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PROJECT PROPOSAL FOR THE MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL FINANCING

COUNTRY : India

PROJECT TITLE : Conversion of precision cleaning & coating processes from ODS solvents to heat cleaning technologies and ODS free solvent coating at Harbans Lal Malhotra & Sons Ltd.

PROJECT IMPACT : Phase out annual consumption of 18 MT of trichlorotrifluoro ethane (14.4 ODP weighted MT).

PROJECT DURATION : 18 months

PROJECT ECONOMIC LIFE : 10 years

TOTAL PROJECT COST : Investment (Capital) costs : US$ 676,310
Incremental operating costs: US$ 10,080
Total Project costs US $ 686,390

OWNERSHIP STRUCTURE : 100 per cent Indian

PROPOSED MF FINANCING : US $ 686,390

UNIT ABATEMENT COST : US $ 6.28 per kg. ODS or
US $ 7.86 per kg. ODP

COUNTERPART ENTERPRISE : Harbans Lal Malhotra & sons Ltd., Calcutta

IMPLEMENTING AGENCY : UNIDO

CO-ORDINATING MINISTRY : Ministry of Environment & Forests.

PROJECT SUMMARY

The project will phase out the use of 18 MT of trichlorotrifluoro ethane (CFC-113), at Harbans Lal Malhotra & Sons Ltd. Calcutta. It has application on two processes (i) Blade cleaning process and (ii) Blade edge coating process. The cleaning process is used for thorough cleaning of razor blades to remove greases, oil, swaft, abrasive, wax, etc. The ODS solvent (CFC-113) is utilized as a degreasing agent in the three stages Degreaser. On Blade Coating Process CFC-113 is used as a carrier of PTFE material which is sprayed on the edges of Razor Blades under the Electrostatic charge.The phase out of ozone depleting substances (ODSs) will be accomplished by replacing the solvent based cleaning methods with heat cleaning process and use of non ODS based (IPA) formulations of PTFE and alternate solvent (IPA) for razor edge coating applications. The project is based on inhouse developed technology. Country studies and the country programme prepared during 1992 have identified the sector as a high priority area. An existing unit will be replaced by a new unit compatible with IPA. To avoid hazard, an automatic Fire Extinguishing system will be required.

CHAPTER I

PROJECT OBJECTIVE :

The objective of this project is to phase out the use of CFC-113 in the blade cleaning and spray coating processes at Harbans Lal Malhotra & Sons Ltd. (HLM). These processes in which the ODS is utilised will be replaced with non-ODS solvents.

This is one of the first project formulated for the solvent based metal cleaning and coating sector in India and has additional objectives. Considering the structure of the Indian Engineering Industry with special reference to blade manufacturing and steps required to phase out ODSs in metal cleaning and coating proceses, it is expected that this project will additionally identify and strengthen the oznone cell of the Ministry of Environment & Forest, New Delhi which will help to increase awareness in the selected metal industries in phasing out ODS. For this purpose the activities like collecting and compiling technical and technological informaiton, and to provide technical support regarding problems asscoiated with phasing out ODSs in the metal cleaning industry (blade manufacture) which include process development, materials compatibility testing, reliability testing and cost effectiveness analysis, technology selction and drawing up of equipment specifications etc. would be useful.

1.2 This project will provide assistance to small private companies involved in the production of razor blades in India. Therefore, this project can be considered as demonstration project for the metal cleaning and coating industry in India.

In co-operation with the Ministry of Environment and Forest, Electronics Trade & Technology (ET&T) of the Department of Electronics has been identified as the focal point.[1]

1. Electronics Trade & Technology Development Corporation Ltd. an enterprise of the Govt. of India under Deptt. of Electronics has been providing support to the Indian Industry in the area of Technology Development, transfer of technology, Import of raw material & components and has experts in the field.

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[1] ET&T is operating as a Government of India Enterprise under Deptt. of Electronics for implementing various programmes for the Govt. of India for commercial trading activities and transfer & upgradation of technology in the field of Electronics Industry.

CHAPTER - 2

SECTOR BACKGROUND

India became a signatory to Montreal Protocol in 1992 and as a part of subsequent exercise, a Country Programme document was prepared by the Government with the assistance of UNDOP. This document has assessed the Ozone Depleting Substances (ODS) consumption in the country and on the basis of this, a National Programme for the Phase-out of ODSs has been prepared to ensure the Phase-out of ODSs according to the national development strategy, without undoe burden to consumers and industry.

