by UNIDO for preparation of the solvent sector projects at the Tenth Meeting of the Executive Committee, the cost of $24,000 is not requested at this time.

SECRETARIAT'S RECOMMENDATION

5. The Secretariat recommends approval of Funding for US $610,160 (capital costs = US $797,000, operational savings = US $186,840).

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India	
PROJECT TITLE:	Replacement of CFC-11 Blowing Agent in Polyurethane (PU) Systems with Low and Non-ODS Materials (Expanded Incorporation)	
BUDGET:	Incremental capital cost	US $565,000
	Incremental operating cost	US $ 41,000
	Financial Agent Fee	US $ 18,000
	Total cost	US $624,000
ODS PHASE-OUT:	72 tonnes (ODP) CFC-11	
PROJECT DURATION:	4 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. This project was given permission to proceed by the Executive Committee at its Eleventh Meeting. When it was first submitted, the requested funds amounted to US $513,000.

2. The objectives of the proposed project are: (a) to eliminate CFC-11 from pre-blended polyol systems manufactured by Expanded Incorporation, and (b) to promote phase out of CFC-11 at foam producers by developing new polyols and systems for processors who normally make their own blends.

3. This project proposal in addition to two approved proposals in the Polyol Production Sector should cover more than 90 per cent of India's needs for new polyol systems (according to the project documents).

4. The project is divided into two phases:

1) Phase 1

(a) To set up an application technology centre in a separate building where development, testing, trials and demonstration of CFC-free foam systems will be carried out as per end-user requirements under local conditions. New polyols suitable for blowing agents, e.g., the HCFC-22 blend, HCFC-141b, cyclopentane, HFC-134a will be evaluated.

(b) This phase seeks to construct a new building to house essential laboratory equipment in addition to other equipment strictly related to foam production and foam application, as well as foam testing equipment.

2) Phase 2

(a) The existing polyol plant will be modified to produce new base polyols suitable for production of CFC-free rigid foams.

5. The direct impact of the project is the elimination of 72 mt/y of ODP as a result of replacing CFC-11 with alternate blowing agent in blended polyol systems manufactured at Expanded Incorporation.

6. The cost of installation of facilities and construction at US $106,000 is not eligible for funding.

SECRETARIAT'S RECOMMENDATIONS

7. The project is recommended for final approval within the framework of the foam sector strategy for India.

8. 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.

9. Incremental operating costs to be incurred as a result of the use of new polyol systems by the foam manufacturer should not be claimed by them when submitting future projects.

10. To approve US $502,130 as the incremental costs of the project as follows:

	US $
Capital costs (less costs of construction)	407,000
10 per cent contingency	40,700
Operating costs	41,000
3 per cent (capital costs) Financial Agent Fee	13,430
Total:	502,130

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India
PROJECT TITLE:	ODS phase-out in sterilisation and siliconisation of disposable syringes and needles (Hindustan Syringes Ltd.)
BUDGET:	Phase I: Incremental capital cost US \$639,000 Incremental operating cost US \$128,000 Financial Agent Fee US \$23,000
INCREMENTAL COSTS:	US \$790,000
ODS PHASE-OUT:	50 mt/y of CFC-12 and 4 mt/y of CFC-113
COST EFFECTIVENESS:	US \$14.8/kg (ODP) of CFC saved
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. 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 Executive Committee considered an earlier project proposal from Hindustan Syringes Ltd. at its Twelfth Meeting. The Committee gave the World Bank permission to proceed, but deferred its final decision contingent upon the provision of details on the existing baseline, revision of operating costs and justification of a transitional period of four years.

3. The objective of the new proposal is to replace the existing sterilisation system with a non-CFC 12 system, and to install 32 silicon application nozzles. The conversion will phase out 50 tonnes of CFC-12 and 4 tonnes of CFC-113.

4. The World Bank has not provided information on the existing baseline. This information is deemed necessary for the determination of incremental capital costs.

5. Incremental operating costs are requested for two years, however, without discounting.

SECRETARIAT'S RECOMMENDATIONS

The Secretariat recommends as follows:

1. To approve the project and to defer approval of requested funds until information is provided on the existing baseline. Once incremental costs are accurately determined, they could be approved on a non-objectional basis between meetings.

2. The Committee may wish to consider whether to fund the twenty per cent of production exported to non Article 5 countries.

PROJECT EVALUATION SHEET

COUNTRY OR REGION:	India
PROJECT TITLE:	Conversion from Halon 1211 to ABC-DCP in Portable Extinguisher Manufacturing (Real Value Appliances Limited)
BUDGET:	Incremental capital costs US $524,190 Incremental operating costs US $268,220 Financial Agent Fee US $23,772
INCREMENTAL COSTS:	US $816,182
COST EFFECTIVENESS[1]:	N/A
PROJECT DURATION:	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. Real Value Appliance Limited was the largest manufacturer of halon 1211 extinguishers in India. In 1992/1993, the enterprise began to produce ABC-DCP extinguishers. The enterprise consumption of halon 1211 dropped as a result to 25 tonnes.

2. The proposal was considered by the Executive Committee at its Twelfth Meeting. The Committee decided that "The project was ineligible for funding, according to the Indicative List of Categories of Incremental Costs. However, the project might become eligible if, when compared with imports, it was more cost effective".

3. The World Bank has modified the proposal and requested both incremental capital costs and incremental operating costs.

4. In the calculation of incremental capital costs, the Bank has shown that it will be cheaper to locally produce the extinguisher's cylinders and valves when compared to imports.

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[1] It is difficult to discern from the project document the actual amount of ODS to be phased out.

5. The calculation of incremental operating costs is based on reimbursing for lost revenue resulting from sale of cheaper ABC powder extinguishers versus the expensive halon 1211 extinguishers.

6. The World Bank provided the following explanation for using this (new) method of calculation of operating costs:

> "For Real Value, there is a reduction in the operating costs of about Rs 21 per 500 g cylinder compared to a revenue loss of Rs 11.9 per 500g cylinder. The conventional methodology would result in an operating cost savings and the enterprise would therefore receive less than full capital costs for implementing a project that also reduces its profits, obviously a bad business decision at the enterprise level. The company must also face a market that is accustomed to halon fire extinguishers and must therefore provide an incentive to the consumer to purchase a product that has less appeal, hence the reason why potential savings in incremental operating costs are passed on to the consumer while the enterprise is required to absorb a reduction in its profits."

7. The project appears to be near completion and at present the halon used in filling of the extinguishers has dropped to 25 tonnes or less.

8. It is mandatory that savings and benefits be taken into consideration when determining the grant amount. Indeed this has been the policy of the Fund thus far.

9. The Executive Committee deferred a decision on two foam projects from Egypt because their operating savings would exceed the requested capital costs. As a result the Secretariat was requested to prepare a paper on such projects.

10. The paper was considered by the Committee at its Twelfth Meeting and is being resubmitted after revision to this meeting.

SECRETARIAT'S RECOMMENDATION

11. The Secretariat recommends that approval of the project should be deferred until operating savings are calculated and taken into account when determining the grant amount for the project.

PROJECT COVER SHEET

COUNTRY	:	INDIA
PROJECT TITLE	:	INDIAN HALON MANAGEMENT AND BANKING SYSTEM
SECTOR COVERED	:	HALON (FIRE FIGHTING)
ODS CONSUMPTION	:	3650 MT. ODP FOR HALON-1211 & 1301, 1991
PROJECT DURATION	:	PHASE-I, OCT. 94 TO SEPT. 95 PHASE II, OCT. 95 TO SEPT. 98.
PROJECT IMPACT	:	RELEVANT FOR PHASE OUT OF 500 MT OF HALON 1211 AND 50 MT OF HALON 1301 ANNUALLY. DIRECT IMPACT, REMOVAL OF 10MT HALON 1211 AND 10 MT 1301 ANNUALLY FROM THE MARKET.
TOTAL COST	:	PHASE I - 230,000 USD PHASE-II - 455,000 USD
PROPOSED GRANT	:	685,000 USD
IMPLEMENTING AGENCY	:	UNEP
NATIONAL IMPLEMENTING AGENCY	:	OZONE CELL, MINISTRY OF ENVIRONMENT AND FOREST.
NATIONAL EXECUTING AGENCY	:	DEFENCE INSTITUTE OF FIRE RESEARCH DELHI.

1. PROJECT SUMMARY

Halon 1211 and 1301 are having highest ozone depletion potential i.e. 3 and 10 respectively. That being the case, phase out of Halons will result in overall reduction of ODP in the country. As it is today and in foreseable future no in kind substitute is indentified for Halons. Because of their high efficacy, low toxicity and other properties, they have some essential uses in power, Defence, aviation, Oil, and other high risk areas. India's Halon production of 1211 is of recent origin and is depending on import of Halon 1301. However there is some quantity of Banked Halon in India with various users. Production of Halons have ceased in developed countries in Dec. 93, and users for their essential requirement have to depend on banked Halon by way of redeployment of old Halon from non-essential sector. Developed countries have already taken initiative to set up National Halon Banking system and International co-operation in this field. India's consumption is relatively low and some quantities are in non-essential uses. This is due to lack of awareness of environmental impact and insufficient information on some of alternatives for non-essential sector. The project aims at to develop a plan for managing existing stocks of Halon in India and.

To facilitate the transfer of available Halon from one user to other to satisfy essential requirement

To discourage emission to atmosphere

International co-operation so that surplus Halon of one country is made available to other's essential needs specially that of developing countries. India's need for Halon-1301 can be met by such co-operation. India does not produce Halon 1301.

To evolve method for international trade in recycled Halon through the various National Halon Banks of the World

Identification of essential uses in India and quantity requirement now and in future

To set the scheme for Halon management and banking in India.

Identification of agency, type and setting up India's Halon Banks.

The project is divided into two phases.

Phase 1 : Includes the preparatory work for establishing the infrastructure of the Indian Halon Management and Banking System.

Phase 1 will also include the development of a halon clearing house for India such as specified in the UNEP recommendation for halon banking.

Phase 2 : Implementation and operation of the Indian Halon Management and Halon Banking System based on the findings and conclusions of phase 1.

Phase 2 will also include the continuation of the clearing House function and the implementation of recovery and recycling activities in the field based on a commercially viable organization of the halon banking.

2.SECTOR BACKGROUND

India's Halon sector background relevanto this demonstration and training project is described as:

Halon consumption during 1991: is 750 MTwhich is 550 MT. halon 1211 & 200 MT 1301. India began using these two halons in early 80's and total quantity was imported till 1990 when one manufacturer started production of Halon 111 with a capacity of 300 MT per annum and producing about 50-70 MT per annum. Halon 131 is not produced till date (May 1994). There are about 25 Halon Extinguisher manufacturersn India and same number are in Halon system design and installation. However, most of the ystems on Halons have been imported in the past which need refill & repairs service now. Thmajor users of Halons in corporate sector are: Power plants, oil refineries, Railways, offshore il platforms, Petrochemical Industry, Aviation Industry, shipping, Banks and Military (Army, Nvy & Airforce) and communication. In addition most of the portable halon extinguishers are i private buildings, Industry and commerce. According to a limited survey conducted by DIR-WWF (India) 1993, and present estimates there is about 700 to 750 MT of Halon 1301 an2500 to 3000 MT of Halon 1211 banked with users/consumers scattered all over the country3ecause of vastness and also non-availability of information from supplier and users, the exa quantities, where about and condition of the systems and extinguishers are not known. This roject also aims at to get these information for managing of this Halon stock.

India's country programme has been apoved and sectorial group report on Halon included this project to be undertaken by Delere Institute of Fire Research. CP indicative list also included this project. It is recommended tht a halon bank strategy for refill, repair and in certain cases for new critical facility be formulaed.

During a survey, suggestion for establishing halon bank was also received. A halon bank company be floated for the procurement, suppl, recycling and monitoring the Halon stocks. The funds for this company may be raised though Multilateral Fund except for physical procurement. However the type of Halon Bank fcIndia will be arrived at after completion of first phase of this project.

National stocks of Halons in India are estimated to be 700 to 750 MT of Halon 1301 and 2500 to 3000 MT of Halon 1211 and currently distributed throughout the country as in Table-1.

TABLE–1

S/No	SECTOR	HALON-1301 (in MT)	HALON-1211 (in MT)
1.	Power (NTPC etc)	300	300
2.	Oil & Petro Chemical	150	500
3.	Electronics	100	500
4.	Defence	100	400
5.	Shipping & Transport	50	400
6.	Domestic & Private Sector	50	700

Halon extinguishers and systems are not stable due to leakage and inadvertent discharge are regularly emitting out the gas. Therefore, they can not be simply stored indefinitly without on going maintenance.

The problem therefore is managing of this stock of Halon and utilizing for future use when productioin ceases and supplies from other countries are restricted in India.

3.PROJECT DESCRIPTION

As per the International protocol, agreement have been made by all Halon producing developed countries to stop production by Dec. 1993. India and China are only two developing countries at present having production capacity of Halons. As per amended protocol, they also will have to cease production by the year 2004 (except for essential uses). It will however still be permitted to refill the existing Halon systems and new critical installations. It is expected that India's Halon demand will continue for meeting the new and maintenance requirement if action in properly managing the Halon at various level is not taken up right now. Otherwise the new production will continue while old halon is either discharged, leaks out and remain stocked in non-essential areas, while one user uses new Halon the other discharges. One nation continues producing new Halon other destroys. This situation may also arise in India. The user in india todayis ignorant of various alternatives, reclying and reuse of Halon. Taking up of this project is crucial to encourage Halon conservation, recyling and reallocation by the formation of Halon management and Banking system.

Though pattern of Halon banking may differ from country to country, the goals set out for this project are to:

(i) Facilitate gradual reduction and possible stop of Halon production in the country.

(ii) Reduce emission of Halon to atmoshphere.

(iii) Utilize existing stock and new Halon in the optimal manner.

(iv) Evaluate process of recyling of old Halon and procedure development for redeployment.

(v) Educate and train users, consultants, suppliers and fire fighting equipment companies.

(vi) Provide data for preparation of new Codes & Standards and training programmes.

(a) The short term objectives.

Creating the awareness, by way of seminars, lectures and personal contact with supplier and users of halon extinguisher and systems, thereby reduction in use of Halon, also getting the factual quantities available in India and preparation of essential use criteria.

(b) The long term objectives.

Use of recyled halon will reduce dependance on newly produced halon. Phase I of this project will also establish the need of recycling, and removal/replacement of some Halon extinguishers by ABC powder from the market.

The project will be carried out at Defence Institute of Fire Research. This Institute is the main Research and Development laboratory having facilities for test/evaluation of Fire Fighting equipments and chemical i.e. Foams, powder, Halons, water based and Inert gas systems including explosion suppression systems. Institute is well aware of Montreal Protocol provision and few scientists are directly engaged in Halon sector. Institute is a member of country's task force for phase out of ODS substances (Halon sector) and active member in preparation of India's country programme. Institute is also a member of UNEP, Halon Technical option committee and in regular list of UNEP/IE/PAC, Halon banking clearing houses services. Institute has done a pilot survery of Halon use in India (Aug. 93), which has been a very useful document for preparation of country programme. Defence Institute of Fire Research will form a project team of 3 Scientists qualified and having experience over 25 years in the field of Fire Technology.

The team will be headed by Director of Institute, and work will be executed through Project Executor, with two more scientists. Other organisations/industry in and out side country will be associated at various stages such as:

UNEP/IE/PAC, France a s Halon bank clearing house services and supply of banking information of other countries.

UNEP Halon Tech Option Committee. In supply of information regarding new alternative technologies developed and being successfully adopted by other countries.

Oil Industeis I.e. OISD, ONGC, Indian Oil, Petrochemicals etc	–	For dissemination of information about Halon use at present and furture, Their codes, standards and stocks of Halon.
Power such as — NTPC, NPC, CEA & state electricity Boards etc	–	– do –
Shipping	–	– do –
Aviation	–	– do –
Defence	–	– do –
Insurance *i.e.* loss Prevention Association (LPA) and Tariff Advisroy committee (TAC)	–	– do –
Bureau of Indian standards (BIS)	–	For supply of codes, manuals etc

Fire advisors of Home Affairs

Fire Chiefs of Metropolitan Cities

Major Halon Equipment Manufacturers & suppliers

Halon banks of other developed and developing countries like China, Denmark, Mexico, Canada, Holland U.K, HARC, USA, Switzerland, France for the information like organisation, Operation and results of their Halon Bank operation.

The work will be progressed in close co-ordination with ministry of Environment & Forests.

4. PROJECT ACTIVITIES

The project plan includes the following activities:

(a) Awareness Raising:

Four workshops are proposed in Delhi, Bombay, Calcutta and Madras, before setting out for project execution. These interactive meetings are expected to apprise the fire protection cummunity, managers and decision makers in Commerce and Industry about the montreal Protocol, India's stand, International scenario and input for fast data collection to the project team either by communication or personal contacts.

(b) Information Gathering:

Information on quantities held, surplus if any, age of Halon, its source of supply and next 5 to 10 years requirement etc. from Indian users, Halon manufacturing activityof two firms, Halon extinguiser and system suppliers, maintenance/refilling agencies etc. about their business in the past 5-10 years, their source of import and supplies to users etc. Information of Halon banks of other countries.

Tech. assesment missions to Indian Industry i.e. user, supplier, manufacturer, Fire fighting equipment and system supplier etc. and collection of data.

Use of UNEP/IE/PAC Data base through the facility to be installed under Institutional strengthening project already approved by Multilatral Fund.

(c) Exchange of Scientists:

Visit of Scientists from project & important users to developed countries to study the operation of their Halon bank system and training on reciying equipments.

(d) Import of three Halon Reciying equipment, its installation and establishing the quality check, method for reciyed Halons at DIFR. Training of the operators at reciying centre in India.

(e) Preparation of report

Mechanics of Banking

Liability of ownership

Physical storage if any
Essential uses

Destruction technology
Criteria for import/export & supply

International co-operation

Specification & standard

(f) Indentification of agency to operatre the Halon Bank

(g) Setting up of Halon bank and its operation start up.

5. PROJECT IMPLEMENTATION PLAN.

Phase I

Includes the preparatory work for establishing the infrastructure of the Indian Halon Management and Banking System.

Phase I will also include the development of a Halon clearing house for India such as specified in the UNEP recommendation for Halon banking.

Work Programme :

a) Reports to be worked out on :

- Physical handling of Halons, such as storage, locally and centralized, Transportation within the country
- Estimated need for further recycling machines
- Examine potential need for destruction of Halons, cost, amount etc.

b) Detailed identification and registration of Halon 1211 and 1301 in India and estimation of future needs taking into account the transfer of technology (The project on alternative technology demonstration is undertaken simultaneously).

c) Proposal for organization and operation of the Indian Halon Banking. Special consideration on the financial viability of the Halon bank and evaluation of various models for operation and income, including co-operation with other Halon banks.

d) Investigate most cost effective way of replacing portable Halon extinguishers with ABC powder extinguishers.

Phase II

Implementation and operation of the Indian Halon Management and Halon Banking System based on the findings and conclusions of phase I.

In phase II the operation of the clearing house function of the Halon and its facility and equipment will be transfered to the identified agency on national basis.

In order to generate the necessary working capital, it is tentatively proposed to obtain financial support, so that Halon extinguishers can be replaced by ABC powder extinguishers without cost for the owners/users and within some specified limits.

By such an exchange programme approach, it is aimed at collecting at least 10 tons Halon 1211 during the first year. After that, the sale of the collected Halon shall finance the future activity of the bank.

Work programme :

To be determined in detail during and after completion of the phase I.

However the undermentioned model of Halon Bank for India will be examined :

(i) The major halon users in the country such as Defence, Power plants & ONGC will join together and start a clearing house activity at DIFR.

(ii) The clearing house will also help in suggesting suitable method for conservation of Halons to various users.

(iii) The clearing house will match the two i.e. one who needs the halon and other who wants to sell the halon.

(iv) DIFR will take up the work of recycling/regeneration of Halon if needed, before clearing/certifying it for reuse by the purchaser of old halons.

(v) A limited physical bank of Halons will be maintained at some central place, if required, for recycling, testing & redeployment.

(vi) The bank will also act as a clearing house functionary of UNEP/IE/PAC Halon banking clearing house and also will be responsible for co-operation with the Halon banks of other countries.

The above type of bank choosen for the following reasons:

(a) In India, Halon users are mainly in Government sector and most of Halon is banked in Government and Public Sector Industries. Therefore a private organisation may not be able to start the Halon Bank initially.

(b) The major supplier of Halon & Halon systems are private fire equipment companies. These companies have their business in almost all types of Fire Fighting Equipments & Systems. Halon business may account to be just about 5 percent of their total output. These companies are not effected by Halon phase out in their business. Also due to bad reputation of Halon in public and some users and environmentalist, no private sector company may like to take up such project where business is uncertain and profits are doubtful. Halon producers might take up the work at the later stage once the feasibility & economic viability is ascertained.

(c) Production of Halon is stopped in advanced countries from Dec. 93. It is seen that no Halon producing country has asked for production exemption specially to meet the requirement of developing countries. HTOC and TEAP of UNEP feels that there will be sufficient recycled Halon available to meet the future requirements of the world for their essential needs.

(d) So far no real Halon replacement are in sight even in advance countries and transition substitutes are very costly.

(e) It is also understood that international Halon banks will trade recycled Halon through the National Halons Banks who will also be responsible for

Halon through the National Halons Banks who will also be responsible for certifying the quality and essentiality of the Halon use for which it being asked.

The above mentioned coiditions can be satisfied only when the management of bank is undertaken by Governmont agencies with the support of National Government.

(f) How the Organisation will Function – A MODEL

A consortium is plannedwith the membership from major users, Fire Fighting Equipment and system manufadurers, regulatory bodies etc. It will have a secretariate run by 2/3 engineers. The usersand consumers will become permanent members and register their annual requiremeit of Halon with the bank. They will also register their stock holdings and the quantity hey want to sell out to other users. Bank secretariate will maintain all these records as well as act as clearing house for National & International Banks. The bank will also have the test facility to certify the quality of recycled halon and will determine the critical use for which the demand is placed to them.

The other area where bank is planned to work is redployment & sale of Halon withdrawn by Fire Fighting Companies from non essential areas such as aerosel type and other types of Halon extiguisher on replacement by ABC Powder or other alternatives. The bank will workas non profitable organisation.

6. PROJECT COST

Phase I Budget :

1. Cost of manpower

   3 engineers fully employed with activities as specified in the work programme 15.000 USD

2. Database for the clearing house function Software and hardware for registration and operation of the clearing house : 45.000

3. Recycling machines for demonstration and training purpose :

   2 Nos. 1211 Recycling machines 20.000

   1 Nos. 1301 Recycling machines 50.000 70.000

4. Laboratories equipment for quality control of Halons : 40.000

5. Travel and other project cost (Domestic cost) : 20.000

6. Participation in UNEP Halon banking Coop. (International cost) : 20.000

7. Workshops and training seminars : Awareness Raising 20.000

Total cost : USD 230.000

Phase II, Budget

Item	*1996*	*1997*	*1998*
Income :			
1. Sale of recovered Halons :	0	50.000	100.000
2. Financial support from MF :	305.000	100.000	50.000
Operation cost :			
3. Clearing house cost	35.000	25.000	35.000
4. Handling and storage of Halons	20.000	25.000	30.000
5. Cost of 2.000 ABC powder extinguishers	250.000	100.000	85.000
Halon stock ultimo year			
6. Halon collected	10 tons	10 tons	10 tons
7. Halon used	0 tons	5 tons	10 tons
8. Stock	10 tons	15 tons	15 tons

Comments :

1. It is assumed, that recovered Halons can be sold for essential/critical uses in accordance with guidelines given by MOEF and the Fire Service.
2. Financial support requested from the Multilateral Fund or another side.
3. Cost of the clearing house function include salaries for a staff of 3 persons, (15.000 USD) office rent and operation cost of the secratariat (20,000 USD). It is assumed, that the handling of Halons in the field shall be covered by the users.
4. Halons will be recovered either at Fire Service centres or by Fire Equipment servicing and maintenance companies. Halons will bestored on 1 tons cylinders from ICI etc. The cost will include cost of lease of such cylinders.
5. As proposed, Halon collection and recovering will initially be based on an exchange programme, where the halon bank will pay the cost of ABC powder extinguishers to be given out free of charge in return for Halon extinguishers. The concept has to be evaluated during phase I.