2.2 The solvents sector is the largest user of ozone depleting substances (ODS) in India. The size of consumption has been investigated in a number of studies. According to India Country Programme : August 1992, the total consumption of ODS in the country by 1991 was 10,370 tonnes equivalent to 13,111 tonnes ODP. Out of which, 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 36.6 per cent of total ODP-weighted consumption in India.

2.3 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), semi-conductor 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 devlopment of the electronics industry. ODS consumption in India : As per the India Country Programme, the ODS & ODP figures for the year 1991 and unconstrained scenario by 2010 is given in the following Table-2, Exhibit-2 and Table-3 respectively.

Table-2
1991 Consumption

Types of ODS	All Sectors			Solvents		
	Actual MT	ODP-Weighted MT	ODP-Weighted %	Actual MT	ODP - Weighted MT	ODP - Weighted %
CFC-11	1900	1900	14.4	0	0	0.0
CFC-12	2850	2850	21.6	100	100	2.1
CFC-113	320	342	2.6	300	321	6.6
Sub-total	5070	5092	38. 6	400	421	9.7

Types of ODS	All Sectors			Solvents		
	Actual MT	ODP-Weighted		Actual MT	ODP - Weighted	
		MT	%		MT	%
Halon-1211	550	1650	12.5	0	0	0.0
Halon-1301	200	2000	15.1	0	0	0.0
Sub-total	750	3650	27.6	0	0	0.0
CTC	4000	4400	33.3	4000	4400	90.2
MCF	550	66	0.5	550	55	1.1
TOTAL	10370	13208	100.0	4950	4876	100.0

Sectoral Distribution

Aerosols	1100	1100	8.3
Forams	1580	1580	12.0
Refrigeration	1990	1990	15.1
Solvents	4950	4876	36.9
Halons	750	3662	27.7
TOTAL	10370	13208	100.0

The total ODS consumption as solvent in India in 1991 is given at Table-1.

Table-1

ODS Consumption in Solvent Sector

Sub-Sector	ODS	Qty.	ODP
Electronics	CFC-113	150	120
	CTC	80	88
	MCF	30	3
Textile cleaning	CTC	600	660

Sub-Sector	ODS	Qty.	ODP
Pharmaceuticals	CTS	1060	1160
Pesticides	CTS	800	880
Rubber industry	CTS	320	352
Chemicals & Laboratory	CTS	70	77
	MCF	50	5
Sterlization	CFC-113	10	8
	CFC-12	100	100
Metal & precision cleaning	CFC-113	130	104
	MCF	40	4
Miscellaneous uses	CFC-113	10	8
	CTC	1070	1177
	MCF	430	43
Sub total	CFC-12	100	100
	CFC-113	300	240
	CTC	4000	4400
	MCF	550	55

2.4 Subsequently to the finalisation of India Country Programme for ozone depleting phase out under Monteal Protocol and taking into consideration the structure and distribution of Indian Electronics Industry and lack of awareness, UNIDO in co-operation with Department of Electronics/ Centre for Materials for Electronics Technology formulated a programme under which 04 OD solvent phase out projects were worked out which have been approved by multilateral Fund for financial assistance. As a follow up to this programme, UNIDO in co-operation with Department of Electronics (DoE) / Electronics Technology Development & Trade (ET&T) has formulated a programme under which a few solvent phase out proposals can be worked out. ET&T is a commercial venture by DoE and involved in the manufacturing of electronics components & products and has got expertise and infrastructure to carry out such programmes in an efficient manner.

CHAPTER 3

ENTERPRISE BACKGROUND :

Harbanslal Malhotra & Sons (HLM), a Pvt. Ltd. Company manufactures shaving razor blades, hi-tech super master shaving systems, disposable as well as lady's razors. In addition, HLM also produces various brands of safety razor blades and shaving system of laser brand. The company has major manufacturing activity in Calcutta. The plant was established in 1950 and it mostly produces high quality disposable razors and super master double edge blades of international standards. The installed capacity of the plant is 1500 million pieces per year whereas the rated production per year is 1200 million pieces. The technology for the blade manufacturing was established by inhouse R&D and in consultation with foreign experts which includes strip perforation machine, heat treatment furnace, printing machine, edge sharpening machine, blade cleaning system, metal & polymer coating systems, blade sintering furnace, wrapping and packing machine, etc. Presently Harbans Lal Malhora has got a total of 2000 manpower in the manufacturing side (skilled and non skilled) distributed in three shifts.