TIME SCHEDULE – PHASE I

Project Plan/ Activity	Months																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1. Awareness Raising	x	x																						
2. Information gathering		x	x	x	x	x	x	x	x	x														
3. Exchange visits						x	x	x	x	x	x	x								x	x	x		
4. Import one recycling machine & demo							x	x	x	x														
5. Practical aspect. Halon Bank operation and report preparation											x	x												
6. Identification of Agency for Halon Bank operation													x	x										
7. Setting up of Halon Bank															x	x	x	x	x	x	x	x	x	x

Activities for Phase II will be given after completion of phase I studies.

TECHNICAL REVIEW

eNVICO AG-Umweltberatung Analysen Konzepte
Forchstrasse 59 CH 8032 Zürich
Phone +411-381 20 60 Fax +411-381 20 68

FAX

Date:	29. April 1994
To:	Rajendra Shende OzonAction Programme Coordinator UNEP IE/PAC
Fax #:	00331 44 37 14 74
# of pages:	3
From:	Walter Brunner

Dear Mr. Shende

Enclosed you receive my review of India's Halon Banking Proposal.

I appologize for the late transmittance due communcation problems in our office. The same fax has been sent to Mr. Kaprwan this morning, according to his request yesterday.

As you can see from the review, I am supporting the proposal. I believe it will be of great importance to India to develop a sound bank managing strategy. However I did again include my comments about the importance of a strong commitment on the side of India's governement to refrain from halon production. Furthermore key persons in the fire protection community as the leading memebers of the Defence Fire Research Institute should time and again transmit the appropriate message to the rest of the community.

I hope that I was of help to the decision making process!

Sincerely

Walter

Dr. W. Brunner

2/4

Technical Review

1. **Country of origin:** India

2. **Project title** Project Proposal for Indian Halon Management and Banking System

3. **Sector** Halon (Fire fighting)

4. **Relationship to country programme:** Project is consistent with country programme

5. **Technology:** In general, the proposal is well written and well organised. The work intended, especially the survey of the existing stock, will certainly be an excellent base for establishing a halon bank management scheme. In addition, bank management is vital for developing as well as developed countries and it will serve to guarantee both the supply of halons necessary for existing critical installations as well as to eliminate the need for continued production. Establishing a steering committee appears to be a very good decision and the intended broad membership is certainly helpful for the eventual acceptance of the scheme.

The proposed solution of a clearing house for the Indian bank management project during Phase 1 appears a most feasible approach. In this period the necessary changes if any for a permanent solution can be evaluated.

Establishing a database of existing installations with type of installation and amount of material banked, true and reality-based evaluation of the expected essential or critical uses is certainly worthwhile supporting. When data are collected they should not only contain information on type and amount of halons but also information about the facility protected and any other information deemed helpful to establish criticality or essentiality of the existing protection installation. Information of this kind will certainly help when allocation of halons have to made at one point.

6. **Environmental Impact:** The environmental impact is dependent on the success of the project in quickly establishing a bank management scheme. The projected figures appear reasonable. However, the longtime success does depend on the willingness of the official agencies of India to stop halon production in the country as soon as possible.

7. **Project costs:** The proposed costs seem to be essential for the success of the proposed programme. However the reviewer would like to advise the project management to be cautious in buying recycling equipment. The real need for recycling surplus halon should first be established.

8. **Implementation timeframe:** The proposed time frame appears feasible. The intention to start with "awareness workshops" right with the programme start is especially useful.

9. **Recommendations:** The proposal should be approved as proposed.

additional comment: This reviewer would like to add, that, from his experience with establishing a halon banking system in Switzerland, it is extremely important to give persistently the right message to all parties involved in fire protection: The use of halon is going to stop – even if a country does have a 10 year grace period for additional consumption! The establishment of a working halon bank (by means of a clearing house as well) was only possible in Switzerland, when the users and the manufacturers became truly aware of the fact, that there would be no more newly produced halon available in a very short time.

Therefore it appears to be of crucial importance that government authorities in India make it clear to the fire protection community that India will rely only on recycled halon for its fire protection needs and that this halon will only reluctantly be imported from other halon banks. It is perfectly understood by this reviewer that the available halon bank in India at the moment might not be sufficient to satisfy all essential needs for the future. However, there should be only a very limited number of additional new halon uses, therefore prolonging the life of the bank for the already existing critical needs.

The message to the people in the marketplace should be that –despite the existence of a national halon bank and reliance on international halon banks– true modern fire protection is fire protection without halon.

TRANSMITTAL LETTER

सत्यमेव जयते

तार :
Telegram : PARYAVARAN,
NEW DELHI

दूरभाष :
Telephone :
टेलेक्स (द्विभाषीय) :
Telex (bi-lingual) : W-66186 DOE IN
Fax : 4360678

भारत सरकार
पर्यावरण एवं वन मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT & FORESTS
पर्यावरण भवन, सी० जी० ओ० कॉम्प्लेक्स
PARYAVARAN BHAWAN, C.G.O. COMPLEX
लोदी रोड, नई दिल्ली-110 003
LODI ROAD, NEW DELHI - 110 003

Anil Agarwal
Deputy Secretary (Ozone)

F.No. 5(2)/61/93-IC-1
Dated June 3, 1994

Dear Mr. Shende,

The MOEF has recommended the following project proposals for posing it to the Executive Committee for its consideration in the July meeting. It is to request that necessary action may kindly be taken accordingly.

DIFR proposal on "Indian Halon Management and Banking System" - $ 685,000 (copy of project enclosed).

With regards,

Yours sincerely,

(Anil Agarwal)
Deputy Secretary(Ozone)

Mr. Rajendra Shende
Coordinator
UNEP IE/PAC, Ozone Action Programme
FAX: (33-1)40588874

Copy to:

1. Dr. Omar E El-Arini
Chief Officer,
Fund Secretariat,
Montreal, Canada.Fax No.- 1-514-282-0068

2. File No. 58, 165
3. Project File No. MPP/39/94-OC

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 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$		1,159,000
	Incremental operating costs/savings, US$		(383,846)
	Project preparation costs, US$		24,000
	Total Project Costs, US$		799,154
OWNERSHIP STRUCTURE	100 per cent Indian		
PROPOSED MF FINANCING	US$	799,154	
UNIT ABATEMENT COST	US$	1.39	per kg of phased-out ODS
CURRENCY CONVERSION	US$ 1.00 = Indian Rs. 31.20		
COUNTERPART ENTERPRISE	Indian Telephone Industries Ltd., Mankapur		
IMPLEMENTING AGENCY	UNIDO		
COORDINATING MINISTRY	Ministry of Environment and Forest		

PROJECT SUMMARY

This project will phase out the use of CFC- 113/methylene chloride blend (TMC formula); CFC-12; carbontetracloride 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 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. The India Country Programme for the Elimination of ODS has also identified the sector as a high priority area.

Contents

1. Project objective

The objective of this project is to phase out the use of CFC- 113/methylene chloride blend (TMC formula); CFC-12; carbontetracloride 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 Exhibit 1 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 Exhibit 2 (table) and Exhibit 3 (chart).

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.

---

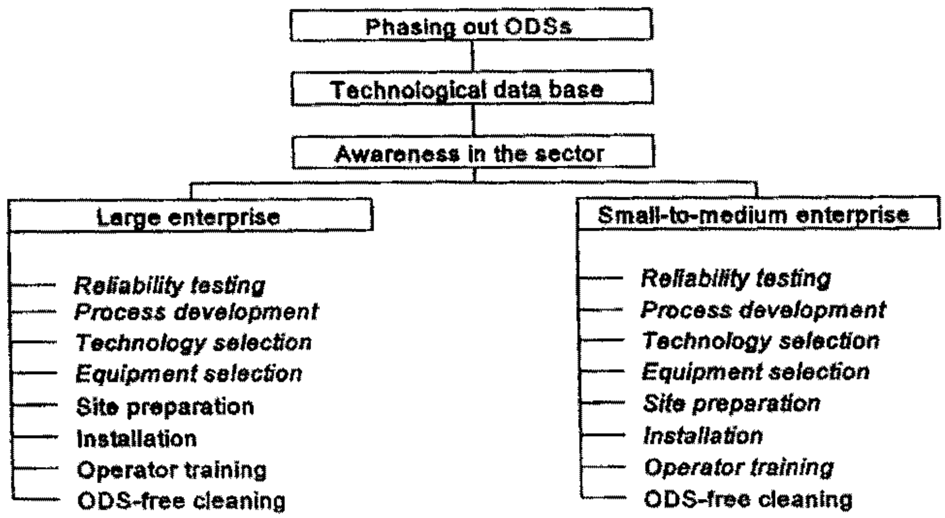
[1] The Centre for Materials for Electronics Technology (C-MET) set up by DOE has experts in the various materials used in the electronics industry covering chemicals, polymers and other related products such as solvents, cleaning agents etc. and in materials development and commercialization of the 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, September 1993.

Exhibit 1

Phasing out of ODSs in Indian Electronics Industry

The role of a focal point of know-how



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

Exhibit 2. 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	1900	1,900.000	14.385	0	0.000	0.000
CFC-12	2850	2,850.000	21.577	100	100.000	2.051
CFC-113	320	342.400	2.592	300	321.000	6.583
Sub-Total	5,070.000	5,092.400	38.554	400.000	421.000	8.634
Halon-1211	550	1,650.000	12.492	0	0.000	0.000
Halon-1301	200	2,000.000	15.142	0	0.000	0.000
Sub-Total	750.000	3,650.000	27.634	0.000	0.000	0.000

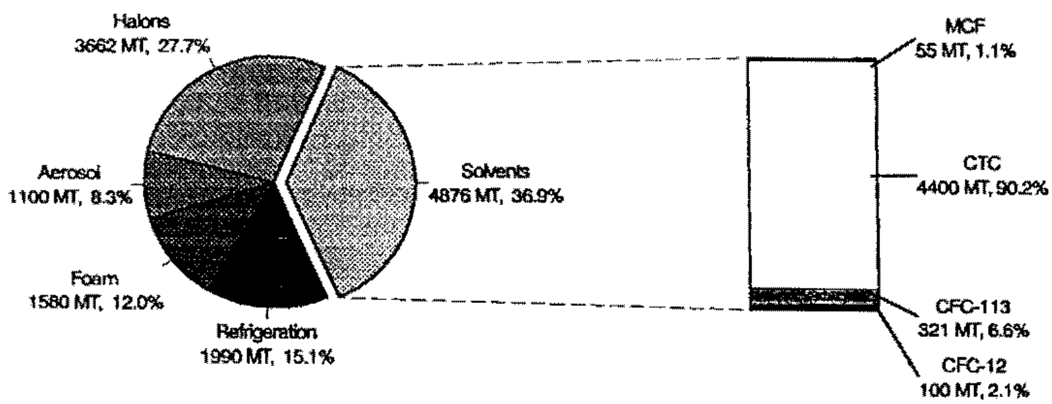
Types of ODS	1991 Consumption					
	All sectors			Solvents		
	Actual, MT	ODP-weighted		Actual, MT	ODP-weighted	
		MT	%		MT	%
CTC	4000	4,400.000	33.312	4000	4,400.000	90.238
MCF	550	66.000	0.500	550	55.000	1.128
TOTAL	10,370.000	13,208.400	100.000	4,950.000	4,876.000	100.000
Sectoral distribution						
Aerosols	1100	1100	8.328			
Foams	1580	1580	11.962			
Refrigeration	1990	1990	15.067			
Solvents	4950	4876	36.917			
Halons	750	3662	27.726			
TOTAL	10,370.000	13,208.000	100.000			

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.

Exhibit 3

ODS consumption in India

1991 figures in ODP-weighted MT



Refrigeration figure includes aerosols.

3. Enterprise background

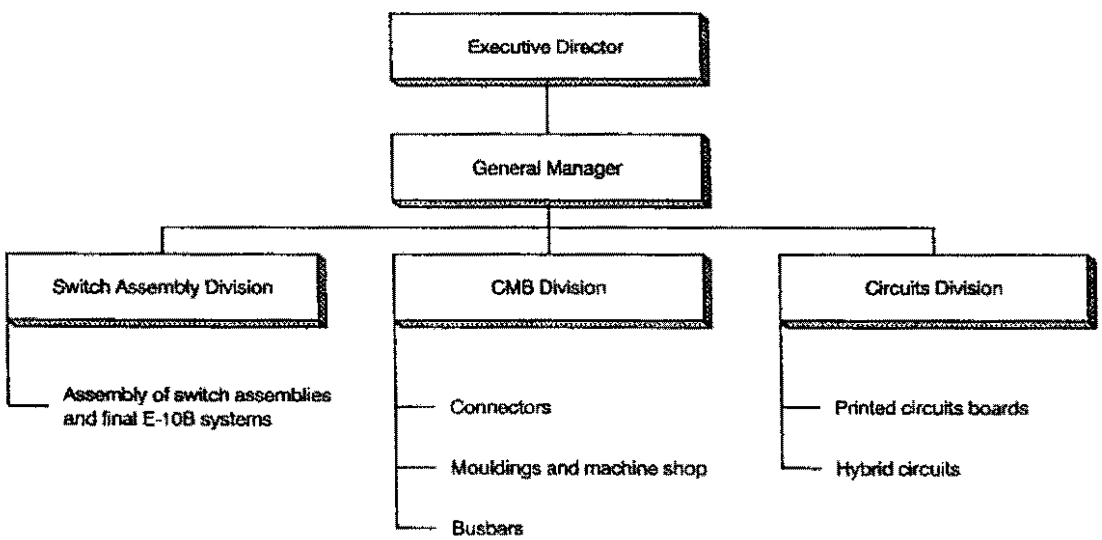
Indian Telephone Industries Limited is a 100 per cent Government of India owned company. ITI has six units all over India and manufactures the entire range of telecommunication equipment and accessories such as telephones, switching, transmission, satellite, fibre optic equipment. Annual production of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

ITI-Mankapur is one of the largest units of ITI employing 2,550 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. Annual capacity of the new production line will also be 500,000 lines.

The manufacturing divisions of ITI-Mankapur are shown in the Exhibit 4 below.

Exhibit 4

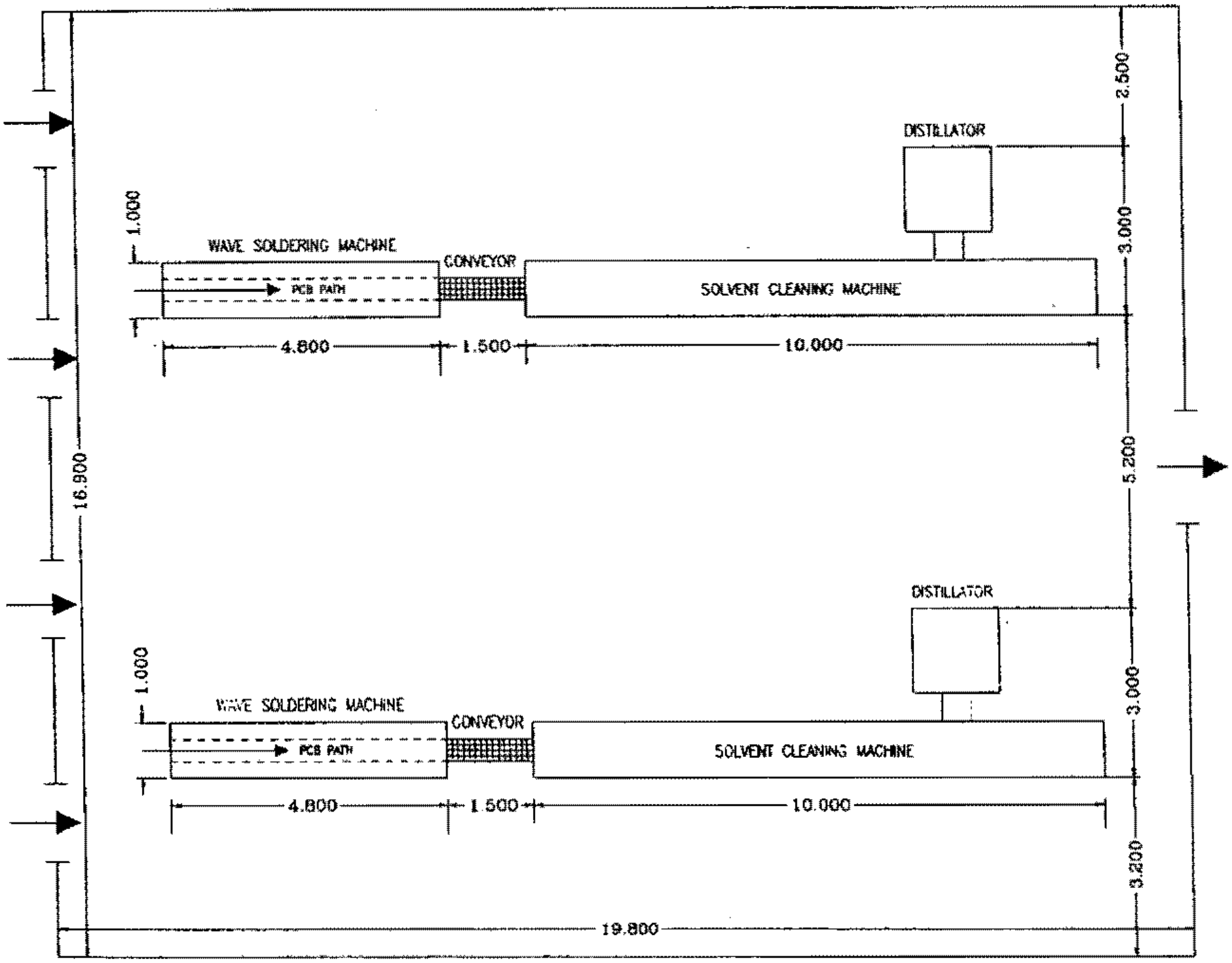
Manufacturing divisions of ITI-Mankapur



The Factory has two shifts, 7.5 hours each. Total annual working hours per shift is 2,040 hours, that is the operating duration of the equipment is 4,080 hours per year.

The Switch Exchange Assembly (SEA) Division produces switch assemblies at a peak rate of about 3,000 cards/day. Required cleaning is basically soldering flux removal and is carried out in two continuous, 3-zone vapour degreaser (OSL, France, Model Netci-in-Line 18) using an azeatrop of trichlorotrifluoroethane ($C_2Cl_3F_3$, CFC-113) and methylene chloride (CH_2Cl_2, dichloromethane, DCM) (TMC 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. The total electric power requirement of each degreaser is about 23 kW (of which 13.5 kW is for degreaser proper and 9.5 kW is for distillator). Annual electricity consumption is 187,680 kWh. Two operators per shift are employed at the cleaning stations. A schematic layout drawing of the cleaning stations is given in Exhibit 5.

Exhibit 5. Floor layout of cleaning stations of SEA Division



The Connectors, Mouldings and Machined Parts, Busbars (CMB) Division uses two cold solvent, ultrasonicly agitated, batch processing bath degreasers to clean relay parts and connectors (KERRY, UK, Model Compact 450). A small ultrasonic degreaser backs up the KERRY cleaners. 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 power requirement of each degreaser is 8 kW yielding a maximum annual energy consumption of 62,280 kWh. The Division employs one operator per shift per cleaning bath. Additionally, the CMB Division uses annually 20 MT of tricholoroethylene (TCE) in different degreasing processes, mainly through manual batch operations.

The Circuits Division produces hybrid circuits and printed circuit boards. The hybrid circuits unit has an annual production capacity of 2 million circuits to be cleaned (with 75 per cent initial yield, annual output 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 with computer-controlled conveyor system (Ultrasons Annemasse, France, Model SFR 40). Annually, 2 MT of TMC blend solvent consisting of trichlorotrifluoroethane (CFC-113) and methylene chloride (CH_2Cl_2, dichloromethane, DCM) is used. Power requirement of the degreaser is 6 kW yielding a maximum annual energy consumption of 24,480 kWh. A smaller ultrasonic cleaner (VIBRONICS, India) backs up this unit. The power requirement of smaller unit is 4 kW, yielding to a maximum annual consumption of 16,320 kWh. Additionally, 2 MT of carbontetrachloride (CTC) are consumed annually to perform other cleaning tasks in a small degreaser (Imeco, India). 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 power requirement of the developer, including the distillator and the chiller is 22 kW, giving a maximum annual consumption of 89,760 kWh.

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 power requirement of the stripper is 7.5 kW, giving a maximum annual consumption of 30,600 kWh.

Information on solvent use at ITI-Mankapur is presented in the following three tables, that is Exhibits 6, 7 and 8.

Exhibit 6. ODS solvent using main equipment at ITI-Mankapur

ACTIVITY	PRODUCTION CAPACITY	PURPOSE	PURPOSE	YEAR OF PURCHASE
Switching exchange assembly	3000 cards/day @ 15 hours/day	Cleaning of solder fluxes from populated PCBs	Freon cleaning station, OSL, France, Model Netci-in-line 18 (2 nos)	1985
Component assembly	Connectors: 2 million/year Relays: 1.1 million/year	Degreasing of metal and plastic parts of relays & connectors	Utrasonic cleaning station, KERRY COMPACT, UK, Model 450 (2 nos)	1985
Hybrid circuits	2 million circuits/year	Cleaning of solder fluxes from hybrid circuits	Multistage ultrasonic cleaners, ANNEMASSE, France, Model SFR 40 and VIBRONICS, India	1985-89
Printed circuit boards	26,000 m^2/year	a) Photoresist development b) Photoresist stripping	a) Development bath b) Stripping bath	1987 1987

Exhibit 7. 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					
Methylene chloride (CH_2Cl_2, dichloro methane, DCM) and trichlorotrifluoroethane (CFC-113) (TMC blend); 86%	37	3.07	113,680	35.150	37.610
Component assembly/ Cleaning of metal and plastic parts					
Dichlorodifluoromethane (CCl_2F_2, CFC-12); 90%	5	2.76	13,816	4.500	4.500
Tricholoroethylene (TCE)	20	1.11	22,276	0.000	0.000
Hybrid circuits/Flux removal					
Methylene chloride (CH_2Cl_2, dichloro methane, DCM) and trichlorotrifluoroethane (CFC-113) (TMC blend); 86%	2	3.07	6,145	1.720	1.840
Carbontetrachloride (CTC)	2	2.55	5,106	2.000	2.200
Printed circuit boards					
a) Photoresist development: 1,1,1-trichloroethane (CH_3CCl_3, MCF)	23	1.44	33,173	23.000	2.300
b) Stripping of photoresist: methylene chloride (CH_2Cl_2, DCM)	47	0.85	39,920	0.000	0.000
TOTALS	136		234,116	66.370	48.450

Exhibit 8. Types and annual consumptions of ODS (and other) solvents used at ITI-Mankapur (Amount used between 1 April 1992 to 31 March 1993)

Purpose	Chemical Compositions	Amount used, MT/ year
Cleaning of solder fluxes from populated PCBs	Methylene chloride (CH_2Cl_2, dichloromethane, DCM) and trichlorotrifluoroethane (CFC-113) (TMC blend); 86%	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
a) Photoresist development b) Photoresist stripping	a) 1,1,1-trichloroethane (CH_3CCl_3, TCA or methyl chloroform, MCF) b) Methylene chloride (CH_2Cl_2, dichloromethane, DCM)	23.0 47.0
TOTAL		136

4. Project description

4.1 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.

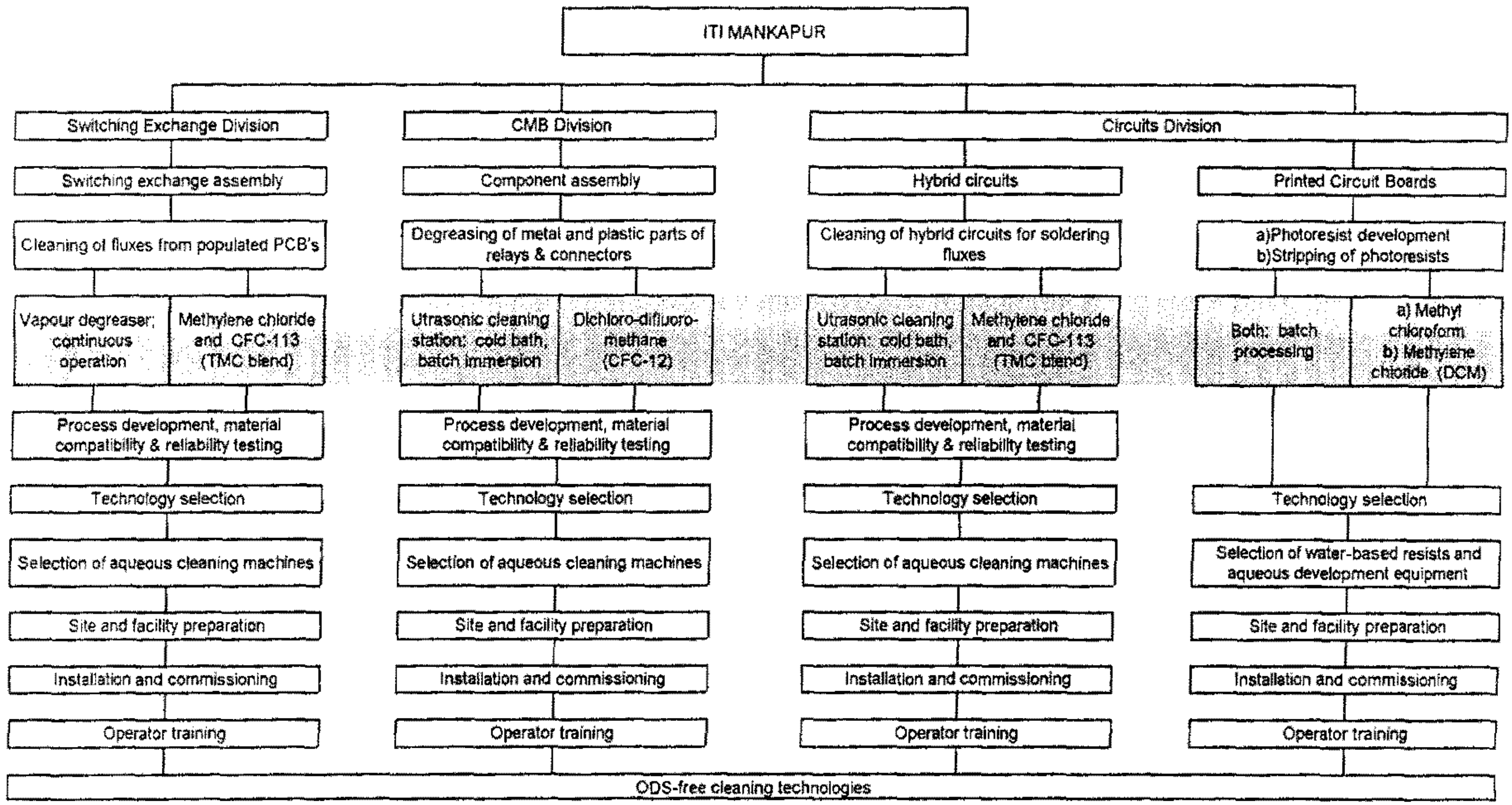
4.2 Description of the ITI-MANKAPUR project

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 Exhibit 9 and explained in detail below.

4.2.1 Reliability testing, material compatibility testing and process development

Reliability testing, material compatibility testing and process development will be performed by ITI-Mankapur in close cooperation with C-MET, 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 machines for the Switching Exchange Assembly Division.

Exhibit 9. Main elements of the ITI-Mankapur ODS phase out project



ITI-Mankapur and C-MET are 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.

4.2.2 Technology selection, equipment selection and purchase of aqueous cleaning machines

ITI-Mankapur will phase out the use of CFC-113/methylene chloride blend (TMC formula); CFC-12; 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 two multi-stage continuous operation vapor degreasers, 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 chlorinated solvents will be eliminated.

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.

Considering the cleaning requirements of ITI-Mankapur, a preliminary selection has been made in favour of aqueous cleaning technology. However, this selection has to be verified by reliability and material compatibility tests.

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 project authorities 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.

4.2.3 Purchase of aqueous cleaning machines and systems

Continuous operation aqueous cleaning system

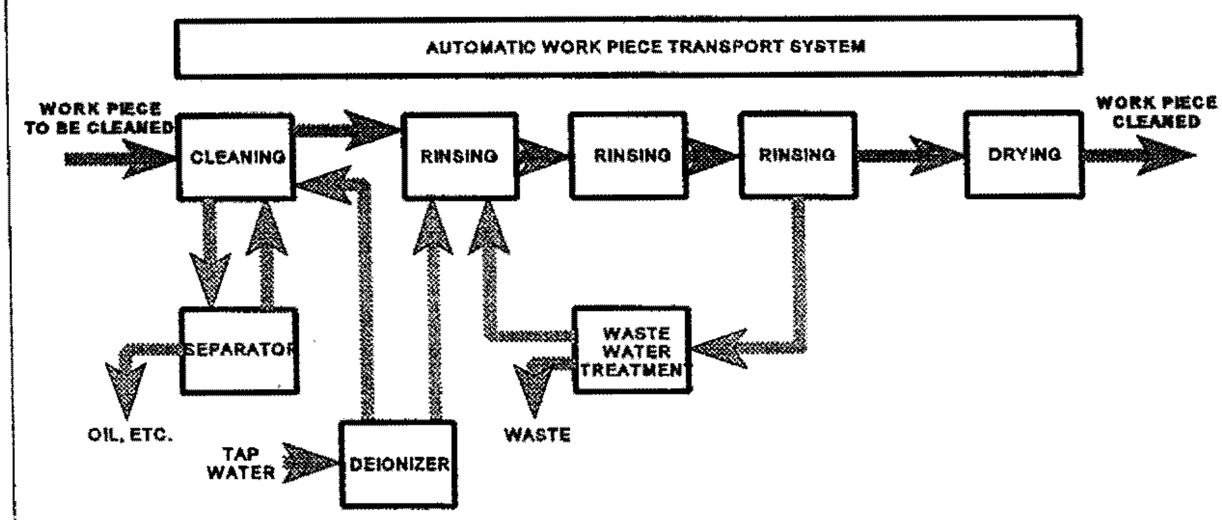
A typical continuous operation aqueous cleaning system is shown in the schematic diagram given in Exhibit 10. This system includes the following components:

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.

Exhibit 10. Continuous operation aqueous cleaning system



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 is seen from the table, the non-ODS systems do not aim at any capacity increase but represent a one-to-one replacement scheme.

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: therefore prices can vary (for the sizes required here) between US$ 50,000 to 100,000. For this project and using the present capacities as the guide (please see Exhibit 11), it is estimated that each cleaner will cost in the region of US$ 60,000. Due to physical location and distance between these cleaners, two water recycling and purification 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. (For a discussion of location of equipment and services, please see section 4.2.5 and Exhibit 13.)

Exhibit 11. Comparison of present and proposed batch operation aqueous cleaning systems

Location	No.	Capacity (tank size in mm) of each stage of the present ultrasonic systems using ODS's	Corresponding capacity (tank size in mm) of the proposed aqueous systems
Component assembly	2	300x450x350	300x400x400
Hybrid circuits	1	460x320x350	300x450x350

4.2.4 Purchase of aqueous exposure and stripper units to process 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 is shown in Exhibit 12 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/development capacity of around 10,000 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 36,000 m^2 is US$ 100,000.

Exhibit 12. Comparison of different development techniques

	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

To complete the photoresist processes, an aqueous stripper will also be needed. Such equipment with an annual capacity of 26,000 m^2 will cost US$ 130,000.

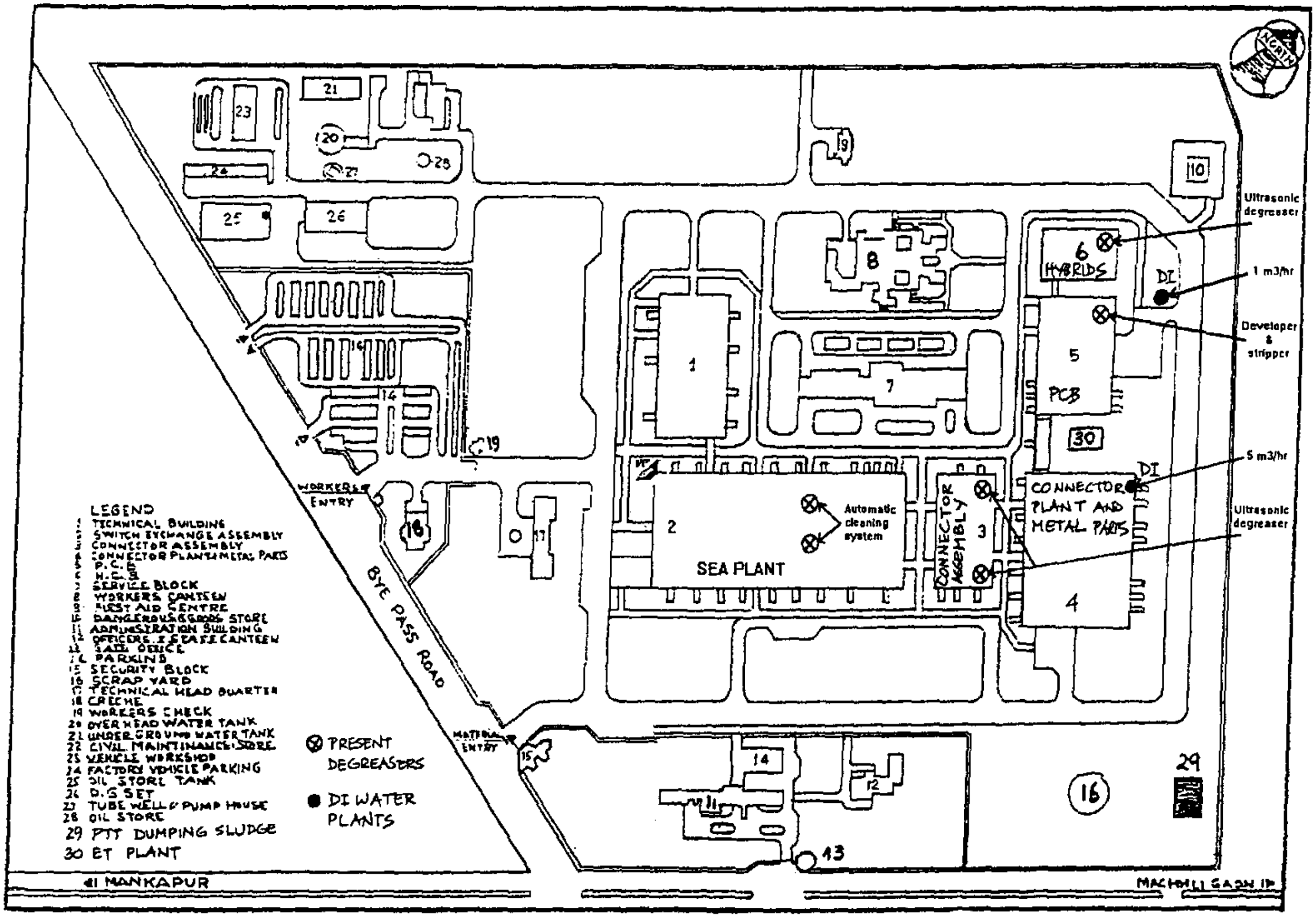
4.2.5 Site preparation and installation of machinery

Exhibit 13 gives the site schematic of the ITI-Mankapur factory and the location of cleaning units and deionized water plants. The initial observation follows:

a) **Deionized water supply:**

Ground water is the only water source at ITI-Mankapur. The quality of the virgin water, however, is not suitable for use in aqueous cleaning operations. It contains dissolved and suspended solids and has a very high pH (alkaline). Therefore, water treatment, that is deionizing, is necessary.

Exhibit 13. Site plan of ITI-Mankapur Factory



Presently, two deionizing plants are employed in the Factory. DI Plant #1 with a capacity of 1 m^3/hr, feeds the Hybrid Circuits. DI Plant #2 has a capacity of 5 m^3/hr and supplies the Connector and Metal Parts plant. Both DI units work at full capacity and cannot allocate any DI water to new cleaning equipment. Furthermore, the new equipment will be installed far from any fresh water piping and drainage. The DI water requirement of the new cleaning equipment is estimated at 5-6 m^3/hr. With the physical locations of the new equipment, it seems very difficult to distribute DI water from one plant. Therefore, it is planned to build two new plants to supply the degreasers in SEA and CMB plants, and to increase the capacity of the DI plant supplying the Hybrid Circuit plant so that it can provide for the aqueous developer and stripper equipment.

b) **Water recycling and purification:**

It is targetted that 80 per cent water recycling and purification will be achieved across the new processes. Again, due to the physical location of the equipment, one-point water processing is impossible. Depending upon the requirements of the actual equipment, it is expected that at least three water treatment units will be required: one for the SEA plant, one for the CMB plant and one for the PCB production. The cost of the first one is estimated at US$ 50,000 and the latter two at US$ 20,000 each.

c) **Waste water drainage:**

Unfortunately, the proposed aqueous cleaners have to be installed at locations without water drainage. Therefore, highly complicated and costly drainage systems will have to be constructed. This separate drainage piping, however, can have an advantage. That is, the waste water from different equipment containing different effluents (such as sponefiers and surfactants from automatic cleaners, stripped film from film stripper, etc.) can be kept separate and treated individually.

d) **Waste stream treatment:**

At the Factory, waste streams from the following processes are treated:

PCB plant:
- electroless copper plating line
- electroplating line
- tin lead plating line
- copper etching line

CMB
- gold plating line
- electroless nickel plating line
- electroplating line
- tin lead plating line

Effluents from the above-mentioned lines are processed in 4 holding tanks, 4 reaction tanks with strirrer and pH controller, chemical dosing tanks with automatic dosers. There is also a combined neutralization tank for final pH adjustments.

Air pollution is controlled by 6 scrubbers.

The above facilities are just adequate to treat the existing quantum of effluents. Therefore, the additional (or different) pollutants from the proposed aqueous processes must be separately treated. US$ 30,000 is allocated for this purpose.

e) **Electric power requirements:**

The electrical power requirement of ITI-Mankapur is obtained from two sources: U.P. State grid and Factory's captive diesel electric generator. Exhibit 14 and 15 give the details of amounts and costs involved in different electric power sources.

Exhibit 14. Electric power requirements and costs

	Consumption, kWh	Unit cost, US$/kWh	Total cost, US$
Grid power	24,000,000	0.074	1,784,615
DG power	750,000	0.332	249,139
Total	24,750,000		2,033,755
Average		0.082	

Exhibit 15. Cost of diesel electric generation at ITI-Mankapur

Investment	US$	1,700,000
Annual depreciation at 10 per cent	US$	170,000
Average annual output	kWh	750,000
Unit depreciation cost	US$/kWh	0.227
Unit fuel cost	US$/kWh	0.071
Unit lubrication cost	US$/kWh	0.005
Subtotal	US$/kWh	0.302
Unit maintenance cost at 10 per cent of production cost	US$/kWh	0.030
Total per unit cost	US$/kWh	0.332

The electric load of present CFC-based cleaning equipment is given in Exhibit 16.

Exibit 16. Installed electric load of present cleaning systems

Division	Equipment	Qty	Unit power kW	Total power kW	hours/ year	Annual total, kWh
SEA	OSL: multi-stage automatic cleaner	2	13.5	27.0	4,080	110,160
SEA	OSL: CFC distillator	2	9.5	19.0	4,080	77,520
CMB	KERRY: ultrasonic vapour degreaser	2	8.0	16.0	4,080	65,280
PCB	ANNEMASSE: ultrasonic vapour degreaser with robot conveyor	1	6.0	6.0	4,080	24,480
PCB	VIBRONICS: ultrasonic vapour degreaser	1	4.0	4.0	4,080	16,320
PCB	DUPONT: film developer	1	4.0	4.0	4,080	16,320

Division	Equipment	Qty	Unit power kW	Total power kW	hours/ year	Annual total, kWh
PCB	ISC: distillator for developer	1	12.0	12.0	4,080	48,960
PCB	ISC: chiller for developer	1	6.0	6.0	4,080	24,480
PCB	ISC: film stripper	1	7.5	7.5	4,080	30,600
TOTAL				101.5		414,120

The proposed aqueous equipment will require much more power which is estimated at 400 kW. Although the present infrastructure, that is, the distribution transformer and diesel electric generator, will be able to handle the added load, a number of cables will have to be replaced to carry the heavier currents.

The project includes funding to prepare the sites for the equipment installation (total US$ 45,000). 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.

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 (or equipment manufacturer). 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 cleaning applications and other uses of chlorinated solvents to water-based processes is the most practical for organizations that prefer to eliminate organic solvents from their cleaning processes. 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.

6. 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$799,154. 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$799,154 was calculated as the economic capital costs minus the net incremental recurrent savings for four years discounted at 10 per cent plus the project preparation costs.

Investment (capital) cost (see Annex 1):

As detailed in Annex 1, the total investment cost is US$1,159,000. Major components of this cost include the purchase and installation of two continuous operation aqueous cleaning systems (US$ 400,000), four batch processing aqueous cleaners (US$ 240,000), three water recycling systems (US$ 90,000), one DFPR exposure and development unit (US$ 100,000), one film stripper (US$ 130,000), 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$277,842. If the project is implemented, the annual operating cost will be US$156,750, resulting in an annual incremental operating savings of US$(121,091). 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$(383,847). 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$799,153.

Contingencies:

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

Breakdown of total project costs:

The breakdown of total project costs is given in Exhibit 17. Although the economic life of the project is 10 years, the incremental operating costs (or savings) is calculated for a period of 4 years.

Exhibit 17. Breakdown of total project costs

Description of cost	10 year period, US $	First four years, US$
Investment (capital) costs	1,159,000	1,159,000
NPV of incremental operating (savings)	(744,056)	(383,846)
NPV of incremental operating revenues	0	0
Total costs	414,944	775,154

Unit Abatement Cost (UAC) (see Annex 4):

As shown in Annex 4, the UAC for this project is US$1.39 per ODP-weighted kilogram of ODS phased out per year. This number is derived from an annualized incremental cost of capital of US$188,569, first year incremental annual operating savings of US$(121,091), and phasing out of 48.48 MT (ODP-weighted) of ODS per year.

Proposed MF Grant:

The proposed MF grant for this project is US$763,899 and was calculated as follows: First, the total investment cost of US$1,159,000 was added to the net present value of the incremental operating savings over the first four years of the project, which is US$(383,846). To the resulting total of US$775,154 project preparation costs of US$24,000 was added to find the total costs US$799,153. 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$799,154.

7. 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.

8. 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

The project roadmap is given in Exhibit 18.

Exhibit 18. Project roadmap

	Activity	Description	Responsible	Timing
1	Approval of the project		Multilateral Fund	Start
2	Make a detailed project work plan		ITI-Mankapur, UNIDO	1 Q
3	Arrange the study-tour		UNIDO, ITI-Mankapur	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	ITI-Mankapur, UNIDO	1 Q
5	Carry out reliability and materials compatibility tests	Evaluate the effectiveness of different non-ODS cleaning techniques	ITI-Mankapur, C-MET, UNIDO	2 Q
6	Select technology	Finalize the optimum cleaning technology & prepare the list and specifications of equipment and materials	ITI-Mankapur, UNIDO	2 Q

	Activity	Description	Responsible	Timing
7	Carry out international bidding, including evaluation and commercial negotiations	Prepare bidding documents, invite bids, evaluate bids and hold commercial negotiations based on the selected technology, select equipment and sign the contract(s)	UNIDO, ITI-Mankapur	3 Q
8	Design modifications of the site and facilities	Engineering design of utilities (water and electricity), 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	Training of technical staff abroad and/or in India	ITI-Mankapur, UNIDO	4 Q
12	Acceptance test, installation and commissioning of equipment		ITI-Mankapur	5 Q
13	Start utilizing new cleaning processes		ITI-Mankapur	5 Q
14	Evaluate the processes		UNIDO, ITI-Mankapur	5 Q
15	Evaluate the project		UNIDO, ITI-Mankapur	6 Q

9. 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.

10. Results

Direct Project Impacts

The project will eliminate annually 48.48 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 ITI-Mankapur, the quality and performance of ITI-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.

Overview of annexes

Annex 1. Breakdown of investment (capital) costs

	Description of cost item	Unit	Unit cost, US$	Qty	Total cost, US$
1.0	Training and engineering				
1.1	Material compatibility, process development and reliability testing (LOCAL)	week	400	30	12,000
1.2	Study-tour	week	4,000	8	32,000
1.3	Consultants: material compatibility studies, installation assistance, follow up, etc. (INTERNATIONAL)	week	10,000	2	20,000
1.4	Project monitoring missions	week	5,000	2	10,000
2.0	Continuous aqueous cleaning system				
2.1	In-line aqueous cleaning machines	nos	200,000	2	400,000
2.2	Water filtration and recycling equipment	nos	50,000	1	50,000
2.3	Installation costs (electrical, piping, etc.)	nos	25,000	1	25,000
3.0	Batch processing aqueous cleaning systems				
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
4.0	Aqueous photoresist exposure and development system				
4.1	Aqueous DFPR exposure and development equipment	set	100000	1	100,000
4.2	Aqueous stripper equipment	set	130000	1	130,000
5.0	Miscellaneous				
5.1	Waste treatment	set	30000	1	30,000
5.2	Transportation: shipping and insurance	set	50000	1	50,000
TOTAL INVESTMENT COSTS					1,159,000

Annex 2. Breakdown of incremental operating costs/savings

	Description of cost item	Unit	Unit cost, US$	Qty	Pre-project total cost, US$	Post-project total cost, US$
A.	Solvent/media costs per year					
A1	CFC-113/Methanol	kg	3.072	39,000	119,825	0
A2	CFC-12	kg	2.800	5,000	14,000	0
A3	CTC	kg	2.553	2,000	5,106	0
A4	MCF	kg	1.440	23,000	33,120	0
A5	TCE	kg	1.110	20,000	22,200	0
A6	DCM	kg	0.850	47,000	39,950	0
A7	Water @ 80% recycling	m3	0.100	30,000	0	3,000
	Sub-total				234,201	3,000
B.	Electricity costs per year					
B1	Current systems '(100 kW, 2040 hr/yr/shift, 2 shifts)	kWh	0.082	414,120	34,041	0
B2	Aqueous cleaning systems '(400 kW, 2040 hr/year/shift, 2 shifts)	kWh	0.082	1,632,000	0	134,150
	Sub-total				34,041	134,150
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					277,842	
TOTAL POST-PROJECT COSTS/YEAR						156,750
TOTAL INCREMENTAL SAVINGS/YEAR						(121,091)

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	36.90
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	4.50
A5	ODP of CFC-12		1.00
A6	ODP-weighted CFC-12 phase out (A4*A5)	MT	4.50
A7	Average use of CTC based solvent per year	MT	2.00
A8	ODP of CTC		1.10
A9	ODP-weighted CTC phase out (A7*A8)	MT	2.20
A10	Average use of MCF based solvent per year	MT	23.00
A11	ODP of MCF		0.10
A12	ODP-weighted MCF phase out (A10*A11)	MT	2.30
A13	Total ODP-weighted phase out		48.48
B.	Annualized capital cost		
B1	Total investment cost from Annex 1	US$	1,159,000
B2	Equipment life	Year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	188,569
C.	Annual incremental operating savings from Annex 2	US$	(121,091)
D.	Unit abatement cost		
D1	Annualized capital cost per kg ODS phased out	US$/kg	3.89
D2	Annual incremental operating savings per kg ODS phased out (C/A13*1000)	US$/kg	-2.50
D3	Unit abatement cost (D1+D2)	US$/kg	1.39

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 <u>more than adequate</u> 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

COUNTRY	India
SECTORS COVERED	Rigid Foams
ODS CONSUMED IN SECTOR	1,280 MT of CFC-11 (1991)
PROJECT TITLE	Replacement of CFC-11 blowing agent in polyurethane (PU) foam systems with low and non-ODS materials.
PROJECT ECONOMIC LIFE	10 Years
PROJECT DURATION	4 Years
PROJECT IMPACT	456 MT ODS per annum
PROPOSED BUDGET	Incremental Capital Cost US$ 565,000 Incremental Operating Cost US$ 41,000 Total Project Cost US$ 606,000
PROPOSED OTF GRANT	US$ 624,000[1]
UNIT ABATEMENT COST	US$ 0.29 per kg ODS[2]
IMPLEMENTING ENTERPRISE	EXPANDED INCORPORATION
IMPLEMENTING AGENCY	THE WORLD BANK/IDBI
NATIONAL COORDINATING AGENCY	MINISTRY OF ENVIRONMENT & FORESTS (MOEF)

PROJECT SUMMARY

In this project Expanded Incorporation would install laboratory & testing equipment and establish demonstration facilities for applications development of new foam systems in close cooperation with foam processors, primarily in the rigid foam sector. The enterprise would use in-house technology to develop new polyols and systems for the production of ODS-free rigid polyurethane (PU) foams under Indian conditions. This would enhance the early phase-out of CFC-11 consumption in rigid PU Foams used in household refrigeration insulation, thermowares, sandwich panels and general insulation rigid PU foams manufactured by various companies using polyols supplied by Expanded Incorporation. After the application technology is established, the enterprise would modify present polyols suitable for CFC-free rigid foams using alternative blowing agents and also modify and relocate the blending plant to manufacture CFC-free blended polyols. Expanded Incorporation would then phase out CFC-11 consumption by manufacturing the new blended polyol formulations for use with new alternative blowing agents. This project would provide a local source of essential materials and technology with which industry would reduce CFC-11 usage in India by about 456 MT per year by 1998. Project scope and cost have been revised taking into account comments from MFEC in November 1993. The project is part of GOI strategy in the foam sector to support competitive roles of three or more existing private sector polyol/foam systems suppliers to the many diverse foam industries throughout India. The project would also provide foam formulations at cost effective prices and would lower overall incremental costs in the foam sector.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by OORG technical reviewer Dr. M. Jeffs. His comments are attached.