3.2 The production of razor blades and shaving systems by HLM during the last 03 years was as follows :-

Year	Production
1993-1994	1014.51 million pieces
1994-1995	1192.11 million pieces
1995-1996	1077.28 million pieces

3.3 The Calcutta Plant of HLM is a pioneer of high-tech blade making in India. The company has developed world class levels of precision oriented manufacturing technology uitlising microprocessor controls & computerised equipments. The company obtained ISO 9002 certification and several prestigious international awards e.g. the Monde selection (Brussel) Belgium and National Export Awards from the Engineering Export Promotion Council (EEPC).

3.4 The major razor blade manufacturing processes are blade strip perforating, hardening, tempering, blade strip sharpening, razor blade cleaning, edge coating, blade parting, and packing. Ozone Depleting Substances (ODS) are used as solvents in blade cleaning (degreasing) and edge coating processes. The plant is

coating of razor blades are done in the separate rooms. Initially the ODS consumption was of the order of 30 tonnes per annum. However,the company took steps to reduce the consumption and by incorporating good house keeping, recovery and recyclying, the consumption of ODS was brought down by almost half.

Blade Cleaning Process :

3.5 A thorough blade cleaning was performed after blade edge sharpening at the degreaser with precision grade of high purity CFC-113 solvents (Freon). The sequence of operation is that the product (blades) are loaded on fixtures which pass through hot immersion chamber, high pressure spray nozzles, again hot immersion (IInd Chamber) and finally through hot distillate spray chamber (details at Annexure 1). The blade cleaning system with all the accessories was purchased from ICI, UK in 1980. The cost of the cleaning system was around Rs.15 lacs at that time. The cleaning was done in ultrasonic cleaner having 03 compartments with different temperature profile. In the first compartment the cleaning is carried out with the solvent by spraying at high pressure where the blades dipped in the solvent. Subsequent to this, the cleaning is performed in the Second compartment at elevated temperature and finally in the third compartment the cleaning is carried out with the help of vapours. The unit has got in-built heating arrangements as well as to condence the vapour at the top of the ultrasonic cleaner. The over all size of the ultrasonic cleaner is 2065 x 890 x 1260 mm, whereas the effective compartment size is 510 x 305 x 305 mm. This can keep a hold up of 250 liter of CFC-113. The energy consumption by this unit was 13.5 KWH per day.

Blade Edge Coating Process

3.6 CFC-113 is used for diluting the polytetrafluoroethylene (PTFE) and as a pulverizing agent for PTFE on the blade. The Harbans Lal Malhotra & Sons was applying Vydax 1000 for coating razor blades. The vydax - 1000 is a 7.5% dispersion of fluorotelomer in freon which is further diluted with CFC-113 to give a suspension of solids containing 1 to 2 per cent before being applied to the edges of the razor blade stack. Vydax-1000 and CFC-113 are later blended in the proportions of 1 to 99 by means of blending two chemicals in a mixer (a mixing tank with integral pump, stirrer mechanism, meter and inter-connecting plumbing) and later homogenizing the blend in a homogenizer (required to make vydax formulation). Vydax and CFC-113 were being imported from Du-Pont, USA. Small quantity of (CFC-113, brand name Mafron-113) was also purchased from Navin Flourin Industry in India.

3.7 The mixture of freon with tertiary butyl alcohol (TBA) was the preferred choice of diluting the vydax-1000 for homogenisation and final spraying/coating. The mixture finally is taken into a homogenizer and mixed further at a pressure of 8000 PSI where the particle size get reduced from 30 microns to 1 micron. The blade

are then finally spray coated. The ODS consumption in the cleaning and coating proesses in HLM unit was as follows :-

ODS-Annual Consumption during 1995-96

Process	Solvent	Consumption (Kgs.)	Unit cost CIF(US$/kg)	Annual cost US $
Blade Cleaning Unit	Freon TF	12,000	3.5	42,000
Blade Edge Coating	Freon	6,000	3.5	21,000