1/ The project was considered by the MFEC at their November 1993 meeting and was given permission to proceed. This OTF request is for financing eligible incremental capital and operating costs.

2/ Indirect UAC to be added to all end-user projects using Expanded's foam systems.

PROJECT OBJECTIVE

The objective of this project is to eliminate CFC-11 from pre-blended polyol systems manufactured by Expanded Incorporation by promoting the phase out of CFC-11 at end users through development and demonstration of new polyols and systems for rigid foam processors.

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 (Expanded, Manali, and UB Products) supply most of the system 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 to support the ability of these foam system suppliers to service the many diverse foam industries throughout India, including the small scale sector who are not well served by importing suppliers.

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.

ENTERPRISE BACKGROUND

In 1983, Expanded Incorporation, a 100% Indian owned company, became the first foam systems producer in India. Today Expanded is the largest producer of rigid PU foam chemical systems in India and is dependent entirely on its own in-house technology. The company has been highly successful in developing and manufacturing various types of polyols and formulations for such diverse industries as refrigerators, building roof spray, and packaging. The plant is located at New Bombay (30 Km North of Bombay) and has an annual production capacity of 2,400 MT of systems. It employs a staff of 50, and is the only plant of its type in India, designed to produce polyurethane polyols based on propylene oxide, polyester polyols and amino polyols. Expanded Incorporation has about one-third of India's foam systems market. It also exports about 15% of its polyol production to Middle East consumers.

PROJECT DESCRIPTION

This project would set up and operate an application technology center at Expanded Incorporation (Phase I). It is considered to be compulsory for a polyol manufacturing enterprise in India to promote and establish CFC-free technology among end-users of polyol systems. The application technology center would be installed in a separate building attached to the present plant where development, testing, trials & demonstration of CFC-free foam systems would be carried out as per end-users requirement under local conditions. New polyols suitable for blowing agents such as HCFC-22, HCFC-141b, cyclopentane, and HCFC-134a would be evaluated. Following successful development trials and testing of ODS-free rigid foam systems, the existing base polyol plant would be modified by installing necessary equipment to produce new base polyols suitable for the production of CFC-free rigid foams (Phase II). Since the elimination of CFCs from blended polyols systems is entirely dependent on phase out programs of final foam processors, the enterprise would first modify & reinstall one of the three existing blending stations in a new building block. Subsequently, the other two existing blending stations would be modified for total phase out of CFC from blended polyol systems manufactured at Expanded Incorporation.

Key project elements are explained and justified as follows:

New polyols & systems would be developed in the laboratory and small quantities of new modified polyols (EO+PO based) would be produced in a laboratory scale autoclave reactor. Subsequently the formulations would be tested in a high pressure foaming machine employing alternative blowing agents. Multi Easy Froth would be used for pre-blending alternative blowing agents (e.g. cyclopentane, HCFC-22/142b, HFC-134a).

Special foaming equipment would be used for demonstration & training purposes. Molds & fixtures would be used to evaluate and demonstrate the application technology. Demonstrations would be made to manufacturers of thermoware, sandwich panel and other insulation applications. Special arrangements will need to be made to test cyclopentane use for refrigerator foams while simple molds would be fabricated in-house for other applications. Such testing equipments is not available at Expanded Incorporation and off-site testing process is laborious & time consuming. Three main testing devices namely, thermal conductivity meter, universal testing machine and closed cell content meter would be installed in the laboratory for spot evaluations, testing & demonstration of resultant CFC-free foams. Additional floor space would be constructed on adjacent land (at Expanded Incorporation expense) to install all the new laboratory equipment involved in Phase-I. Also, a small ethylene oxide tank needed for the second stage of plant modification would be installed and the modified pre-blending stations would be relocated there. The additional construction would not increase plant capacity. Safety issues relating to use of cyclopentane in Expanded's facilities would be in conformance with local regulation and will be addressed through use of consultants with expertise in handling of flammable petroleum products. The cost of these consultations will be born by Expanded.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION

In the rigid polyurethane foam sector there is still global uncertainty on the identity of a preferred alternative to CFC-11. However, there are currently three main options for CFC-free systems in rigid PU insulation foams.

a. CFC-11 > 50% CFC-11 or HCFC-141b
b. CFC-11 > HCFC-22 or HCFC-22/142b, HFC-134a
c. CFC-11 > Pentane or Cyclopentane.

In addition, compounds such as perflouroalkanes, HCFC-123, fluorinated ethers and 2-chloropropane, have been suggested but have limited availability and/or are not toxicologically proven to be safe. Option a) also called the "liquid" solution employs technology that is closely related to the existing use of CFC-11. The final step in this process is not yet decided although HFC-134a and hydro-carbons have received the most attention. The second option, the "gas" solution, utilizes a gaseous mixture of blowing agents. It requires high pressure equipment, "Easy Froth" blending and adjustments in formulation and handling. The final step in this process is seen as the introduction of (gaseous) HFC's. Hydrocarbon (Cyclopentane) technology was introduced recently in Germany. Its flammability characteristics require major attention to safety conditions and extensive upgrading of facilities as well as the support of a technology supplier experienced in the handling of flammable blowing agents.

The acceptability of alternatives by the end processors would be decided by easy availability of local raw materials and production technology at economical cost, simple designed molds, fixtures and peripheral equipments (as there are large number of small processors), and very importantly for foreign partners of local companies on whose recommendations the local companies would adopt suggested alternatives. 50% CFC reduction technology adopted by some developed countries in initial stage of CFC phase out is not very attractive under Indian conditions as major changes would be called for in final product design and may prove expensive. In this case there is also a disadvantage of not being recognized as 100% CFC-free products. In view of the diverse selection of alternative blowing agents Expanded Incorporation would develop and manufacture polyols to be used with HCFC-22 mixtures where possible. Such technology could be adopted economically for less critical foams, particularly for thermowares. The enterprise would also manufacture blended polyol systems using HCFC-141b and cyclopentane as an alternative blowing agent.

PROJECT COSTS

Project Costs (Annex A), total US$606,000, of which US$486,000 is estimated for completion of Phase I and US$120,000 for completion of Phase II.

Incremental Capital Cost

The total incremental capital cost for this project is US$565,000.

Financial Agent Fee:

A 3% financial agent fee of US$18,000 has been added to the requested OTF grant.

Incremental Operating Cost

Incremental operating costs are to be incurred for running the development testing program and include incremental staff and material costs. These are estimated to be $41,000 for Phase I only. Incremental operating costs for Phase II can not be determined until a clear technology choice is made by refrigerator manufacturers with respect to insulation efficiency and blowing agent type.

Unit Abatement Cost (UAC)

The unit abatement cost for the project is estimated at $0.29/kg, based on the use of 456 MT per year ODS by Expanded and its customers.

Proposed OTF Grant

US$624,000 is requested in OTF financing based on 100% Indian ownership of Expanded Incorporation.

Economic Rate of Return (ERR)

Since the project entails an initial investment only with no cash flow, the ERR for the project is undefined.

Financial Rate of Return

Financial rate of return is undefined at present.

Implementation Schedule

The implementation schedule is illustrated in Annex B.

Required Regulatory Actions

Required regulatory action for the successful implementation of this project is the permission and NOC to install an Ethylene Oxide storage tank adjacent to the present plant.

Direct Project Impact

The direct project impact would be realized during Phase II only. By the end of Phase II an annual average of at least 72 ODP weighted MT of CFC-11 would be eliminated as a result of replacing CFC-11 with alternate blowing agent in blended polyol systems manufactured at Expanded.

Indirect Project Impact

The impact of the Phase I would be realized at the foam processors level as a result of direct efforts put in by Expanded Incorporation during Phase I & II. An estimated annual average of 384 ODP weighted MT of CFC-11 would be eliminated.

Environmental Assessment

This project would not result in any additional emissions, effluents or wastes being produced at Expanded Incorporation plant. Installation of Ethylene Oxide storage tank in Phase II would require clearance from environment & explosive departments of Government of India.

Changes in Project Scope and Cost Due to OORG/MFEC Comments

The technology employed uses ethylene oxide (EO) in the formulation for which the enterprise is developing its own technology. EO is used by several other international suppliers, including Mitsui (Japan). The design includes all necessary safety provisions for handling flammable EO.

Following previous OORG/MPEC review, the project capital cost was reduced by $58,000 by elimination of a large mould and jig for full scale testing of flammable blowing agents (e.g. cyclopentane). It is considered to be more cost effective to transfer the responsibility for these tests to the refrigerator manufactures who choose flammable technology.

A $41,000 cost (included in previous capital cost estimates) for demonstrating performance of non-ODS technology at small scale industry facilities was considered to be a Phase I incremental operating cost. The project was supported by OORG Reviewer Dr. M. Jeffs following his review of a previous nearly identical project proposal and feasibility study in August 1993.

The following modifications are based on the recent recommendation of OORG reviewer.

The implementation schedule was accelerated by 1 year.

Safety issues related to cyclopentane will be resolved in consultation with qualified consultants.

Annex A

PROJECT COST SUMMARY
Expanded Incorporation

SUB-TOTAL	
CAPITAL COSTS	US$
Phase I	
Lab autoclave reactor	12,000
Testing and Control Equip.	53,000
Blending and Mixing	70,000
Moulds and Jigs	10,000
High Pressure Foam Machine	142,000
Training	12,000
Installation of Facilities & Structure	106,000
SUB-TOTAL	405,000
Phase II	
EO Storage Tank	30,000
Blending Station	26,000
Piping and Installation	52,000
SUB-TOTAL	108,000
Contingency (10%)	52,000
INCREMENTAL CAPITAL COSTS	565,000
INCREMENTAL OPERATING COSTS	41,000
TOTAL PROJECT COST[3]	606,000

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

Annex B

IMPLEMENTATION SCHEDULE

Expanded Incorporation

	From	To
Phase I		
Building Construction	3Q-94	2Q-95
Procurement	1Q-95	2Q-95
Bench trials and testing	2Q-94	2Q-95
Demonstrations at Expanded Lab and at customer location	2Q-95	2Q-97
Phase II		
Plant Modification	3Q-95	4Q-96
Commercial production of modified polyols and systems	1Q-96	1Q-97

* Modified schedule to refect OORG review.

c:\wp51\naimeh\expand 6/7/94

ICI Polyurethanes

TELEFAX

Dr. Mike Jeffs
International Environmental
Affairs Manager

Everslaan 45
B-3078 Everberg
Belgium

Telephone (02) 758 9394
Telex 26332 ICIEVB B
Telefax (02) 758 9894

To Ms. N. Hadjitarkhani
The World Bank

cc : Mr. T. Waltz

1st June, 1994

Review of Expanded Incorporation as requested.

G. M. F. Jeffs
GMFJ/kd

OORG TECHNICAL REVIEW - EXPANDED INCORPORATION (INDIA)

TECHNOLOGY

The enterprise is a polyol / formulation manufacturer serving a range of mainly rigid polyurethane foam applications. Hence, in line with world trends, it has to consider a range of CFC 11 replacement options. There is no such animal as "a preferred option" as referred to on page 4 and I would comment that some sections of the often repeated "Justification for Alternative Technology Selection" section are becoming outdated. For example, HCFC 123 has not been considered for some years.

The enterprise is developing its own polyol technology and the reviewer considers this is to be a natural and supportable development in a country such as India with its university / institute culture and specific market needs dictated by factors such as climate which can be met by home grown technology.

A range of transitional and zero ODP technologies are listed. Transitional (HCFC) technologies are the norm in the construction industry in developed countries and are necessary in the intermediate term.

The use of HCFC 22 is proven for some applications such as steel-faced panels but the enterprise is aware of limits in domestic refrigerators and freezers because of insulation loss due to diffusion through plastic liners and be aware that its low boiling point (-41°C) could render it especially problematic to use in hot climates.

The enterprise has listed cyclopentane as an option for some applications, in line with global trends and notes on P4 that the support of an experienced technology supplier is required. There is no evidence in the remainder of the project of the identification of this partner nor of adequate training to handle cyclopentane. This is a significant deficiency.

Note - cyclopentane is not a low boiling blowing agent as stated on Page 3.

The technologies listed, with the exception of HFC 134a for domestic refrigerators and freezers, are generally cost effective.

ENVIRONMENTAL IMPACT

Zero ODP alternatives are listed as well as HCFCs giving the enterprise experience in developing robust formulations. In the case of cyclopentane there should be knowledge built up of the VOC regulations in the regions in which the technology is to be applied to ensure that these are complied with. The technology partner issue relating to cyclopentane is noted above. There should also be further detailing of measures (extraction, nitrogen purging, level detectors etc.) to ensure safe handling of cyclopentane on the enterprises' premises.

PROJECT COSTS

It is necessary for a polyol / formulation manufacturer to have in-house facilities for trial manufacture of foam using production type equipment and its subsequent testing. The range of blowing agents necessary for CFC 11 replacement justify the purchase of the specified polyurethane processing equipment. The testing equipment should normally be on the complement of a polyol / formulation manufacturer but with CFC 11 it was probably not necessary to demonstrate the technology to the many small and medium sized enterprises which Expanded Incorporation serves.

The UAC is low but as the enterprise is an intermediate in the supply chain no ODS at the end user are actually phased out. Care should be taken in subsequent (foam manufacturer) projects that capital items are not duplicated.

IMPLEMENTATION TIME SCALE

This appears to be leisurely and the end customer is likely to be demanding CFC free chemical systems well before 1997. If this timetable is adhered to the enterprise might find itself uncompetitive.

RECOMMENDATION

Approved with modifications to include further information on the acquiring of expertise, particularly on safety issues, relating to cyclopentane.

Other comments - note those on implementation timescale.

OORG Technical Reviewer Dr. M. Jaffs (MD 152) MJaffs

Date Review Completed May 31st 1994

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER

COUNTRY	India
SECTORS COVERED	Solvents
ODS CONSUMED IN SECTOR	100MT CFC-12; 19MT CFC-113 (1991)
PROJECT TITLE	Conversion of Process for Manufacture of Disposable Syringes from EO/CFC-12 to EO/CO_2 Sterilisation and Direct Siliconisation
PROJECT ECONOMIC LIFE	7 Years
PROJECT DURATION	1 Year
PROJECT IMPACT	54 MT ODS per annum
PROPOSED BUDGET	Incremental Capital Cost US$ 639,000 Incremental Operating Cost US$ 128,000 Total Project Cost US$ 767,000
PROPOSED OTF GRANT	US$ 790,000[1]
UNIT ABATEMENT COST	US$ 3.37 Per kg ODS
IMPLEMENTING ENTERPRISE	HINDUSTAN SYRINGES AND MEDICAL DEVICES PVT. LTD.
IMPLEMENTING AGENCY	THE WORLD BANK/IDBI
NATIONAL COORDINATING AGENCY	MINISTRY OF ENVIRONMENT & FORESTS (MOEF)

PROJECT SUMMARY

This project will phase out CFC-12 currently used in combination with Ethylene Oxide for sterilization of syringes, needles and other disposable medical devices manufactured by Hindustan Syringes. It is proposed to replace the 12/88 EO/CFC-12 sterilization gas mixture with a 10/90 EO/CO_2 gas mixture and to replace silicon CFC-113 sprayers with pure silicon sprayers. To accomplish these objectives, new higher pressure sterilization chambers will be installed to assure satisfactory sterilization with EO/CO_2 and special silicon spray nozzles will be installed to eliminate the need for CFC-113 as a silicon carrier.

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

[1] The project was considered by the MFEC at their March 1994 meeting and was given permission to proceed. This OTF request is for financing eligible incremental capital and operating costs.

PROJECT OBJECTIVE

The objective of present project is to install carbon dioxide (CO_2)-ethylene oxide (EO) sterilisers to replace the current CFC-EO system and replace nozzles for siliconisation of syringes 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

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 and 32 new siliconization spray nozzles.

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 proven. The chosen technology is in commercial use with manufacturers of similar products in the developed countries. Pure silicon application nozzles have recently become commercially available and have been chosen to completely eliminate the need for solvents in this service.

PROJECT COST

The project incremental cost of US$767,000 has been calculated as the economic capital cost plus the net incremental recurrent costs for 2 years, plus 10% contingency on capital cost.

CAPITAL COSTS

Capital cost is US$639,000 including handling, installation charges and 10% contingency. Taxes and duties are excluding (Annex A).

INCREMENTAL RECURRENT COSTS

Net incremental operating cost of US$64,000 per year undiscounted for 2 years amounts to US$128,000 (Annex C).

BENEFITS

There will be no benefits to the enterprise by changing the existing CFC-EO steriliser and replacing silicon applicators.

OTF GRANT: The request for $790,000 includes project costs of $767,000 plus a 3% financial agents fee of $23,000.

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

UNIT ABATEMENT COST

US$ 3.37 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 illustrated in Annex B.

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 and non-ODS alternatives as part of the technology selection process for siliconisation.

Annex A

PROJECT COST SUMMARY
Hindustan Syringes

SUB-TOTAL CAPITAL COSTS	US$
3 - 6m3 Sterilization Chambers	297,000
32 - Silicon Application Nozzles	256,000
Clearance and Installation	28,000
SUB-TOTAL	581,000
Contingency (10%)	58,000
INCREMENTAL CAPITAL COSTS	639,000
INCREMENTAL OPERATING COSTS	128,000
TOTAL PROJECT COST[2]	767,000

2 Duties and taxes have been excluded from all project costs.

Annex B

IMPLEMENTATION SCHEDULE

Hindustan Syringes

	From	To
Procurement & Installation	3Q-94	4Q-94
Startup	4Q-94	1Q-95

Annex B

INCREMENTAL OPERATING COST

Hindustan Syringes

The new sterilization process employing CO_2/EO will operate at pressure 4 times greater than that currently used. Larger (20%) chambers will also be required to accomplish comparable rates of production. Consequently the total weight of gas required at a given production level will increase in proportion to the molecular weight, pressure, and chamber volume as shown below.

	Current - ODS	Non - ODS
Base Year	1993	1993
Syringe Production (million units/year)	105	105
Gas Composition	12% EO 88% CFC-12	10% EO 90% CO_2
Avg. Molecular Weight of Gas	111.2	44
Total Chamber Volume (m3)	15	18
Chamber Pressure (KN/cm2 abs)	50	200
Cycles per Year	900	900
Gas Consumed (metric tons)	56.82	107.92 [a]
Gas Price (US$/metric ton)	3111	2222

[a] Gas consumption projected for current production using non ODS gas as per calculation below.

MT Gas/year = 56.82 x (44/111.2) x (18/15) x (200/50) x (900/900) = 107.92

Incremental Operating Cost per year = (107.92 x 2222) - (56.82 x 3111) = $64,000

The incremental costs requested are for 2 years only on the basis that by 1997, Hindustan Syringes will have reduced their operating costs and/or increased their prices sufficiently to sustain profitability at current levels without further assistance from the Multilateral Fund.

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northern telecom

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

Executive offices

Tel.: (905) 566 3000
Telex: 06 960348
Fax: (905) 275 1143

FOR DELIVERY BY FAX

June 2, 1994

Naimeh Hadjitarkhani
The World Bank
Fax: 202-477-7352

Dear Ms. Hadjitarkhani:

As requested I have reviewed the latest proposal for Hindustan Syringes (your fax of May 25, 1994).

The technology as now proposed eliminates CFC's in the needle manufacture and, as I recall, a reduction in operating costs has also been attained.

I offer my approval of the proposal as it now stands.

Sincerely,

AD Fitzgerald

A. D. Fitzgerald
Director, Environmental Projects

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
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 portable extinguisher manufacturing
PROJECT DURATION	1 year and 6 months
PROJECT IMPACT	Phase-out 142 tons Halon 1211 and 35.5 tons CFC 12 in first year (1995-96) and 800 tons Halon 1211 and 200 tons CFC-12 in the year when operating at full capacity.
UNIT ABATEMENT COST	US$ 0.475 per kg ODS
TOTAL PROJECT COST	Incremental capital costs US$524,190 Incremental operating costs US$268,220
PROPOSED OTF FINANCING	Incremental capital costs US$524,190 Incremental operating costs US$268,220 Total US$792,410 Financial Agent Fee US$ 23,772 Total OTF request US$816,182
COST EFFECTIVENESS	0.4755 US$ per kg
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 800 tons of Halon 1211 consumption, annually when in full capacity operation, in the production of portable extinguishers by converting the manufacturing line to suit the alternative ABC-DCP. In case of Halon 1211, the components of the portable extinguisher were externally sourced but with ABC-DCP it will be necessary to manufacture the components in-house due to cost and quality considerations. While a full-fledged technology transfer agreement for this conversion project is not required, certain capital equipment will have to be imported.

Apart from incremental capital costs, this project also involves a significant incremental operating costs due to the switch-over from Halon 1211 to ABC-DCP. However, the incremental operating costs has been claimed for a lower-than-actual annual consumption of 142 tons of Halon 1211 (the largest consumption level of the enterprise in the past) and only for the first two years of operation.

This halon phase-out project is presently ongoing. The project was launched in November 1993 and is expected to be completed by March 1995 provided the OTF grant is approved in principle by the Montreal Protocol Executive Committee in July 1994. This project has been identified as one of high priority projects in the India country program.

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, the 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. The present and future demand of the three ozone-depleting substances along with their ODPs has been given 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

In the organized sector, there are only a few manufacturers of portable extinguishers and therefore of Halon 1211 consumers. Real Value Appliances Limited is the largest Halon consumer and based on forecast from the Country Program it is estimated that by the year 1996 its share of the total country's consumption would be more than 50%.

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% Indian owned and had a turnover of US$ 0.44 million for a 16-month period in the year 1992-93, and it employs around 150 people. The manufacturing unit is located in Bhor in Maharashtra (Western India) with its head office in Bombay. It has 20 branches all over the country to support the aggressive marketing strategies in promoting its portable extinguisher as a user-friendly product.

Real Value commenced operations in September 1989 with the 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 the 500 gm Halon 1211 portable extinguisher. The enterprise imported Halon 1211 from ICI-UK. The quantity of halons consumed from the time of commencement of production till date is given in Table 2.

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 the assistance of the 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 the availability of halons, the enterprise launched its phase-out project after the country became a party to the Protocol.

PROJECT DESCRIPTION. The enterprise will convert from the use of Halon 1211 to ABC-DCP in their portable extinguisher manufacturing facility. The conversion to ABC-DCP in the facility is essential for the country, as the price of imported ABC-DCP portable extinguisher is significantly higher than the price of the indigenously-manufactured product. (Annex 3)

With Halon 1211, most of the components of the 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 the case of ABC-DCP. Importing the components such as the valve and the cans for the ABC-DCP portable extinguisher is not possible since this will make the product prohibitively expensive and sourcing the components locally does not give the required quality standards. For instance, the indigenous manufacture of valves for a 0.5 kg portable extinguisher is Rs. 24.40 while the cost of imported valve without duties is Rs. 104.0. Even without duties, the imported cost is four times that of the indigenous costs (Annex 4). Hence it is required to establish a production line for the manufacture of the cans and valves in addition to the assembling and filling operations which are to be adapted to the ABC-DCP in lieu of Halon 1211.

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

After the completion of this phase, investments on an imported powder filling machine and for the in-house manufacturing facility for the can and the valve will be undertaken. Certain components such as the pressure gauge will have to be imported as it will not be possible to manufacture these high-quality gauges cost effectively at the enterprise's scale of production. In installing the powder filling machine and in the manufacturing facility, the enterprise will not require know-how 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 phase-out the same tonnage of Halon 1211. Since this is an on-going project, small quantities of Halon 1211 and CFC-12 have already been phased out using the trial capital equipment.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION. ABC-DCP is an accepted alternative to Halon 1211 for portable extinguishers. However in terms of effectiveness in fire protection, ABC-DCP is not superior to Halon 1211.

ABC-DCP is a recognized alternative by the UNEP Technical Options Committee (Halon sector) and has been included in the India Country Program.

PROJECT COST (all costs are provided in US$ and the exchange rate used in all conversions is Rs. 31.50 per US$).

Incremental capital costs. The incremental capital costs of US$524,190 comprises capital costs and expenses in project management. (Annex 1).

Incremental Operating costs. In the calculation of the incremental operating costs, operation with Halon 1211 is used as the baseline and this is compared with ABC-DCP operation. Since the revenue margins in Halon 1211 operation is significantly higher than the ABC-DCP operation, the incremental operating costs is the profit margin which gives a net loss to the enterprise. The revenue during Halon 1211 operation is compared with that of ABC-DCP operation and the net incremental operating cost due to the changeover is tabulated for the first four years of operation. It is to be noted that in the calculation of the incremental operating costs the consumption of Halon 1211 has been assumed to be lower-than-actual quantity of 142 tons (the maximum the enterprise has achieved in the past). In practice, by 1996, through this project the enterprise is expected to phase-out well over 50% of the estimated Halon 1211 consumption that is forecast in the India Country Program for 1996.

The incremental operating costs for the first four years of operation are US$134,110 each year. However, the request for OTF grant is only the incremental operating costs for the first two years, which totals up to US$268,220. (Annex 2)

Incremental Operating benefits. There are no incremental benefits to this project.

TOTAL INCREMENTAL COSTS OF THE PROJECT. The total incremental capital cost for the project is summarized below:

Incremental capital costs	:	US$ 524,190
Incremental operating costs (two years not discounted)	:	US$ 268,220
Total	:	US$ 792,410
Financial Agent Fee:	:	US$ 23,772
Total OTF request:	:	US$ 816,182

Therefore, the total OTF request is US$816,182.

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

CONTINGENCIES. Provision for contingencies has been included at 10 percent of the incremental capital costs.

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 (incl. contingencies) is US$524,190. The net operating costs at the assumed lower consumption level of 142 tons year, OC, is US$134,110. The ODS phased out is 142 tons of Halon 1211 and 35.5 tons of CFC 12 (taken at a lower-than-actual level). Therefore, W - the annual ODS reduction at the first year of full operation expressed in ODP units - is 461.50 tons. C(F) is evaluated as US$85,300 where F is the capital recovery factor. The unit abatement costs is therefore evaluated as 0.4755 US$ per kg.

FINANCIAL HEALTH OF ENTERPRISE:

This project commenced in November 1993 and is expected to be completed in March 1995. 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 OTF grant for this project will fund the incremental capital cost and the incremental operating costs for the first two years at lower-than-actual consumption levels. The investment will be undertaken only after the OTF grant is approved in principle by the Montreal Protocol Executive Committee. If this approval is obtained by July 1995, the investments are expected to be undertaken by December 1994 so that the project could be completed by March 1995.

PROJECT IMPLEMENTATION. This on-going project commenced in November 1993 and is expected to be completed in March 1995, (duration of around one year and six months). The past and expected future schedule of the implementation is give below:

Phase I (November '93 - September '94)

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 (September '94 - March '95)

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 Ministry of Finance, Government of India, to waive the duties/taxes for all equipment supplied for this project as these are considered transfer payments rather than true economic costs.

RESULTS. In the first year of operation (1995-96), this project will phase-out 142 tons of Halon 1211 and 35.5 tons of CFC-12. However, this is a lower-than-actual consumption taken for the purpose of the calculation. In reality, by 1996, this project will phase-out more than 50% of the country's consumption of Halon 1211 as forecasted in the India Country Program. On achieving full capacity operation, 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.

Annex A

BREAKDOWN OF INCREMENTAL CAPITAL COSTS

Particulars	Costs Excl. Taxes/Duties US$ 000	Costs Excl. Taxes/Duties Rs. Mill.	Taxes/Duties US$ 000	Taxes/Duties Rs.Mill.
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
Total	554.30	17.46	89.74	2.83
EXP. IN PROJECT MANAGEMENT				
Exp. during pre-appraisal	3.17	0.10		
Exp. during appraisal and post-appraisal	3.17	0.10		
Total	6.35	0.20		
SUB TOTAL	476.54	15.01	89.74	2.83
CONTINGENCY (@ 10 Percent)	47.65	1.50		
TOTAL	524.19	16.51	89.74	2.83

Notes to the breakdown of incremental capital costs

1. Capital equipment

An imported powder filling plant will be required for the project. This will cost US$79,270. The duties payable for the procurement will amount to US$27,740. The cost of the powder filling plant will be entirely incremental.

For the enterprise to convert to ABC-DCP from Halon 1211 portable extinguishers, it will be required to establish a valve manufacturing and a can processing plant within the enterprise. If this were not done, the valves and the processed cans will have to be imported to meet the required quality standards and these are prohibitively expensive (Annex 4). For instance, an imported valve for the 0.5 kg can will cost Rs. 104.00 (excluding duties) while the indigenously made valve will cost around Rs. 24.40.

The valve and can manufacturers in the country do not have the equipment to supply the required quality and are more expensive. For example, a one kg can costs Rs. 62.83 when sourced locally, while made in-house it will cost around Rs. 55. Not only will there be a reduction in costs but also a significant improvement in quality.

Therefore, the enterprise will have to establish a can processing and valve manufacturing plant in order to be able to supply the portable extinguishers of required quality and at an affordable price. Being a change induced because of the phase-out of halons, the investment on the can and valve plant is considered as incremental for the enterprise. The cost of the valve manufacturing plant excluding taxes/duties would be US$93,140, while the cost of the can manufacturing plant excluding taxes/duties would be around US$297,780.

Documents supporting the prices for the above capital equipment have been tabulated under the last section Supporting Documentation. However, the quotations and estimates have not been included due to large volume and will be provided on request.

2. Expenses in project management

Expenses incurred due to proposal preparation include tours to Delhi of the senior management, the finance and technical managers of the enterprise in the pre-appraisal stage. This amounts to US$3,170. Similar such expenditures are foreseen during the fund disbursement stage with the local financial institution.

Annex 2

BREAKDOWN OF INCREMENTAL OPERATING COSTS

Particulars I to V	1995-96 to 1998-99 Halon 1211/Baseline Operation
Estimated consumption of halons in tons (based on demand or equipment capacity): Number of 500 gm halon extinguishers ('000)	142.00 355.00
Material cost per 500 gm extinguisher:	Rs.
Halon 1211	112.50
Valves	16.40
Cans	18.80
CFC 12	22.40
Nitrogen	0.10
Other raw materials	11.00
Total material cost per 500 extinguisher	181.20
Salaries & wages per 500 extinguisher	5.80
Advertising cost per 500 extinguisher	51.00
Establishing and overhead cost per 500 gm extinguisher	18.10
Cost per 500 gm extinguisher	256.10
Selling price per 500 gm extinguisher	278.50
Net revenue per 500 gem extinguisher	22.40
Total net revenue in the prod. of halon extinguishers	(Rs. million) 7.95 ('000 US$) 252.44

Annex 2

Particulars I to V	1995-96 to 1998-99 ABC-DCP Operations
Number of 500 gm ABC-DCP extinguishers	Rs. 355.00
Material cost per 500 gm extinguisher: ABC-CDP Valves Cans Container welding, etc. Nitrogen Pressure gauge Gun assembly Other raw materials Total material cost per 500 gm extinguisher	Rs. 29.00 11.90 28.90 1.40 0.20 9.10 5.60 16.70 102.80
Salaries & wages per 500 extinguisher Advertising cost per 500 extinguisher Establishing and overhead cost per 500 gm extinguisher Cost per 500 gm extinguisher Selling price per 500 gm extinguisher Net revenue per 500 gem extinguisher	21.30 51.00 59.90 235.00 245.50 10.50
Total net revenue in the prod. of ABC-DCP extinguishers	(Rs. million) 3.73 ('000 US$) 118.33

Particulars I to V	1995-96 to 1998-99 Incremental Operating Costs
Due to Changeover Total net revenue in the prod. of halon extinguishers	(Rs. million) 7.95 ('000 US$) 252.44
Total net revenue in the prod. of ABC-DCP extinguishers	(Rs. million) 3.73 ('000 US$) 118.33
Net Incremental operating costs incurred due to changeover	(Rs. million) 4.22 ('000 US$) 134.11

Notes to the breakdown of incremental operating costs:

In these tables, the Halon 1211 operation is used as a baseline and is compared with ABC-DCP operation. The incremental operating costs due to changeover is the profit margin between Halon 1211 operation and ABC-DCP operation which gives a net loss to the enterprise. This is evaluated as the difference in the revenue streams due to the two operations. Here the 500 gm portable extinguisher is used for operating cost comparison. Since the enterprise makes several sizes, this standardization for the sake of comparison was found to be necessary.

Material cost

The cost of Halon 1211, valves, cans, CFC 12, nitrogen and miscellaneous raw materials have been taken at 1992-93 prices in the halon operation. The cost of ABC-DCP, valves, cans, container welding, pressure gauge, gun assembly and other raw materials have also been taken at 1992-93 prices. The present imported price of ABC-DCP is Rs. 58 per kg which has been assumed for the first three years of operation.

Salaries and wages

The manpower requirement for the ABC-DCP operation will be significantly more than the halon operation since the activities of can processing and valve manufacturing are also included in the ABC-DCP operation. Since the enterprise has already started on this project, the salaries and wages included are actual costs during Halon operation and the present ABC-DCP operation.

Advertising cost

Similar advertising costs for the halon product and the ABC-DCP product are assumed. In the first two years (1992-93), the advertising cost for the ABC-DCP product are assumed to be the same.

Establishment and overheads

The actual establishment and overheads for the Halon operation in the last year of production and for the ABC-DCP operation in the first year of production have been included. These costs for the ABC-DCP operation are significantly higher because of the different plants.

Selling price

The 1992-93 actual selling prices of the Halon extinguisher and the ABC-DCP extinguisher are used in the calculations.

Net revenue per extinguisher

This is evaluated as a difference between the selling price and the cost price of the extinguisher. The net revenue per halon extinguisher is significantly higher than the ABC-DCP extinguisher as depicted in the table.

Total net revenue

The total net revenue is determined as a product of the number of extinguishers sold and the net revenue per extinguisher. This is done for both the halon operation and the ABC-DCP operation.

Incremental operating costs due to changeover

The difference in the revenue in the halon operation and the ABC-DCP operation is considered as the incremental operating costs due to changeover.

Annex 3

Price comparison between imported and indigenous portable extinguisher

1. PRICE OF IMPORTED ABC-DCP PORTABLE EXTINGUISHER

1 Kg Portable extinguisher : 30.30 DM or Rs. 552.97

2 Kg Portable extinguisher : 39.95 DM or Rs. 729.08

Quotations from Jokel, Germany. The above prices do not include import duties (98.5 %) and handling charges (3 %).

2. PRICE OF INDIGENOUSLY-MANUFACTURED ABC-DCP PORTABLE EXTINGUISHER

1 Kg Portable extinguisher : Rs. 434.00

2 Kg Portable extinguisher : Rs. 558.00

The above prices do not include excise duty, sales tax and selling expenses.

(Note:The price comparison has been shown for the high volume sizes of portable extinguishers, one kg and two kg. The comparison for the 0.5 kg is not shown as this is not a common size in other countries and therefore the imported price is not available. However the same price differential will hold for the entire size range.)

Annex 4

Cost comparison between imported and indigenous valve manufacturing

1. IMPORTED COSTS

Valve for 0.5 kg portable extinguisher (quotation from Muzzoni, Italy)	:	Rs. 104.00 excl.duties

It is to be noted that the import duties are 98.5% and handling charges are 3%. These have not been included in the above figure.

2. IN-HOUSE MANUFACTURING COSTS

Valve costs for 0.5 kg portable extinguisher

Material costs	:	Rs. 16.40
Salaries and wages	:	Rs. 2.00
Establishment and overhead costs	:	Rs. 6.00
Total	:	Rs. 24.40

3. ADDITIONAL COSTS IF IMPORTED

Additional cost per 0.5 kg portable extinguisher by importing:

Valves	: Rs. 104.00 - Rs.24.40
Cans	: Rs. 79.60 or US$ 2.53

	Production (tons)	Production ('000)	Additional costs US$
Year I	142	284	718,520
Year II	142	284	718,520
Year III	142	284	718,520
Year IV	142	284	718,520

4. COMPARISON WITH INCREMENTAL CAPITAL COSTS FOR VALVE MANUFACTURING

Incremental capital costs for valve manufacturing	: US$ 93,140
Annual Increase in incremental recurring costs due to import of valve	: US$ 718,520

5. JUSTIFICATION

Since the annual increase in incremental recurring costs is significantly higher than the incremental capital costs for a valve manufacturing plant, request for a valve manufacturing unit is justified. It is to be noted that the imported price of valve used is without import duties. If included, this will only further justify the case.

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Hughes Associates, Inc.
Fire Science & Engineering

6770 Oak Hall Lane, Suite 125, Columbia, Maryland 21045 (301) 596-2190 FAX (301) 596-2295

Memorandum

Date: June 3, 1994

To: Naimeh Hadjitarkhani
Dept/Div: SA2CI 24410
Room G-3079
The World Bank

From: Phil DiNenno

Subject: Review of India ODS Project

I approve of the India ODS Project as proposed. Complete documentation in accordance with the OORG Format for Technical Reviewers will be forwarded early next week.

FAX 2382P

Attn: Mr. Pahil

Technical Review of
Halon 1211 Portable Extinguisher
Conversion to DCP

Real Value Appliances Ltd.
India

1. Introduction

This project was reviewed and supported with a request for more information regarding valve sourcing. The additional information was provided; the project was supported again via a letter on February 15, 1994. This review represents a re-review of the re-submitted project proposal.

2. Technology Assessment

Conversion of Halon 1211 to Class ABC, Dry Chemical Powder (DCP) is a safer and environmentally sound ODS reduction technology. Direct replacement of 1211 with DCP in all applications is not possible; hence, it is important to ensure that the ODS replaced (Halon 1211) is not used in other applications.

The project makes use of proven, relatively simple, safe technology. It appears that the local enterprise has solved any outstanding problems related to valve design and manufacturing. Therefore, there is little technical risk associated with the project and no need for technology licensing agreements.

The proposed conversion to ABC/DCP cost-effective technology.

3. Environmental Impact

Dry chemical powder is a zero ODP and close to zero GWP substance. There is little environmental impact caused by the changeover.

4. Project Costs

The project costs appear reasonable.

Capitol Costs:

Costs associated with a new "can processing" plant at $297.78K are new to this proposal. Based on the description in the proposal which identifies these costs on the basis of the quantity of locally manufactured cylinders, it appears reasonable.

Operating Costs:

All of the operating cost estimates appear reasonable. I question the utility, in general, of reimbursing for "lost revenue" based on the higher sale price of 1211 portables versus ABC portables. This difference is more than double the net revenue of ABC/DCP production. Note that in the near future there will be no 1211 portables to sell; hence, the funding of "lost revenue" based on the <u>reduced</u> cost of ABC/DCP extinguishers seems unreasonable. I understand that this point is well understood and such "costs" are allowed.

5. **Timeframe**

The proposed implementation timeframe is aggressive but attainable.

6. **Recommendation**

I recommend approval of the project as proposed.

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEPLETE THE OZONE LAYER

COUNTRY	India
SECTORS COVERED	Rigid Foams
ODS CONSUMED IN SECTOR	1,280 MT of CFC-11 (1991)
PROJECT TITLE	Replacement of CFC-11 blowing agent in polyurethane (PU) foam systems with low and non-ODS materials.
PROJECT ECONOMIC LIFE	10 Years
PROJECT DURATION	4 Years
PROJECT IMPACT	456 MT ODS per annum
PROPOSED BUDGET	Incremental Capital Cost US$ 565,000 Incremental Operating Cost US$ 41,000 Total Project Cost US$ 606,000
PROPOSED OTF GRANT	US$ 624,000[1]
UNIT ABATEMENT COST	US$ 0.29 per kg ODS[2]
IMPLEMENTING ENTERPRISE	EXPANDED INCORPORATION
IMPLEMENTING AGENCY	THE WORLD BANK/IDBI
NATIONAL COORDINATING AGENCY	MINISTRY OF ENVIRONMENT & FORESTS (MOEF)

PROJECT SUMMARY

In this project Expanded Incorporation would install laboratory & testing equipment and establish demonstration facilities for applications development of new foam systems in close cooperation with foam processors, primarily in the rigid foam sector. The enterprise would use in-house technology to develop new polyols and systems for the production of ODS-free rigid polyurethane (PU) foams under Indian conditions. This would enhance the early phase-out of CFC-11 consumption in rigid PU Foams used in household refrigeration insulation, thermowares, sandwich panels and general insulation rigid PU foams manufactured by various companies using polyols supplied by Expanded Incorporation. After the application technology is established, the enterprise would modify present polyols suitable for CFC-free rigid foams using alternative blowing agents and also modify and relocate the blending plant to manufacture CFC-free blended polyols. Expanded Incorporation would then phase out CFC-11 consumption by manufacturing the new blended polyol formulations for use with new alternative blowing agents. This project would provide a local source of essential materials and technology with which industry would reduce CFC-11 usage in India by about 456 MT per year by 1998. Project scope and cost have been revised taking into account comments from MFEC in November 1993. The project is part of GOI strategy in the foam sector to support competitive roles of three or more existing private sector polyol/foam systems suppliers to the many diverse foam industries throughout India. The project would also provide foam formulations at cost effective prices and would lower overall incremental costs in the foam sector.

TECHNICAL ASSESSMENT: This subproject has been reviewed and supported by OORG technical reviewer Dr. M. Jeffs. His comments are attached.

1/ The project was considered by the MFEC at their November 1993 meeting and was given permission to proceed. This OTF request is for financing eligible incremental capital and operating costs.

2/ Indirect UAC to be added to all end-user projects using Expanded's foam systems.

PROJECT OBJECTIVE

The objective of this project is to eliminate CFC-11 from pre-blended polyol systems manufactured by Expanded Incorporation by promoting the phase out of CFC-11 at end users through development and demonstration of new polyols and systems for rigid foam processors.

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 (Expanded, Manali, and UB Products) supply most of the system 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 to support the ability of these foam system suppliers to service the many diverse foam industries throughout India, including the small scale sector who are not well served by importing suppliers.

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.

ENTERPRISE BACKGROUND

In 1983, Expanded Incorporation, a 100% Indian owned company, became the first foam systems producer in India. Today Expanded is the largest producer of rigid PU foam chemical systems in India and is dependent entirely on its own in-house technology. The company has been highly successful in developing and manufacturing various types of polyols and formulations for such diverse industries as refrigerators, building roof spray, and packaging. The plant is located at New Bombay (30 Km North of Bombay) and has an annual production capacity of 2,400 MT of systems. It employs a staff of 50, and is the only plant of its type in India, designed to produce polyurethane polyols based on propylene oxide, polyester polyols and amino polyols. Expanded Incorporation has about one-third of India's foam systems market. It also exports about 15% of its polyol production to Middle East consumers.

PROJECT DESCRIPTION

This project would set up and operate an application technology center at Expanded Incorporation (Phase I). It is considered to be compulsory for a polyol manufacturing enterprise in India to promote and establish CFC-free technology among end-users of polyol systems. The application technology center would be installed in a separate building attached to the present plant where development, testing, trials & demonstration of CFC-free foam systems would be carried out as per end-users requirement under local conditions. New polyols suitable for blowing agents such as HCFC-22, HCFC-141b, cyclopentane, and HCFC-134a would be evaluated. Following successful development trials and testing of ODS-free rigid foam systems, the existing base polyol plant would be modified by installing necessary equipment to produce new base polyols suitable for the production of CFC-free rigid foams (Phase II). Since the elimination of CFCs from blended polyols systems is entirely dependent on phase out programs of final foam processors, the enterprise would first modify & reinstall one of the three existing blending stations in a new building block. Subsequently, the other two existing blending stations would be modified for total phase out of CFC from blended polyol systems manufactured at Expanded Incorporation.

Key project elements are explained and justified as follows:

New polyols & systems would be developed in the laboratory and small quantities of new modified polyols (EO+PO based) would be produced in a laboratory scale autoclave reactor. Subsequently the formulations would be tested in a high pressure foaming machine employing alternative blowing agents. Multi Easy Froth would be used for pre-blending alternative blowing agents (e.g. cyclopentane, HCFC-22/142b, HFC-134a).

Special foaming equipment would be used for demonstration & training purposes. Molds & fixtures would be used to evaluate and demonstrate the application technology. Demonstrations would be made to manufacturers of thermoware, sandwich panel and other insulation applications. Special arrangements will need to be made to test cyclopentane use for refrigerator foams while simple molds would be fabricated in-house for other applications. Such testing equipments is not available at Expanded Incorporation and off-site testing process is laborious & time consuming. Three main testing devices namely, thermal conductivity meter, universal testing machine and closed cell content meter would be installed in the laboratory for spot evaluations, testing & demonstration of resultant CFC-free foams. Additional floor space would be constructed on adjacent land (at Expanded Incorporation expense) to install all the new laboratory equipment involved in Phase-I. Also, a small ethylene oxide tank needed for the second stage of plant modification would be installed and the modified pre-blending stations would be relocated there. The additional construction would not increase plant capacity. Safety issues relating to use of cyclopentane in Expanded's facilities would be in conformance with local regulation and will be addressed through use of consultants with expertise in handling of flammable petroleum products. The cost of these consultations will be born by Expanded.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION

In the rigid polyurethane foam sector there is still global uncertainty on the identity of a preferred alternative to CFC-11. However, there are currently three main options for CFC-free systems in rigid PU insulation foams.

a. CFC-11 > 50% CFC-11 or HCFC-141b
b. CFC-11 > HCFC-22 or HCFC-22/142b, HFC-134a
c. CFC-11 > Pentane or Cyclopentane.

In addition, compounds such as perflouroalkanes, HCFC-123, fluorinated ethers and 2-chloropropane, have been suggested but have limited availability and/or are not toxicologically proven to be safe. Option a) also called the "liquid" solution employs technology that is closely related to the existing use of CFC-11. The final step in this process is not yet decided although HFC-134a and hydro-carbons have received the most attention. The second option, the "gas" solution, utilizes a gaseous mixture of blowing agents. It requires high pressure equipment, "Easy Froth" blending and adjustments in formulation and handling. The final step in this process is seen as the introduction of (gaseous) HFC's. Hydrocarbon (Cyclopentane) technology was introduced recently in Germany. Its flammability characteristics require major attention to safety conditions and extensive upgrading of facilities as well as the support of a technology supplier experienced in the handling of flammable blowing agents.

The acceptability of alternatives by the end processors would be decided by easy availability of local raw materials and production technology at economical cost, simple designed molds, fixtures and peripheral equipments (as there are large number of small processors), and very importantly for foreign partners of local companies on whose recommendations the local companies would adopt suggested alternatives. 50% CFC reduction technology adopted by some developed countries in initial stage of CFC phase out is not very attractive under Indian conditions as major changes would be called for in final product design and may prove expensive. In this case there is also a disadvantage of not being recognized as 100% CFC-free products. In view of the diverse selection of alternative blowing agents Expanded Incorporation would develop and manufacture polyols to be used with HCFC-22 mixtures where possible. Such technology could be adopted economically for less critical foams, particularly for thermowares. The enterprise would also manufacture blended polyol systems using HCFC-141b and cyclopentane as an alternative blowing agent.

PROJECT COSTS

Project Costs (Annex A), total US$606,000, of which US$486,000 is estimated for completion of Phase I and US$120,000 for completion of Phase II.

Incremental Capital Cost

The total incremental capital cost for this project is US$565,000.

Financial Agent Fee:

A 3% financial agent fee of US$18,000 has been added to the requested OTF grant.

Incremental Operating Cost

Incremental operating costs are to be incurred for running the development testing program and include incremental staff and material costs. These are estimated to be $41,000 for Phase I only. Incremental operating costs for Phase II can not be determined until a clear technology choice is made by refrigerator manufacturers with respect to insulation efficiency and blowing agent type.

Unit Abatement Cost (UAC)

The unit abatement cost for the project is estimated at $0.29/kg, based on the use of 456 MT per year ODS by Expanded and its customers.

Proposed OTF Grant

US$624,000 is requested in OTF financing based on 100% Indian ownership of Expanded Incorporation.