3.8 The list of equipments used for ODS based cleaning and coating at HLM unit alongwith specifications and purchase price are indicated below :-

ODS Solvent Equipment at Harbans Lal Malhotra & Sons

List of Equipments	Quantity/Detail	Price (FOB)
1) Ultrasonic Degreaser	1 No.	15 lacs
Manufacturers	ICI	
Cleaning Action	3 stages	
Solvent Chambers	3 Nos.	
Still unit	1 No.	
High Pressure Pumps	2 Nos.	
Solvent Vapor Recovery Unit	1 No.	
2) Blade Edge Coating System	2 Nos.	50 lacs
Manufactuers	Ransberg	
Quantity of Guns	2 Nos.	
Heat Zone, with	2 Nos.	
Exhaust Fan,Transformer, etc.		

List of Equipments	Quantity/Detail	Price (FOB)
3) Anccillary Equipment		Rs 27.30 lacs
Homogenizer	1 No	
Mixing tank	1 No	
Shaker	1 No	
Drying Chamber with Exhaust Fan.	1 No	

3.9 Soon after India signed Montreal Protocol for ozone depleting substances phase out, HLM were concerned about the ODS phase out in their razor blade plant. They started exploring the possible alternative and discussed with various agencies in India and abroad. On the basis of the information available, they started developmental work at inhouse R&D for development of alternate process. The process was standardised in R&D and later through a pilot plant put to semi-commercial use. This shows the seriousness of the HLM about the commitment to phase out ODS. After successfully translating the inhouse process in the semi-commercial unit, now they have approached Department of Electronics (DoE) and Electronics Technology Development and Trade (ET&T) for helping them in prepartion of the project for ODS phase out and financial assistance from Multilateral Fund. The proejct has now been prepared incorporating the alternate technology using non-ODS solvent and worked out as per the guidelines of Montreal Protocol.

CHAPTER - 4

PROJECT DESCRIPTION :

The replacement of ODS in the blade manufacture require alternative processes with extensive engineering know how to carry out tasks such as reliability testing, material compatibility testing, quality consistency and process development, technology selection for alternative cleaning and coating system, site preparation, installation of machinery and staff training etc. This was carefully studied by HLM and selected a suitable technology as an alternate to the existing ODS technology. HLM pursued the developmental work in their inhouse R&D and developed technology based on non-OD solvents and tested in the pilot plant cum semi-commercial plant. Inhouse development of the heat cleaning and coating process has costed HML Rs.150 lacs.

4.2. Technology selection, equipment selection and purchase of alternative cleaning and coating machines.

Harbanslal Malhotra & Sons Ltd. have put considerable efforts in identifying a suitable alternative from ODS to non ODS solvents/technology. It was found that the other chlorinated solvents, (trichloroethylene, perchloroethylene and methylene chloride), aqueous and semi-aqueous cleaning and cleaning with petroleum solvents, ketones and alcohol were found to be acceptable for new alternative technology to phase out the utilisation of ODSs in cleaning processes.

Cleaning process at Harbanslal Malhotra Ltd. Calcutta Plant :

4.3 In the blade technology, the edge surfaces must be free from oil/grease/swaft and any other sort of contamination prior to protective coatings. Water will not be a suitable solvent for precision cleaning of razor blades. Hydrocarbons are still expensive. The best suitable solvents available in the market which could be tried are Trichloroethylene, Perchloroethylene, methylene chlororide, etc. which are non ozone depleting substances and have the least adverse effect on the ground product. Heat cleaning is another process which can produce compatible cleaning to solvent cleaning and has been proved to be an attractive technology. However, this require process standarisation and considerable efforts on developmental study which have been successfully carried out by HLM and the process so developed is ready for commercial exploitation.

Alternative Blade Cleaning System :

4.4 Twin chamber vacuum purged furnaces for Heat cleaning and sintering of Razor Blade Stacks are required to meet

results. Ammonia crackers are required to break ammonia into Hydrogen and Nitrogen. Hydrogen is burnt whereas Nitrogen is used as protective atmosphere which protect the blade for oxidation during heat cleaning. This alternate technology has been developed by HLM in house and the required eqipments, heat cleaning furnaces and accessories have been fabricated by the local fabricators for setting up a pilot plant cum semi-commercial unit. There is high power consumption but no solvent or ozone depleting substances are used in this process. This cleaning process has been proved to be very successful as it has resulted into the product quality of international standard. The new heat cleaning system would cost Rs.152 lacs (US$ 415,000).