Economic Rate of Return (ERR)

Since the project entails an initial investment only with no cash flow, the ERR for the project is undefined.

Financial Rate of Return

Financial rate of return is undefined at present.

Implementation Schedule

The implementation schedule is illustrated in Annex B.

Required Regulatory Actions

Required regulatory action for the successful implementation of this project is the permission and NOC to install an Ethylene Oxide storage tank adjacent to the present plant.

Direct Project Impact

The direct project impact would be realized during Phase II only. By the end of Phase II an annual average of at least 72 ODP weighted MT of CFC-11 would be eliminated as a result of replacing CFC-11 with alternate blowing agent in blended polyol systems manufactured at Expanded.

Indirect Project Impact

The impact of the Phase I would be realized at the foam processors level as a result of direct efforts put in by Expanded Incorporation during Phase I & II. An estimated annual average of 384 ODP weighted MT of CFC-11 would be eliminated.

Environmental Assessment

This project would not result in any additional emissions, effluents or wastes being produced at Expanded Incorporation plant. Installation of Ethylene Oxide storage tank in Phase II would require clearance from environment & explosive departments of Government of India.

Changes in Project Scope and Cost Due to OORG/MFEC Comments

The technology employed uses ethylene oxide (EO) in the formulation for which the enterprise is developing its own technology. EO is used by several other international suppliers, including Mitsui (Japan). The design includes all necessary safety provisions for handling flammable EO.

Following previous OORG/MPEC review, the project capital cost was reduced by $58,000 by elimination of a large mould and jig for full scale testing of flammable blowing agents (e.g. cyclopentane). It is considered to be more cost effective to transfer the responsibility for these tests to the refrigerator manufactures who choose flammable technology.

A $41,000 cost (included in previous capital cost estimates) for demonstrating performance of non-ODS technology at small scale industry facilities was considered to be a Phase I incremental operating cost. The project was supported by OORG Reviewer Dr. M. Jeffs following his review of a previous nearly identical project proposal and feasibility study in August 1993.

The following modifications are based on the recent recommendation of OORG reviewer.

The implementation schedule was accelerated by 1 year.

Safety issues related to cyclopentane will be resolved in consultation with qualified consultants.

Annex A

PROJECT COST SUMMARY
Expanded Incorporation

SUB-TOTAL	
CAPITAL COSTS	US$
Phase I	
Lab autoclave reactor	12,000
Testing and Control Equip.	53,000
Blending and Mixing	70,000
Moulds and Jigs	10,000
High Pressure Foam Machine	142,000
Training	12,000
Installation of Facilities & Structure	106,000
SUB-TOTAL	405,000
Phase II	
EO Storage Tank	30,000
Blending Station	26,000
Piping and Installation	52,000
SUB-TOTAL	108,000
Contingency (10%)	52,000
INCREMENTAL CAPITAL COSTS	565,000
INCREMENTAL OPERATING COSTS	41,000
TOTAL PROJECT COST[3]	606,000

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

Annex B

IMPLEMENTATION SCHEDULE

Expanded Incorporation

		From	To
Phase I			
	Building Construction	3Q-94	2Q-95
	Procurement	1Q-95	2Q-95
	Bench trials and testing	2Q-94	2Q-95
	Demonstrations at Expanded Lab and at customer location	2Q-95	2Q-97
Phase II			
	Plant Modification	3Q-95	4Q-96
	Commercial production of modified polyols and systems	1Q-96	1Q-97

* Modified schedule to refect OORG review.

c:\wp51\naimeh\expand 6/7/94

ICI Polyurethanes

TELEFAX

Dr. Mike Jeffs
International Environmental
Affairs Manager

Everslaan 45
B-3078 Everberg
Belgium

Telephone (02) 758 9394
Telex 26332 ICIEVB B
Telefax (02) 758 9894

To Ms. N. Hadjitarkhani
The World Bank

cc : Mr. T. Waltz

1st June, 1994

Review of Expanded Incorporation as requested.

G. M. F. Jeffs
GMFJ/kd

OORG TECHNICAL REVIEW - EXPANDED INCORPORATION (INDIA)

TECHNOLOGY

The enterprise is a polyol / formulation manufacturer serving a range of mainly rigid polyurethane foam applications. Hence, in line with world trends, it has to consider a range of CFC 11 replacement options. There is no such animal as "a preferred option" as referred to on page 4 and I would comment that some sections of the often repeated "Justification for Alternative Technology Selection" section are becoming outdated. For example, HCFC 123 has not been considered for some years.

The enterprise is developing its own polyol technology and the reviewer considers this is to be a natural and supportable development in a country such as India with its university / institute culture and specific market needs dictated by factors such as climate which can be met by home grown technology.

A range of transitional and zero ODP technologies are listed. Transitional (HCFC) technologies are the norm in the construction industry in developed countries and are necessary in the intermediate term.

The use of HCFC 22 is proven for some applications such as steel-faced panels but the enterprise is aware of limits in domestic refrigerators and freezers because of insulation loss due to diffusion through plastic liners and be aware that its low boiling point (-41°C) could render it especially problematic to use in hot climates.

The enterprise has listed cyclopentane as an option for some applications, in line with global trends and notes on P4 that the support of an experienced technology supplier is required. There is no evidence in the remainder of the project of the identification of this partner nor of adequate training to handle cyclopentane. This is a significant deficiency.

Note - cyclopentane is not a low boiling blowing agent as stated on Page 3.

The technologies listed, with the exception of HFC 134a for domestic refrigerators and freezers, are generally cost effective.

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 portable extinguisher manufacturing	
PROJECT DURATION	1 year and 6 months	
PROJECT IMPACT	Phase-out 142 tons Halon 1211 and 35.5 tons CFC 12 in first year (1995-96) and 800 tons Halon 1211 and 200 tons CFC-12 in the year when operating at full capacity.	
UNIT ABATEMENT COST	US$ 0.475 per kg ODS	
TOTAL PROJECT COST	Incremental capital costs	US$524,190
	Incremental operating costs	US$268,220
PROPOSED OTF FINANCING	Incremental capital costs	US$524,190
	Incremental operating costs	US$268,220
	Total	US$792,410
	Financial Agent Fee	US$ 23,772
	Total OTF request	US$816,182
COST EFFECTIVENESS	0.4755 US$ per kg	
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 800 tons of Halon 1211 consumption, annually when in full capacity operation, in the production of portable extinguishers by converting the manufacturing line to suit the alternative ABC-DCP. In case of Halon 1211, the components of the portable extinguisher were externally sourced but with ABC-DCP it will be necessary to manufacture the components in-house due to cost and quality considerations. While a full-fledged technology transfer agreement for this conversion project is not required, certain capital equipment will have to be imported.

Apart from incremental capital costs, this project also involves a significant incremental operating costs due to the switch-over from Halon 1211 to ABC-DCP. However, the incremental operating costs has been claimed for a lower-than-actual annual consumption of 142 tons of Halon 1211 (the largest consumption level of the enterprise in the past) and only for the first two years of operation.

This halon phase-out project is presently ongoing. The project was launched in November 1993 and is expected to be completed by March 1995 provided the OTF grant is approved in principle by the Montreal Protocol Executive Committee in July 1994. This project has been identified as one of high priority projects in the India country program.

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, the 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. The present and future demand of the three ozone-depleting substances along with their ODPs has been given 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	ODS	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

In the organized sector, there are only a few manufacturers of portable extinguishers and therefore of Halon 1211 consumers. Real Value Appliances Limited is the largest Halon consumer and based on forecast from the Country Program it is estimated that by the year 1996 its share of the total country's consumption would be more than 50%.

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% Indian owned and had a turnover of US$ 0.44 million for a 16-month period in the year 1992-93, and it employs around 150 people. The manufacturing unit is located in Bhor in Maharashtra (Western India) with its head office in Bombay. It has 20 branches all over the country to support the aggressive marketing strategies in promoting its portable extinguisher as a user-friendly product.

Real Value commenced operations in September 1989 with the 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 the 500 gm Halon 1211 portable extinguisher. The enterprise imported Halon 1211 from ICI-UK. The quantity of halons consumed from the time of commencement of production till date is given in Table 2.

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 the assistance of the 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 the availability of halons, the enterprise launched its phase-out project after the country became a party to the Protocol.

PROJECT DESCRIPTION. The enterprise will convert from the use of Halon 1211 to ABC-DCP in their portable extinguisher manufacturing facility. The conversion to ABC-DCP in the facility is essential for the country, as the price of imported ABC-DCP portable extinguisher is significantly higher than the price of the indigenously-manufactured product. (Annex 3)

With Halon 1211, most of the components of the 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 the case of ABC-DCP. Importing the components such as the valve and the cans for the ABC-DCP portable extinguisher is not possible since this will make the product prohibitively expensive and sourcing the components locally does not give the required quality standards. For instance, the indigenous manufacture of valves for a 0.5 kg portable extinguisher is Rs. 24.40 while the cost of imported valve without duties is Rs. 104.0. Even without duties, the imported cost is four times that of the indigenous costs (Annex 4). Hence it is required to establish a production line for the manufacture of the cans and valves in addition to the assembling and filling operations which are to be adapted to the ABC-DCP in lieu of Halon 1211.

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

After the completion of this phase, investments on an imported powder filling machine and for the in-house manufacturing facility for the can and the valve will be undertaken. Certain components such as the pressure gauge will have to be imported as it will not be possible to manufacture these high-quality gauges cost effectively at the enterprise's scale of production. In installing the powder filling machine and in the manufacturing facility, the enterprise will not require know-how 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 phase-out the same tonnage of Halon 1211. Since this is an on-going project, small quantities of Halon 1211 and CFC-12 have already been phased out using the trial capital equipment.

JUSTIFICATION FOR ALTERNATIVE TECHNOLOGY SELECTION. ABC-DCP is an accepted alternative to Halon 1211 for portable extinguishers. However in terms of effectiveness in fire protection, ABC-DCP is not superior to Halon 1211.

ABC-DCP is a recognized alternative by the UNEP Technical Options Committee (Halon sector) and has been included in the India Country Program.

PROJECT COST (all costs are provided in US$ and the exchange rate used in all conversions is Rs. 31.50 per US$).

Incremental capital costs. The incremental capital costs of US$524,190 comprises capital costs and expenses in project management. (Annex 1).

Incremental Operating costs. In the calculation of the incremental operating costs, operation with Halon 1211 is used as the baseline and this is compared with ABC-DCP operation. Since the revenue margins in Halon 1211 operation is significantly higher than the ABC-DCP operation, the incremental operating costs is the profit margin which gives a net loss to the enterprise. The revenue during Halon 1211 operation is compared with that of ABC-DCP operation and the net incremental operating cost due to the changeover is tabulated for the first four years of operation. It is to be noted that in the calculation of the incremental operating costs the consumption of Halon 1211 has been assumed to be lower-than-actual quantity of 142 tons (the maximum the enterprise has achieved in the past). In practice, by 1996, through this project the enterprise is expected to phase-out well over 50% of the estimated Halon 1211 consumption that is forecast in the India Country Program for 1996.

The incremental operating costs for the first four years of operation are US$134,110 each year. However, the request for OTF grant is only the incremental operating costs for the first two years, which totals up to US$268,220. (Annex 2)

Incremental Operating benefits. There are no incremental benefits to this project.

TOTAL INCREMENTAL COSTS OF THE PROJECT. The total incremental capital cost for the project is summarized below:

Incremental capital costs	:	US$ 524,190
Incremental operating costs (two years not discounted)	:	US$ 268,220
Total	:	US$ 792,410
Financial Agent Fee:	:	US$ 23,772
Total OTF request:	:	US$ 816,182

Therefore, the total OTF request is US$816,182.

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

CONTINGENCIES. Provision for contingencies has been included at 10 percent of the incremental capital costs.

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 (incl. contingencies) is US$524,190. The net operating costs at the assumed lower consumption level of 142 tons year, OC, is US$134,110. The ODS phased out is 142 tons of Halon 1211 and 35.5 tons of CFC 12 (taken at a lower-than-actual level). Therefore, W - the annual ODS reduction at the first year of full operation expressed in ODP units - is 461.50 tons. C(F) is evaluated as US$85,300 where F is the capital recovery factor. The unit abatement costs is therefore evaluated as 0.4755 US$ per kg.

FINANCIAL HEALTH OF ENTERPRISE:

This project commenced in November 1993 and is expected to be completed in March 1995. 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 OTF grant for this project will fund the incremental capital cost and the incremental operating costs for the first two years at lower-than-actual consumption levels. The investment will be undertaken only after the OTF grant is approved in principle by the Montreal Protocol Executive Committee. If this approval is obtained by July 1995, the investments are expected to be undertaken by December 1994 so that the project could be completed by March 1995.

PROJECT IMPLEMENTATION. This on-going project commenced in November 1993 and is expected to be completed in March 1995, (duration of around one year and six months). The past and expected future schedule of the implementation is give below:

Phase I (November '93 - September '94)

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 (September '94 - March '95)

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 Ministry of Finance, Government of India, to waive the duties/taxes for all equipment supplied for this project as these are considered transfer payments rather than true economic costs.

RESULTS. In the first year of operation (1995-96), this project will phase-out 142 tons of Halon 1211 and 35.5 tons of CFC-12. However, this is a lower-than-actual consumption taken for the purpose of the calculation. In reality, by 1996, this project will phase-out more than 50% of the country's consumption of Halon 1211 as forecasted in the India Country Program. On achieving full capacity operation, 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.

Annex A

BREAKDOWN OF INCREMENTAL CAPITAL COSTS

Particulars	Costs Excl. Taxes/Duties US$ 000	Costs Excl. Taxes/Duties Rs. Mill.	Taxes/Duties US$ 000	Taxes/Duties Rs.Mill.
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
Total	554.30	17.46	89.74	2.83
EXP. IN PROJECT MANAGEMENT				
Exp. during pre-appraisal	3.17	0.10		
Exp. during appraisal and post-appraisal	3.17	0.10		
Total	6.35	0.20		
SUB TOTAL	476.54	15.01	89.74	2.83
CONTINGENCY (@ 10 Percent)	47.65	1.50		
TOTAL	524.19	16.51	89.74	2.83

Notes to the breakdown of incremental capital costs

1. Capital equipment

An imported powder filling plant will be required for the project. This will cost US$79,270. The duties payable for the procurement will amount to US$27,740. The cost of the powder filling plant will be entirely incremental.

For the enterprise to convert to ABC-DCP from Halon 1211 portable extinguishers, it will be required to establish a valve manufacturing and a can processing plant within the enterprise. If this were not done, the valves and the processed cans will have to be imported to meet the required quality standards and these are prohibitively expensive (Annex 4). For instance, an imported valve for the 0.5 kg can will cost Rs. 104.00 (excluding duties) while the indigenously made valve will cost around Rs. 24.40.

The valve and can manufacturers in the country do not have the equipment to supply the required quality and are more expensive. For example, a one kg can costs Rs. 62.83 when sourced locally, while made in-house it will cost around Rs. 55. Not only will there be a reduction in costs but also a significant improvement in quality.

Therefore, the enterprise will have to establish a can processing and valve manufacturing plant in order to be able to supply the portable extinguishers of required quality and at an affordable price. Being a change induced because of the phase-out of halons, the investment on the can and valve plant is considered as incremental for the enterprise. The cost of the valve manufacturing plant excluding taxes/duties would be US$93,140, while the cost of the can manufacturing plant excluding taxes/duties would be around US$297,780.

Documents supporting the prices for the above capital equipment have been tabulated under the last section Supporting Documentation. However, the quotations and estimates have not been included due to large volume and will be provided on request.

2. Expenses in project management

Expenses incurred due to proposal preparation include tours to Delhi of the senior management, the finance and technical managers of the enterprise in the pre-appraisal stage. This amounts to US$3,170. Similar such expenditures are foreseen during the fund disbursement stage with the local financial institution.

Annex 2

BREAKDOWN OF INCREMENTAL OPERATING COSTS

Particulars I to V	1995-96 to 1998-99 Halon 1211/Baseline Operation
Estimated consumption of halons in tons (based on demand or equipment capacity):	142.00
Number of 500 gm halon extinguishers ('000)	355.00
Material cost per 500 gm extinguisher:	Rs.
Halon 1211	112.50
Valves	16.40
Cans	18.80
CFC 12	22.40
Nitrogen	0.10
Other raw materials	11.00
Total material cost per 500 extinguisher	181.20
Salaries & wages per 500 extinguisher	5.80
Advertising cost per 500 extinguisher	51.00
Establishing and overhead cost per 500 gm extinguisher	18.10
Cost per 500 gm extinguisher	256.10
Selling price per 500 gm extinguisher	278.50
Net revenue per 500 gem extinguisher	22.40
Total net revenue in the prod. of halon extinguishers	(Rs. million) 7.95 ('000 US$) 252.44

Annex 2

Particulars I to V	1995-96 to 1998-99 ABC-DCP Operations
Number of 500 gm ABC-DCP extinguishers	Rs. 355.00
Material cost per 500 gm extinguisher: ABC-CDP Valves Cans Container welding, etc. Nitrogen Pressure gauge Gun assembly Other raw materials Total material cost per 500 gm extinguisher	Rs. 29.00 11.90 28.90 1.40 0.20 9.10 5.60 16.70 102.80
Salaries & wages per 500 extinguisher Advertising cost per 500 extinguisher Establishing and overhead cost per 500 gm extinguisher Cost per 500 gm extinguisher Selling price per 500 gm extinguisher Net revenue per 500 gem extinguisher	21.30 51.00 59.90 235.00 245.50 10.50
Total net revenue in the prod. of ABC-DCP extinguishers	(Rs. million) 3.73 ('000 US$) 118.33

Particulars I to V	1995-96 to 1998-99 Incremental Operating Costs
Due to Changeover Total net revenue in the prod. of halon extinguishers	 (Rs. million) 7.95 ('000 US$) 252.44
Total net revenue in the prod. of ABC-DCP extinguishers	(Rs. million) 3.73 ('000 US$) 118.33
Net Incremental operating costs incurred due to changeover	(Rs. million) 4.22 ('000 US$) 134.11

Notes to the breakdown of incremental operating costs:

In these tables, the Halon 1211 operation is used as a baseline and is compared with ABC-DCP operation. The incremental operating costs due to changeover is the profit margin between Halon 1211 operation and ABC-DCP operation which gives a net loss to the enterprise. This is evaluated as the difference in the revenue streams due to the two operations. Here the 500 gm portable extinguisher is used for operating cost comparison. Since the enterprise makes several sizes, this standardization for the sake of comparison was found to be necessary.

Material cost

The cost of Halon 1211, valves, cans, CFC 12, nitrogen and miscellaneous raw materials have been taken at 1992-93 prices in the halon operation. The cost of ABC-DCP, valves, cans, container welding, pressure gauge, gun assembly and other raw materials have also been taken at 1992-93 prices. The present imported price of ABC-DCP is Rs. 58 per kg which has been assumed for the first three years of operation.

Salaries and wages

The manpower requirement for the ABC-DCP operation will be significantly more than the halon operation since the activities of can processing and valve manufacturing are also included in the ABC-DCP operation. Since the enterprise has already started on this project, the salaries and wages included are actual costs during Halon operation and the present ABC-DCP operation.

Advertising cost

Similar advertising costs for the halon product and the ABC-DCP product are assumed. In the first two years (1992-93), the advertising cost for the ABC-DCP product are assumed to be the same.

Establishment and overheads

The actual establishment and overheads for the Halon operation in the last year of production and for the ABC-DCP operation in the first year of production have been included. These costs for the ABC-DCP operation are significantly higher because of the different plants.

Selling price

The 1992-93 actual selling prices of the Halon extinguisher and the ABC-DCP extinguisher are used in the calculations.

Net revenue per extinguisher

This is evaluated as a difference between the selling price and the cost price of the extinguisher. The net revenue per halon extinguisher is significantly higher than the ABC-DCP extinguisher as depicted in the table.

Total net revenue

The total net revenue is determined as a product of the number of extinguishers sold and the net revenue per extinguisher. This is done for both the halon operation and the ABC-DCP operation.

Incremental operating costs due to changeover

The difference in the revenue in the halon operation and the ABC-DCP operation is considered as the incremental operating costs due to changeover.

Annex 3

Price comparison between imported and indigenous portable extinguisher

1. PRICE OF IMPORTED ABC-DCP PORTABLE EXTINGUISHER

   1 Kg Portable extinguisher : 30.30 DM or Rs. 552.97

   2 Kg Portable extinguisher : 39.95 DM or Rs. 729.08

   Quotations from Jokel, Germany. The above prices do not include import duties (98.5 %) and handling charges (3 %).

2. PRICE OF INDIGENOUSLY-MANUFACTURED ABC-DCP PORTABLE EXTINGUISHER

   1 Kg Portable extinguisher : Rs. 434.00

   2 Kg Portable extinguisher : Rs. 558.00

   The above prices do not include excise duty, sales tax and selling expenses.

(Note:The price comparison has been shown for the high volume sizes of portable extinguishers, one kg and two kg. The comparison for the 0.5 kg is not shown as this is not a common size in other countries and therefore the imported price is not available. However the same price differential will hold for the entire size range.)

Annex 4

Cost comparison between imported and indigenous valve manufacturing

1. IMPORTED COSTS

Valve for 0.5 kg portable extinguisher (quotation from Muzzoni, Italy)	:	Rs. 104.00 excl.duties

It is to be noted that the import duties are 98.5% and handling charges are 3%. These have not been included in the above figure.

2. IN-HOUSE MANUFACTURING COSTS

Valve costs for 0.5 kg portable extinguisher

Material costs	:	Rs. 16.40
Salaries and wages	:	Rs. 2.00
Establishment and overhead costs	:	Rs. 6.00
Total	:	Rs. 24.40

3. ADDITIONAL COSTS IF IMPORTED

Additional cost per 0.5 kg portable extinguisher by importing:

Valves	: Rs. 104.00 - Rs.24.40
Cans	: Rs. 79.60 or US$ 2.53

	Production (tons)	Production ('000)	Additional costs US$
Year I	142	284	718,520
Year II	142	284	718,520
Year III	142	284	718,520
Year IV	142	284	718,520

4. COMPARISON WITH INCREMENTAL CAPITAL COSTS FOR VALVE MANUFACTURING

Incremental capital costs for valve manufacturing : US$ 93,140

Annual Increase in incremental recurring costs due to import of valve : US$ 718,520

5. JUSTIFICATION

Since the annual increase in incremental recurring costs is significantly higher than the incremental capital costs for a valve manufacturing plant, request for a valve manufacturing unit is justified. It is to be noted that the imported price of valve used is without import duties. If included, this will only further justify the case.

FAX 23258?

Attn: Mr. Pohill

Meinab

Technical Review of Halon 1211 Portable Extinguisher Conversion to DCP

Real Value Appliances Ltd. India

1. Introduction

This project was reviewed and supported with a request for more information regarding valve sourcing. The additional information was provided; the project was supported again via a letter on February 15, 1994. This review represents a re-review of the re-submitted project proposal.

2. Technology Assessment

Conversion of Halon 1211 to Class ABC, Dry Chemical Powder (DCP) is a safer and environmentally sound ODS reduction technology. Direct replacement of 1211 with DCP in all applications is not possible; hence, it is important to ensure that the ODS replaced (Halon 1211) is not used in other applications.

The project makes use of proven, relatively simple, safe technology. It appears that the local enterprise has solved any outstanding problems related to valve design and manufacturing. Therefore, there is little technical risk associated with the project and no need for technology licensing agreements.

The proposed conversion to ABC/DCP cost-effective technology.

3. Environmental Impact

Dry chemical powder is a zero ODP and close to zero GWP substance. There is little environmental impact caused by the changeover.

4. Project Costs

The project costs appear reasonable.

Capitol Costs:

> Costs associated with a new "can processing" plant at $297.78K are new to this proposal. Based on the description in the proposal which identifies these costs on the basis of the quantity of locally manufactured cylinders, it appears reasonable.

Operating Costs:

All of the operating cost estimates appear reasonable. I question the utility, in general, of reimbursing for "lost revenue" based on the higher sale price of 1211 portables versus ABC portables. This difference is more than double the net revenue of ABC/DCP production. Note that in the near future there will be no 1211 portables to sell; hence, the funding of "lost revenue" based on the reduced cost of ABC/DCP extinguishers seems unreasonable. I understand that this point is well understood and such "costs" are allowed.

5. **Timeframe**

The proposed implementation timeframe is aggressive but attainable.

6. **Recommendation**

I recommend approval of the project as proposed.

सत्यमेव जयते

तार :
Telegram : PARYAVARAN,
NEW DELHI

दूरभाष :
Telephone :
टेलेक्स (द्विभाषीय) :
Telex (bi-lingual) : W-66186 DOE IN
Fax : 4360678

भारत सरकार
पर्यावरण एवं वन मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT & FORESTS
पर्यावरण भवन, सी० जी० ओ० कॉम्प्लेक्स
PARYAVARAN BHAWAN, C.G.O. COMPLEX
लोदी रोड, नई दिल्ली-११० ००३
LODI ROAD, NEW DELHI - 110 003

Anil Agarwal
Deputy Secretary (Ozone)

F.No. 5(2)/61/93-IC-1
Dated June 3, 1994

Dear Mr. Shende,

The MOEF has recommended the following project proposals for posing it to the Executive Committee for its consideration in the July meeting. It is to request that necessary action may kindly be taken accordingly.

DIFR proposal on "Indian Halon Management and Banking System" - $ 685,000 (copy of project enclosed).

With regards,

Yours sincerely,

(Anil Agarwal)
Deputy Secretary(Ozone)

Mr. Rajendra Shende
Coordinator
UNEP IE/PAC, Ozone Action Programme
FAX: (33-1)40588874

Copy to:

1. Dr. Omar E El-Arini
   Chief Officer,
   Fund Secretariat,
   Montreal, Canada.Fax No.- 1-514-282-0068

2. File No. 58, 165
3. Project File No. MPP/39/94-OC

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 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$		1,159,000
	Incremental operating costs/savings, US$		(383,846)
	Project preparation costs, US$		24,000
	Total Project Costs, US$		799,154
OWNERSHIP STRUCTURE	100 per cent Indian		
PROPOSED MF FINANCING	US$	799,154	
UNIT ABATEMENT COST	US$	1.39	per kg of phased-out ODS
CURRENCY CONVERSION	US$ 1.00 = Indian Rs. 31.20		
COUNTERPART ENTERPRISE	Indian Telephone Industries Ltd., Mankapur		
IMPLEMENTING AGENCY	UNIDO		
COORDINATING MINISTRY	Ministry of Environment and Forest		

PROJECT SUMMARY

This project will phase out the use of CFC- 113/methylene chloride blend (TMC formula); CFC-12; carbontetracloride 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 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. The India Country Programme for the Elimination of ODS has also identified the sector as a high priority area.

Contents

1. Project objective

The objective of this project is to phase out the use of CFC- 113/methylene chloride blend (TMC formula); CFC-12; carbontetracloride 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 Exhibit 1 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 Exhibit 2 (table) and Exhibit 3 (chart).

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.

---

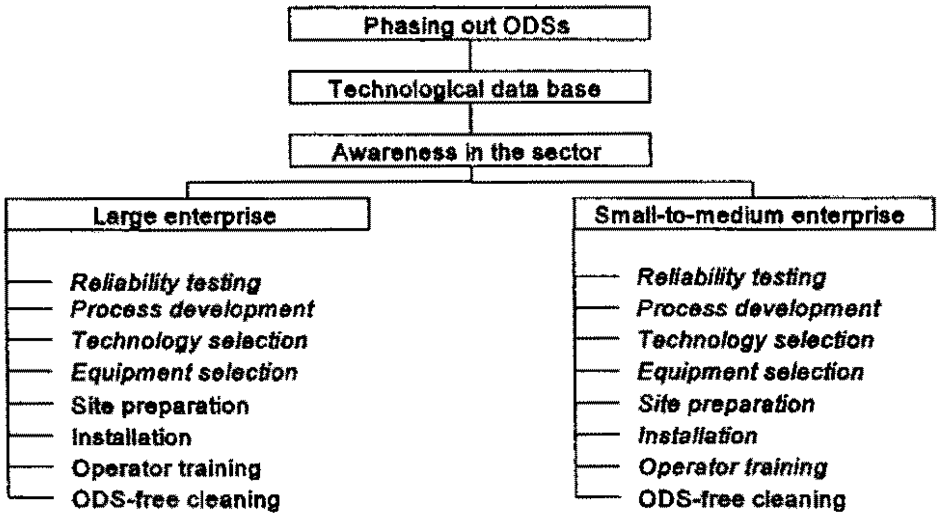
[1] The Centre for Materials for Electronics Technology (C-MET) set up by DOE has experts in the various materials used in the electronics industry covering chemicals, polymers and other related products such as solvents, cleaning agents etc. and in materials development and commercialization of the 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. September 1993.

Exhibit 1

Phasing out of ODSs in Indian Electronics Industry

The role of a focal point of know-how



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

Exhibit 2. 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	1900	1,900.000	14.385	0	0.000	0.000
CFC-12	2850	2,850.000	21.577	100	100.000	2.051
CFC-113	320	342.400	2.592	300	321.000	6.583
Sub-Total	5,070.000	5,092.400	38.554	400.000	421.000	8.634
Halon-1211	550	1,650.000	12.492	0	0.000	0.000
Halon-1301	200	2,000.000	15.142	0	0.000	0.000
Sub-Total	750.000	3,650.000	27.634	0.000	0.000	0.000

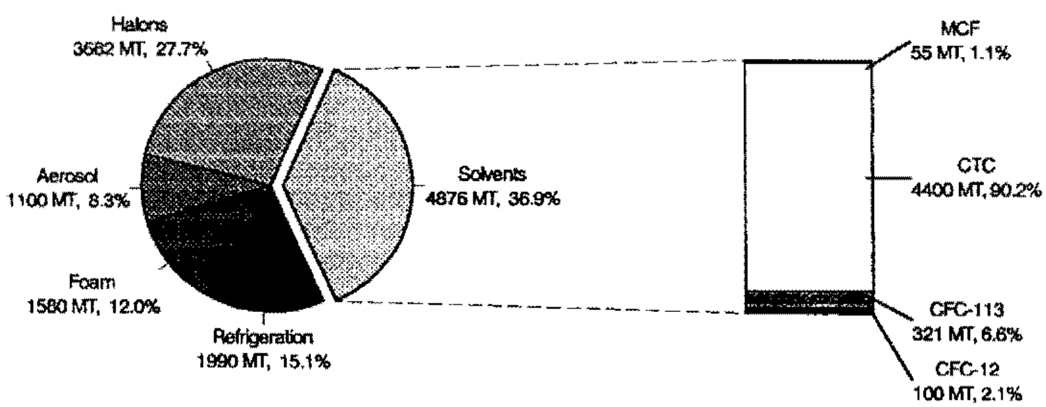
Types of ODS	1991 Consumption					
	All sectors			Solvents		
	Actual, MT	ODP-weighted		Actual, MT	ODP-weighted	
		MT	%		MT	%
CTC	4000	4,400.000	33.312	4000	4,400.000	90.238
MCF	550	66.000	0.500	550	55.000	1.128
TOTAL	10,370.000	13,208.400	100.000	4,950.000	4,876.000	100.000
Sectoral distribution						
Aerosols	1100	1100	8.328			
Foams	1580	1580	11.962			
Refrigeration	1990	1990	15.067			
Solvents	4950	4876	36.917			
Halons	750	3662	27.726			
TOTAL	10,370.000	13,208.000	100.000			

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.

Exhibit 3

ODS consumption in India

1991 figures in ODP-weighted MT



Refrigeration figure includes aerosols.

3. Enterprise background

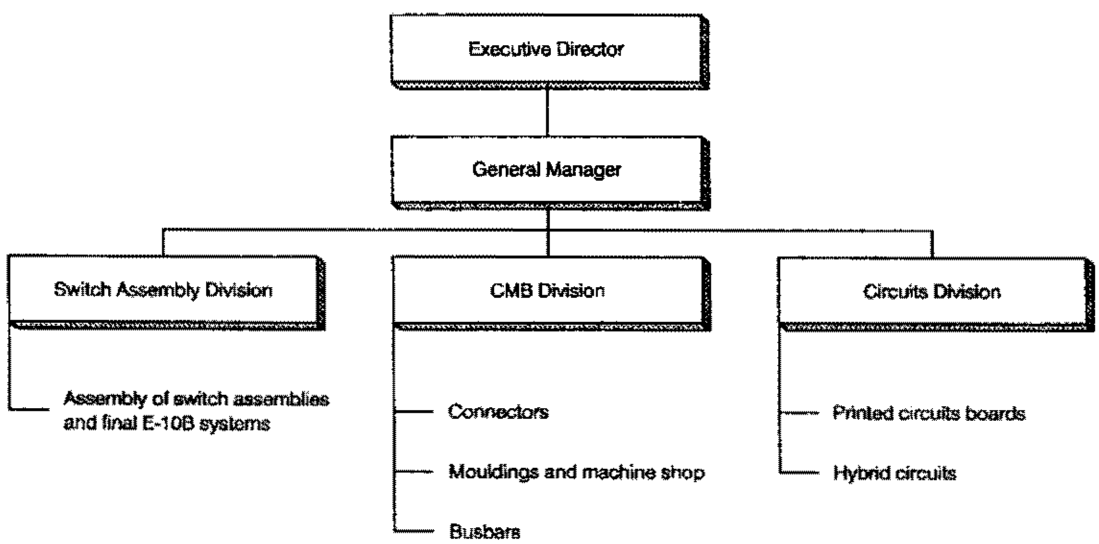
Indian Telephone Industries Limited is a 100 per cent Government of India owned company. ITI has six units all over India and manufactures the entire range of telecommunication equipment and accessories such as telephones, switching, transmission, satellite, fibre optic equipment. Annual production of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

ITI-Mankapur is one of the largest units of ITI employing 2,550 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. Annual capacity of the new production line will also be 500,000 lines.

The manufacturing divisions of ITI-Mankapur are shown in the Exhibit 4 below.

Exhibit 4

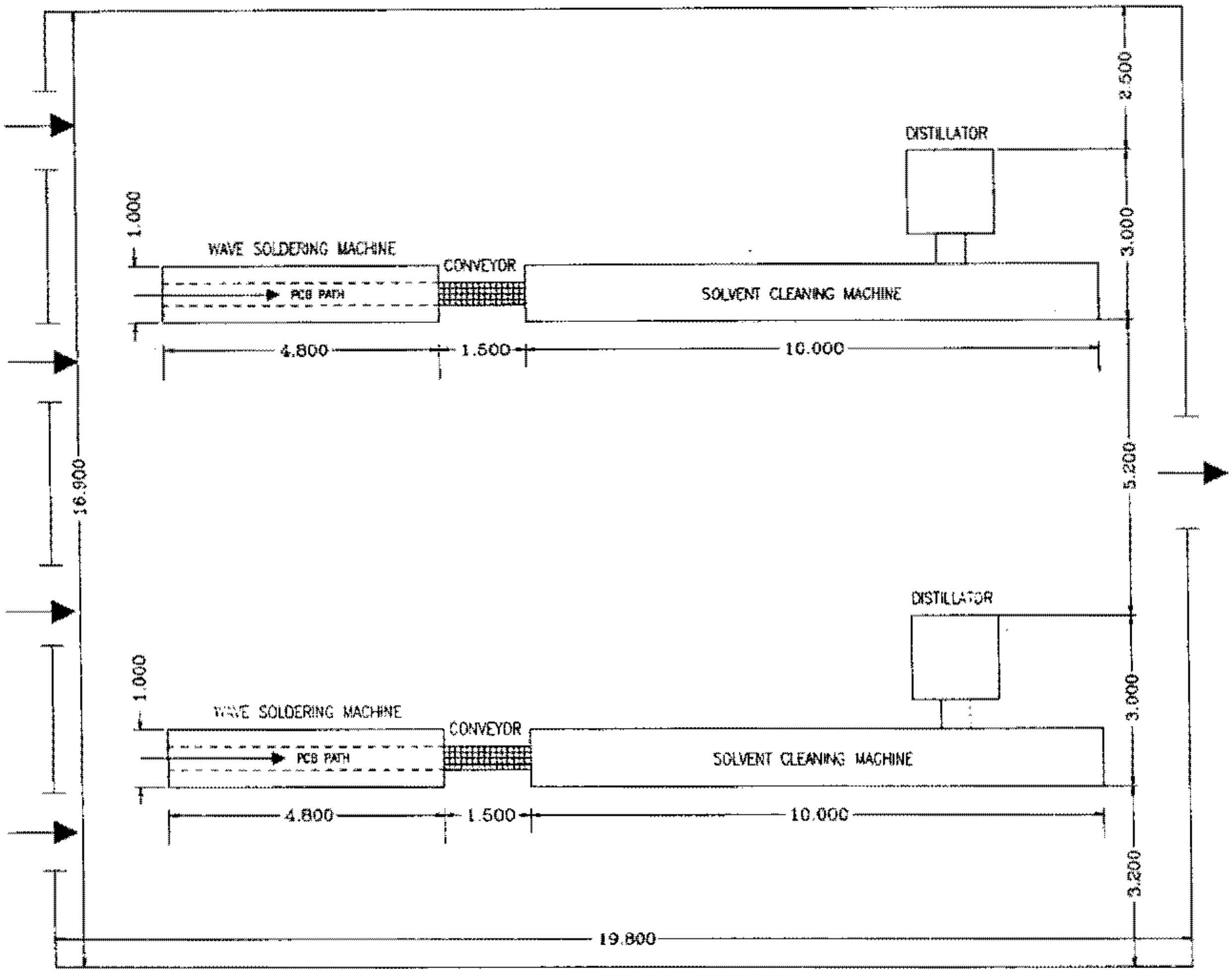
Manufacturing divisions of ITI-Mankapur



The Factory has two shifts, 7.5 hours each. Total annual working hours per shift is 2,040 hours, that is the operating duration of the equipment is 4,080 hours per year.

The Switch Exchange Assembly (SEA) Division produces switch assemblies at a peak rate of about 3,000 cards/day. Required cleaning is basically soldering flux removal and is carried out in two continuous, 3-zone vapour degreaser (OSL, France, Model Netci-in-Line 18) using an azeatrop of trichlorotrifluoroethane ($C_2Cl_3F_3$, CFC-113) and methylene chloride (CH_2Cl_2, dichloromethane, DCM) (TMC 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. The total electric power requirement of each degreaser is about 23 kW (of which 13.5 kW is for degreaser proper and 9.5 kW is for distillator). Annual electricity consumption is 187,680 kWh. Two operators per shift are employed at the cleaning stations. A schematic layout drawing of the cleaning stations is given in Exhibit 5.

Exhibit 5. Floor layout of cleaning stations of SEA Division



The Connectors, Mouldings and Machined Parts, Busbars (CMB) Division uses two cold solvent, ultrasonicly agitated, batch processing bath degreasers to clean relay parts and connectors (KERRY, UK, Model Compact 450). A small ultrasonic degreaser backs up the KERRY cleaners. 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 power requirement of each degreaser is 8 kW yielding a maximum annual energy consumption of 62,280 kWh. The Division employs one operator per shift per cleaning bath. Additionally, the CMB Division uses annually 20 MT of tricholoroethylene (TCE) in different degreasing processes, mainly through manual batch operations.

The Circuits Division produces hybrid circuits and printed circuit boards. The hybrid circuits unit has an annual production capacity of 2 million circuits to be cleaned (with 75 per cent initial yield, annual output 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 with computer-controlled conveyor system (Ultrasons Annemasse, France, Model SFR 40). Annually, 2 MT of TMC blend solvent consisting of trichlorotrifluoroethane (CFC-113) and methylene chloride (CH_2Cl_2, dichloromethane, DCM) is used. Power requirement of the degreaser is 6 kW yielding a maximum annual energy consumption of 24,480 kWh. A smaller ultrasonic cleaner (VIBRONICS, India) backs up this unit. The power requirement of smaller unit is 4 kW, yielding to a maximum annual consumption of 16,320 kWh. Additionally, 2 MT of carbontetrachloride (CTC) are consumed annually to perform other cleaning tasks in a small degreaser (Imeco, India). 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 power requirement of the developer, including the distillator and the chiller is 22 kW, giving a maximum annual consumption of 89,760 kWh.

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 power requirement of the stripper is 7.5 kW, giving a maximum annual consumption of 30,600 kWh.

Information on solvent use at ITI-Mankapur is presented in the following three tables, that is Exhibits 6, 7 and 8.

Exhibit 6. ODS solvent using main equipment at ITI-Mankapur

ACTIVITY	PRODUCTION CAPACITY	PURPOSE	PURPOSE	YEAR OF PURCHASE
Switching exchange assembly	3000 cards/day @ 15 hours/day	Cleaning of solder fluxes from populated PCBs	Freon cleaning station, OSL, France, Model Netci-in-line 18 (2 nos)	1985
Component assembly	Connectors: 2 million/year Relays: 1.1 million/year	Degreasing of metal and plastic parts of relays & connectors	Ultrasonic cleaning station, KERRY COMPACT, UK, Model 450 (2 nos)	1985
Hybrid circuits	2 million circuits/year	Cleaning of solder fluxes from hybrid circuits	Multistage ultrasonic cleaners, ANNEMASSE, France, Model SFR 40 and VIBRONICS, India	1985-89
Printed circuit boards	26,000 m^2/year	a) Photoresist development b) Photoresist stripping	a) Development bath b) Stripping bath	1987 1987

Exhibit 7. 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					
Methylene chloride (CH_2Cl_2, dichloro methane, DCM) and trichlorotrifluoroethane (CFC-113) (TMC blend); 86%	37	3.07	113,680	35.150	37.610
Component assembly/ Cleaning of metal and plastic parts					
Dichlorodifluoromethane (CCl_2F_2, CFC-12); 90%	5	2.76	13,816	4.500	4.500
Tricholoroethylene (TCE)	20	1.11	22,276	0.000	0.000
Hybrid circuits/Flux removal					
Methylene chloride (CH_2Cl_2, dichloro methane, DCM) and trichlorotrifluoroethane (CFC-113) (TMC blend); 86%	2	3.07	6,145	1.720	1.840
Carbontetrachloride (CTC)	2	2.55	5,106	2.000	2.200
Printed circuit boards					
a) Photoresist development: 1,1,1-trichloroethane (CH_3CCl_3, MCF)	23	1.44	33,173	23.000	2.300
b) Stripping of photoresist: methylene chloride (CH_2Cl_2, DCM)	47	0.85	39,920	0.000	0.000
TOTALS	136		234,116	66.370	48.450

Exhibit 8. Types and annual consumptions of ODS (and other) solvents used at ITI-Mankapur (Amount used between 1 April 1992 to 31 March 1993)

Purpose	Chemical Compositions	Amount used, MT/ year
Cleaning of solder fluxes from populated PCBs	Methylene chloride (CH_2Cl_2, dichloromethane, DCM) and trichlorotrifluoroethane (CFC-113) (TMC blend); 86%	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
a) Photoresist development b) Photoresist stripping	a) 1,1,1-trichloroethane (CH_3CCl_3, TCA or methyl chloroform, MCF) b) Methylene chloride (CH_2Cl_2, dichloromethane, DCM)	23.0 47.0
TOTAL		136

4. Project description

4.1 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.

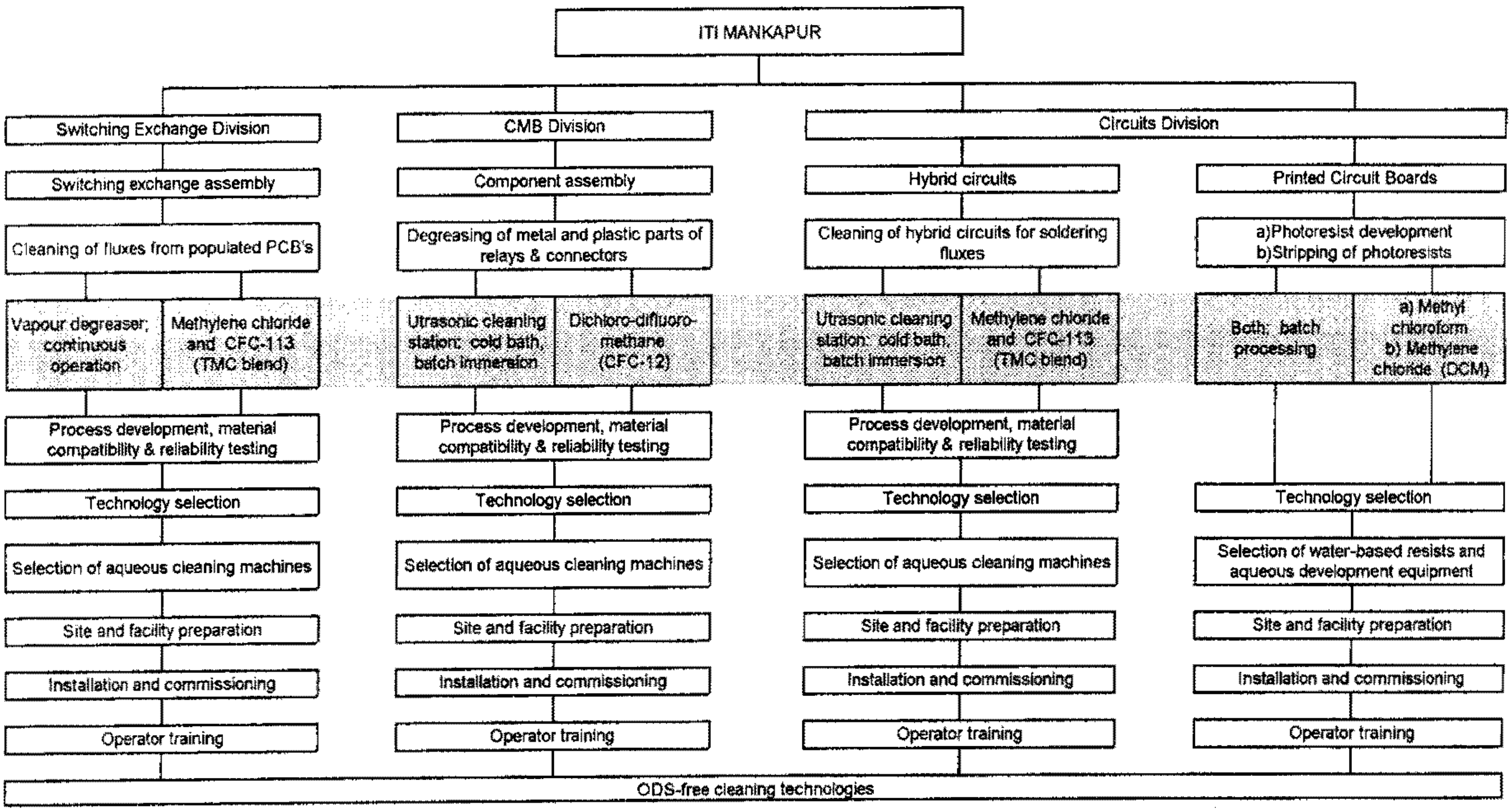
4.2 Description of the ITI-MANKAPUR project

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 Exhibit 9 and explained in detail below.

4.2.1 Reliability testing, material compatibility testing and process development

Reliability testing, material compatibility testing and process development will be performed by ITI-Mankapur in close cooperation with C-MET, 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 machines for the Switching Exchange Assembly Division.

Exhibit 9. Main elements of the ITI-Mankapur ODS phase out project



ITI-Mankapur and C-MET are 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.

4.2.2 Technology selection, equipment selection and purchase of aqueous cleaning machines

ITI-Mankapur will phase out the use of CFC-113/methylene chloride blend (TMC formula); CFC-12; 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 two multi-stage continuous operation vapor degreasers, 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 chlorinated solvents will be eliminated.

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.

Considering the cleaning requirements of ITI-Mankapur, a preliminary selection has been made in favour of aqueous cleaning technology. However, this selection has to be verified by reliability and material compatibility tests.

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 project authorities 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.

4.2.3 Purchase of aqueous cleaning machines and systems

Continuous operation aqueous cleaning system

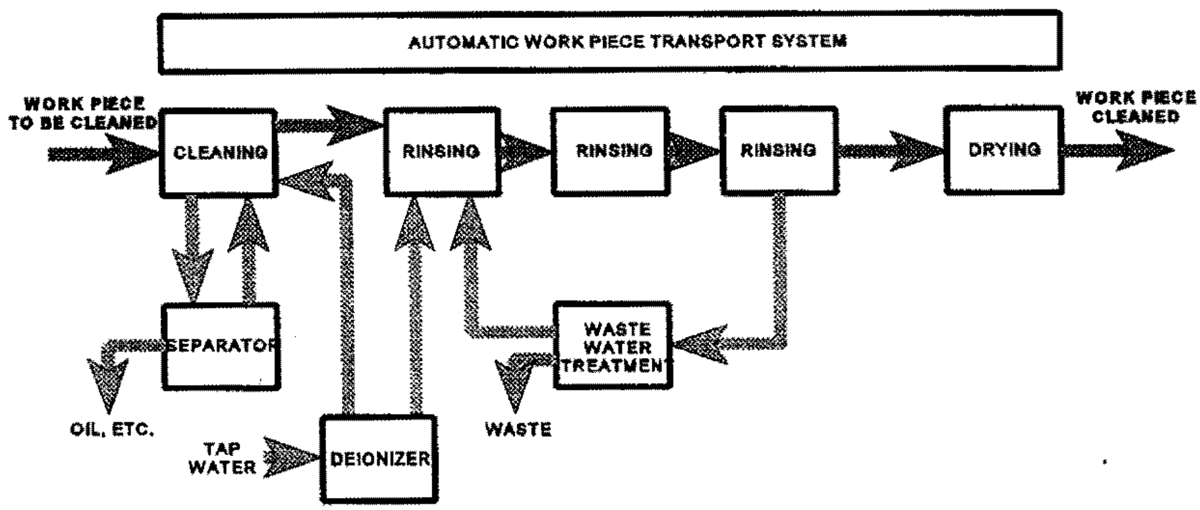
A typical continuous operation aqueous cleaning system is shown in the schematic diagram given in Exhibit 10. This system includes the following components:

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.

Exhibit 10. Continuous operation aqueous cleaning system



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 is seen from the table, the non-ODS systems do not aim at any capacity increase but represent a one-to-one replacement scheme.

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: therefore prices can vary (for the sizes required here) between US$ 50,000 to 100,000. For this project and using the present capacities as the guide (please see Exhibit 11), it is estimated that each cleaner will cost in the region of US$ 60,000. Due to physical location and distance between these cleaners, two water recycling and purification 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. (For a discussion of location of equipment and services, please see section 4.2.5 and Exhibit 13.)

Exhibit 11. Comparison of present and proposed batch operation aqueous cleaning systems

Location	No.	Capacity (tank size in mm) of each stage of the present ultrasonic systems using ODS's	Corresponding capacity (tank size in mm) of the proposed aqueous systems
Component assembly	2	300x450x350	300x400x400
Hybrid circuits	1	460x320x350	300x450x350

4.2.4 Purchase of aqueous exposure and stripper units to process 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 is shown in Exhibit 12 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/development capacity of around 10,000 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 36,000 m^2 is US$ 100,000.

Exhibit 12. Comparison of different development techniques

	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

To complete the photoresist processes, an aqueous stripper will also be needed. Such equipment with an annual capacity of 26,000 m^2 will cost US$ 130,000.

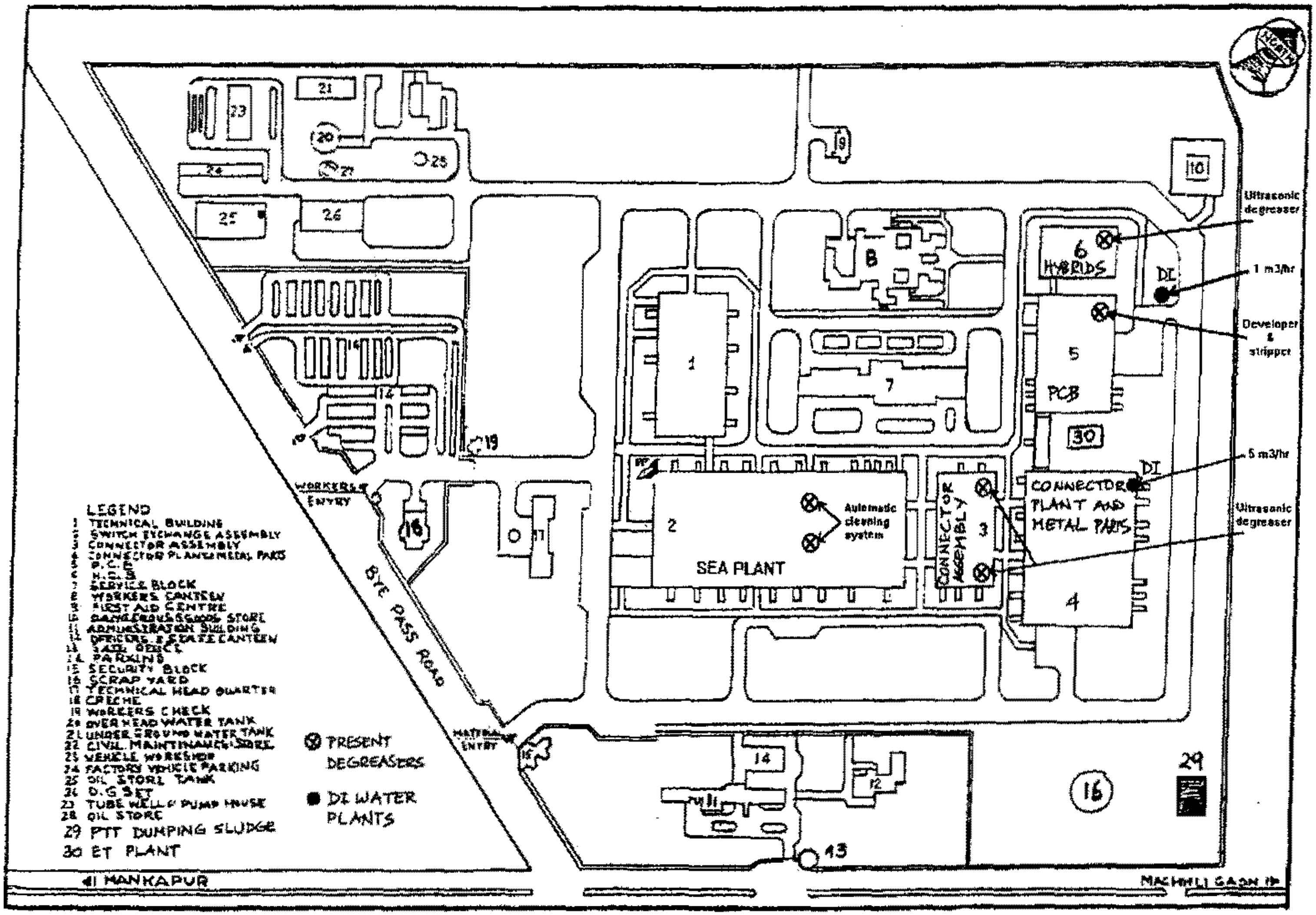
4.2.5 Site preparation and installation of machinery

Exhibit 13 gives the site schematic of the ITI-Mankapur factory and the location of cleaning units and deionized water plants. The initial observation follows:

a) **Deionized water supply:**

Ground water is the only water source at ITI-Mankapur. The quality of the virgin water, however, is not suitable for use in aqueous cleaning operations. It contains dissolved and suspended solids and has a very high pH (alkaline). Therefore, water treatment, that is deionizing, is necessary.

Exhibit 13. Site plan of ITI-Mankapur Factory



Presently, two deionizing plants are employed in the Factory. DI Plant #1 with a capacity of 1 m^3/hr, feeds the Hybrid Circuits. DI Plant #2 has a capacity of 5 m^3/hr and supplies the Connector and Metal Parts plant. Both DI units work at full capacity and cannot allocate any DI water to new cleaning equipment. Furthermore, the new equipment will be installed far from any fresh water piping and drainage. The DI water requirement of the new cleaning equipment is estimated at 5-6 m^3/hr. With the physical locations of the new equipment, it seems very difficult to distribute DI water from one plant. Therefore, it is planned to build two new plants to supply the degreasers in SEA and CMB plants, and to increase the capacity of the DI plant supplying the Hybrid Circuit plant so that it can provide for the aqueous developer and stripper equipment.

b) **Water recycling and purification:**

It is targetted that 80 per cent water recycling and purification will be achieved across the new processes. Again, due to the physical location of the equipment, one-point water processing is impossible. Depending upon the requirements of the actual equipment, it is expected that at least three water treatment units will be required: one for the SEA plant, one for the CMB plant and one for the PCB production. The cost of the first one is estimated at US$ 50,000 and the latter two at US$ 20,000 each.

c) **Waste water drainage:**

Unfortunately, the proposed aqueous cleaners have to be installed at locations without water drainage. Therefore, highly complicated and costly drainage systems will have to be constructed. This separate drainage piping, however, can have an advantage. That is, the waste water from different equipment containing different effluents (such as sponefiers and surfactants from automatic cleaners, stripped film from film stripper, etc.) can be kept separate and treated individually.

d) **Waste stream treatment:**

At the Factory, waste streams from the following processes are treated:

PCB plant:
- electroless copper plating line
- electroplating line
- tin lead plating line
- copper etching line

CMB
- gold plating line
- electroless nickel plating line
- electroplating line
- tin lead plating line

Effluents from the above-mentioned lines are processed in 4 holding tanks, 4 reaction tanks with strirrer and pH controller, chemical dosing tanks with automatic dosers. There is also a combined neutralization tank for final pH adjustments.

Air pollution is controlled by 6 scrubbers.

The above facilities are just adequate to treat the existing quantum of effluents. Therefore, the additional (or different) pollutants from the proposed aqueous processes must be separately treated. US$ 30,000 is allocated for this purpose.

e) **Electric power requirements:**

The electrical power requirement of ITI-Mankapur is obtained from two sources: U.P. State grid and Factory's captive diesel electric generator. Exhibit 14 and 15 give the details of amounts and costs involved in different electric power sources.

Exhibit 14. Electric power requirements and costs

	Consumption, kWh	Unit cost, US$/kWh	Total cost, US$
Grid power	24,000,000	0.074	1,784,615
DG power	750,000	0.332	249,139
Total	24,750,000		2,033,755
Average		0.082	

Exhibit 15. Cost of diesel electric generation at ITI-Mankapur

Investment	US$	1,700,000
Annual depreciation at 10 per cent	US$	170,000
Average annual output	kWh	750,000
Unit depreciation cost	US$/kWh	0.227
Unit fuel cost	US$/kWh	0.071
Unit lubrication cost	US$/kWh	0.005
Subtotal	US$/kWh	0.302
Unit maintenance cost at 10 per cent of production cost	US$/kWh	0.030
Total per unit cost	US$/kWh	0.332

The electric load of present CFC-based cleaning equipment is given in Exhibit 16.

Exibit 16. Installed electric load of present cleaning systems

Division	Equipment	Qty	Unit power kW	Total power kW	hours/ year	Annual total, kWh
SEA	OSL: multi-stage automatic cleaner	2	13.5	27.0	4,080	110,160
SEA	OSL: CFC distillator	2	9.5	19.0	4,080	77,520
CMB	KERRY: ultrasonic vapour degreaser	2	8.0	16.0	4,080	65,280
PCB	ANNEMASSE: ultrasonic vapour degreaser with robot conveyor	1	6.0	6.0	4,080	24,480
PCB	VIBRONICS: ultrasonic vapour degreaser	1	4.0	4.0	4,080	16,320
PCB	DUPONT: film developer	1	4.0	4.0	4,080	16,320

Division	Equipment	Qty	Unit power kW	Total power kW	hours/ year	Annual total, kWh
PCB	ISC: distillator for developer	1	12.0	12.0	4,080	48,960
PCB	ISC: chiller for developer	1	6.0	6.0	4,080	24,480
PCB	ISC: film stripper	1	7.5	7.5	4,080	30,600
TOTAL				101.5		414,120

The proposed aqueous equipment will require much more power which is estimated at 400 kW. Although the present infrastructure, that is, the distribution transformer and diesel electric generator, will be able to handle the added load, a number of cables will have to be replaced to carry the heavier currents.

The project includes funding to prepare the sites for the equipment installation (total US$ 45,000). 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.

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 (or equipment manufacturer). 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 cleaning applications and other uses of chlorinated solvents to water-based processes is the most practical for organizations that prefer to eliminate organic solvents from their cleaning processes. 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.

6. 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$799,154. 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$799,154 was calculated as the economic capital costs minus the net incremental recurrent savings for four years discounted at 10 per cent plus the project preparation costs.

Investment (capital) cost (see Annex 1):

As detailed in Annex 1, the total investment cost is US$1,159,000. Major components of this cost include the purchase and installation of two continuous operation aqueous cleaning systems (US$ 400,000), four batch processing aqueous cleaners (US$ 240,000), three water recycling systems (US$ 90,000), one DFPR exposure and development unit (US$ 100,000), one film stripper (US$ 130,000), 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$277,842. If the project is implemented, the annual operating cost will be US$156,750, resulting in an annual incremental operating savings of US$(121,091). 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$(383,847). 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$799,153.

Contingencies:

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

Breakdown of total project costs:

The breakdown of total project costs is given in Exhibit 17. Although the economic life of the project is 10 years, the incremental operating costs (or savings) is calculated for a period of 4 years.

Exhibit 17. Breakdown of total project costs

Description of cost	10 year period, US $	First four years, US$
Investment (capital) costs	1,159,000	1,159,000
NPV of incremental operating (savings)	(744,056)	(383,846)
NPV of incremental operating revenues	0	0
Total costs	414,944	775,154

Unit Abatement Cost (UAC) (see Annex 4):

As shown in Annex 4, the UAC for this project is US$1.39 per ODP-weighted kilogram of ODS phased out per year. This number is derived from an annualized incremental cost of capital of US$188,569, first year incremental annual operating savings of US$(121,091), and phasing out of 48.48 MT (ODP-weighted) of ODS per year.

Proposed MF Grant:

The proposed MF grant for this project is US$763,899 and was calculated as follows: First, the total investment cost of US$1,159,000 was added to the net present value of the incremental operating savings over the first four years of the project, which is US$(383,846). To the resulting total of US$775,154 project preparation costs of US$24,000 was added to find the total costs US$799,153. 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$799,154.

7. 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.

8. 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

The project roadmap is given in Exhibit 18.

Exhibit 18. Project roadmap

	Activity	Description	Responsible	Timing
1	Approval of the project		Multilateral Fund	Start
2	Make a detailed project work plan		ITI-Mankapur, UNIDO	1 Q
3	Arrange the study-tour		UNIDO, ITI-Mankapur	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	ITI-Mankapur, UNIDO	1 Q
5	Carry out reliability and materials compatibility tests	Evaluate the effectiveness of different non-ODS cleaning techniques	ITI-Mankapur, C-MET, UNIDO	2 Q
6	Select technology	Finalize the optimum cleaning technology & prepare the list and specifications of equipment and materials	ITI-Mankapur, UNIDO	2 Q

	Activity	Description	Responsible	Timing
7	Carry out international bidding, including evaluation and commercial negotiations	Prepare bidding documents, invite bids, evaluate bids and hold commercial negotiations based on the selected technology, select equipment and sign the contract(s)	UNIDO, ITI-Mankapur	3 Q
8	Design modifications of the site and facilities	Engineering design of utilities (water and electricity), 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	Training of technical staff abroad and/or in India	ITI-Mankapur, UNIDO	4 Q
12	Acceptance test, installation and commissioning of equipment		ITI-Mankapur	5 Q
13	Start utilizing new cleaning processes		ITI-Mankapur	5 Q
14	Evaluate the processes		UNIDO, ITI-Mankapur	5 Q
15	Evaluate the project		UNIDO, ITI-Mankapur	6 Q

9. 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.

10. Results

Direct Project Impacts

The project will eliminate annually 48.48 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 ITI-Mankapur, the quality and performance of ITI-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.

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$
1.0	Training and engineering				
1.1	Material compatibility, process development and reliability testing (LOCAL)	week	400	30	12,000
1.2	Study-tour	week	4,000	8	32,000
1.3	Consultants: material compatibility studies, installation assistance, follow up, etc. (INTERNATIONAL)	week	10,000	2	20,000
1.4	Project monitoring missions	week	5,000	2	10,000
2.0	Continuous aqueous cleaning system				
2.1	In-line aqueous cleaning machines	nos	200,000	2	400,000
2.2	Water filtration and recycling equipment	nos	50,000	1	50,000
2.3	Installation costs (electrical, piping, etc.)	nos	25,000	1	25,000
3.0	Batch processing aqueous cleaning systems				
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
4.0	Aqueous photoresist exposure and development system				
4.1	Aqueous DFPR exposure and development equipment	set	100000	1	100,000
4.2	Aqueous stripper equipment	set	130000	1	130,000
5.0	Miscellaneous				
5.1	Waste treatment	set	30000	1	30,000
5.2	Transportation: shipping and insurance	set	50000	1	50,000
TOTAL INVESTMENT COSTS					1,159,000

Annex 2. Breakdown of incremental operating costs/savings

	Description of cost item	Unit	Unit cost, US$	Qty	Pre-project total cost, US$	Post-project total cost, US$
A.	Solvent/media costs per year					
A1	CFC-113/Methanol	kg	3.072	39,000	119,825	0
A2	CFC-12	kg	2.800	5,000	14,000	0
A3	CTC	kg	2.553	2,000	5,106	0
A4	MCF	kg	1.440	23,000	33,120	0
A5	TCE	kg	1.110	20,000	22,200	0
A6	DCM	kg	0.850	47,000	39,950	0
A7	Water @ 80% recycling	m3	0.100	30,000	0	3,000
	Sub-total				234,201	3,000
B.	Electricity costs per year					
B1	Current systems '(100 kW, 2040 hr/yr/shift, 2 shifts)	kWh	0.082	414,120	34,041	0
B2	Aqueous cleaning systems '(400 kW, 2040 hr/year/shift, 2 shifts)	kWh	0.082	1,632,000	0	134,150
	Sub-total				34,041	134,150
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					277,842	
TOTAL POST-PROJECT COSTS/YEAR						156,750
TOTAL INCREMENTAL SAVINGS/YEAR						(121,091)

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	36.90
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	4.50
A5	ODP of CFC-12		1.00
A6	ODP-weighted CFC-12 phase out (A4*A5)	MT	4.50
A7	Average use of CTC based solvent per year	MT	2.00
A8	ODP of CTC		1.10
A9	ODP-weighted CTC phase out (A7*A8)	MT	2.20
A10	Average use of MCF based solvent per year	MT	23.00
A11	ODP of MCF		0.10
A12	ODP-weighted MCF phase out (A10*A11)	MT	2.30
A13	Total ODP-weighted phase out		48.48
B.	Annualized capital cost		
B1	Total investment cost from Annex 1	US$	1,159,000
B2	Equipment life	Year	10
B3	Discount rate	%	10
B4	Annualized capital cost (B1*0.1627)	US$	188,569
C.	Annual incremental operating savings from Annex 2	US$	(121,091)
D.	Unit abatement cost		
D1	Annualized capital cost per kg ODS phased out	US$/kg	3.89
D2	Annual incremental operating savings per kg ODS phased out (C/A13*1000)	US$/kg	-2.50
D3	Unit abatement cost (D1+D2)	US$/kg	1.39

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

COUNTRY	India
SECTORS COVERED	Solvents
ODS CONSUMED IN SECTOR	100MT CFC-12; 19MT CFC-113 (1991)
PROJECT TITLE	Conversion of Process for Manufacture of Disposable Syringes from EO/CFC-12 to EO/CO_2 Sterilisation and Direct Siliconisation
PROJECT ECONOMIC LIFE	7 Years
PROJECT DURATION	1 Year
PROJECT IMPACT	54 MT ODS per annum
PROPOSED BUDGET	Incremental Capital Cost US$ 639,000 Incremental Operating Cost US$ 128,000 Total Project Cost US$ 767,000
PROPOSED OTF GRANT	US$ 790,000[1]
UNIT ABATEMENT COST	US$ 3.37 Per kg ODS
IMPLEMENTING ENTERPRISE	HINDUSTAN SYRINGES AND MEDICAL DEVICES PVT. LTD.
IMPLEMENTING AGENCY	THE WORLD BANK/IDBI
NATIONAL COORDINATING AGENCY	MINISTRY OF ENVIRONMENT & FORESTS (MOEF)

PROJECT SUMMARY

This project will phase out CFC-12 currently used in combination with Ethylene Oxide for sterilization of syringes, needles and other disposable medical devices manufactured by Hindustan Syringes. It is proposed to replace the 12/88 EO/CFC-12 sterilization gas mixture with a 10/90 EO/CO_2 gas mixture and to replace silicon CFC-113 sprayers with pure silicon sprayers. To accomplish these objectives, new higher pressure sterilization chambers will be installed to assure satisfactory sterilization with EO/CO_2 and special silicon spray nozzles will be installed to eliminate the need for CFC-113 as a silicon carrier.

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

[1] The project was considered by the MFEC at their March 1994 meeting and was given permission to proceed. This OTF request is for financing eligible incremental capital and operating costs.

PROJECT OBJECTIVE

The objective of present project is to install carbon dioxide (CO_2)-ethylene oxide (EO) sterilisers to replace the current CFC-EO system and replace nozzles for siliconisation of syringes 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

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 and 32 new siliconization spray nozzles.

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 proven. The chosen technology is in commercial use with manufacturers of similar products in the developed countries. Pure silicon application nozzles have recently become commercially available and have been chosen to completely eliminate the need for solvents in this service.

PROJECT COST

The project incremental cost of US$767,000 has been calculated as the economic capital cost plus the net incremental recurrent costs for 2 years, plus 10% contingency on capital cost.

CAPITAL COSTS

Capital cost is US$639,000 including handling, installation charges and 10% contingency. Taxes and duties are excluding (Annex A).

INCREMENTAL RECURRENT COSTS

Net incremental operating cost of US$64,000 per year undiscounted for 2 years amounts to US$128,000 (Annex C).

BENEFITS

There will be no benefits to the enterprise by changing the existing CFC-EO steriliser and replacing silicon applicators.

OTF GRANT: The request for $790,000 includes project costs of $767,000 plus a 3% financial agents fee of $23,000.

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

UNIT ABATEMENT COST

US$ 3.37 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 illustrated in Annex B.

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 and non-ODS alternatives as part of the technology selection process for siliconisation.

Annex A

PROJECT COST SUMMARY
Hindustan Syringes

SUB-TOTAL CAPITAL COSTS	US$
3 - 6m3 Sterilization Chambers	297,000
32 - Silicon Application Nozzles	256,000
Clearance and Installation	28,000
SUB-TOTAL	581,000
Contingency (10%)	58,000
INCREMENTAL CAPITAL COSTS	639,000
INCREMENTAL OPERATING COSTS	128,000
TOTAL PROJECT COST[2]	767,000

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

Annex B

IMPLEMENTATION SCHEDULE

Hindustan Syringes

	From	To
Procurement & Installation	3Q-94	4Q-94
Startup	4Q-94	1Q-95

Annex B

INCREMENTAL OPERATING COST

Hindustan Syringes

The new sterilization process employing CO_2/EO will operate at pressure 4 times greater than that currently used. Larger (20%) chambers will also be required to accomplish comparable rates of production. Consequently the total weight of gas required at a given production level will increase in proportion to the molecular weight, pressure, and chamber volume as shown below.

	Current - ODS	Non - ODS
Base Year	1993	1993
Syringe Production (million units/year)	105	105
Gas Composition	12% EO 88% CFC-12	10% EO 90% CO_2
Avg. Molecular Weight of Gas	111.2	44
Total Chamber Volume (m3)	15	18
Chamber Pressure (KN/cm2 abs)	50	200
Cycles per Year	900	900
Gas Consumed (metric tons)	56.82	107.92 [a]
Gas Price (US$/metric ton)	3111	2222

[a] Gas consumption projected for current production using non ODS gas as per calculation below.

MT Gas/year = 56.82 x (44/111.2) x (18/15) x (200/50) x (900/900) = 107.92

Incremental Operating Cost per year = (107.92 x 2222) - (56.82 x 3111) = $64,000

The incremental costs requested are for <u>2 years only</u> on the basis that by 1997, Hindustan Syringes will have reduced their operating costs and/or increased their prices sufficiently to sustain profitability at current levels without further assistance from the Multilateral Fund.

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northern telecom

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

Tel.: (905) 566 3000
Telex: 06 960348
Fax: (905) 275 1143

Executive offices

FOR DELIVERY BY FAX

June 2, 1994

Naimeh Hadjitarkhani
The World Bank
Fax: 202-477-7352

Dear Ms. Hadjitarkhani:

As requested I have reviewed the latest proposal for Hindustan Syringes (your fax of May 25, 1994).

The technology as now proposed eliminates CFC's in the needle manufacture and, as I recall, a reduction in operating costs has also been attained.

I offer my approval of the proposal as it now stands.

Sincerely,

A D Fitzgerald

A. D. Fitzgerald
Director, Environmental Projects

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.