Alternative Blade Coating System :

4.5 The existing blade coating system was designed for Freon and tertiary butyl alcohol. The new blade coating system should have following mechanism and ancillary equipments i.e. a complete razor blade coating systems having a fully automatic spray facility and consisting of spray booth equipment, transport conveyor and all power fitting and disconnects. This also include a homogenizer which break the suspension particle size from 30 microns to 01 microns at a high pressure of about 8000 PSI. HLM have conducted studies in their R&D laboratory for an alternate coating process. They have been successful in developing non ODS alternate coating process which has been employed in the semi-commercial unit. The new technology incorporate the change of freon by IPA and TBA mixture. The drying chamber is also attached to vaporize IPA before the sintering process. Presently the retrofits are used on experimental basis in smaller batches. It is now proposed to go in for a new coating system. The cost of coating system would be around Rs.55 lacs (US$ 150,000). The new coating material vydax-1000 has a 20% dispersion of Fluorotelometer solids in IPA and TBA. The amount of vydax-1000/IPA requirement for this plant per annum is same ($ 22,500) as against vydax-1000/CFC-113. The consumption of IPA (Dried IPA) is as follows :-

Estimated Consumption of Non-ODS Solvents (Dried IPA)

Description	Unit	Unit cost US $	Quantity	Cost/Year US $
Dried IPA	Lit	2.2	30,000	66,000

4.6 Ancillary new fire-proof equipments to be installed with their main system are as under :-

1. Homogenizer 1 No
2. Mixing Tank 1 No
3. Shaker 1 No
4. Drying chamber 1 No
5. Fire extinguishing system 1 No

4.7 Due to flammable nature of IPA and ODS free coating solution, the personnel and the coating equipment needs to be properly protected against fire hazards. This can be achieved through installation of an automatic fine water mist fire protection system, which allows to extinguish fires at much lower application rates than a conventional water sprinkler system. This equipment is yet to be installed in HML Calcutta Plant. The cost of the equipment is around Rs.4.5 lacs (US$ 12,000).

Environmental aspects :

4.8 Under this project the Calcutta Plant has been converted to non-ODS cleaning and coating proesses which is technologically accepted world wide. Since the cleaning process involve only heat treatment, no adverse implication to environment are there during cleaning process.

4.9 With regard to the condensed waste, all the contaminants can be easily removed and economically disposed off. No additional cost are needed since the factory normally burns all the wastes.

Site Preparation and installation of Machinery :

4.10 The project includes funding to prepare the sites for the equipment installation. This is for electrical supply and plumbing to ensure safe installation of the equipment. Technical staff of the equipment supplier or their agents in India would help the installation work.

Staff Training :

4.11 Since HLM have developed inhouse process for heat cleaning and coating. The existing Engineers, operators and maintenance personnel have to be trained in operating the new systems.

Project Costs :

4.12 The project costs refers to all costs including incremental recurring costs. The cost of utilities and solvents may differ between project to project in the country. Annexure-I indicates the total project cost of US$ 676,310. The total project incremental cost of US $ 686,390 was calculated as the investment capital cost US $ 676,310 plus the net incremental operating cost of US$ 10,080 for 04 years discounted at 10%.

Capital Investment Cost :

4.13 As given in Annexure-I, the total investment cost is US $ 676,310. The major components of this cost include the purchase, installation of heat cleaning system and Blade Coating Systems with necessary acillary equipments.

Incremental Operating Costs/Savings :

4.14 If the project was not undertaken, the annual operating cost could have been US $ 109,800. Once the project is implemented, the annual operating cost is US $ 112,980, resulting in an additional annual operating cost of US $ 3,180. Given an equipment lifetime of 10 years and discount rate of 10% , the net value of the first 04 years of incremental operating cost is US $ 10,080. The details are provided in Annexure II.

Revenues :

4.15 This project provide to HLM Calcutta with US$ 10,080 as annual incremental costs.

Local Ownership ratio :

4.16 Since the total project incremental cost should be multiplied by the fraction of local ownership i.e 100% to determine the proposed grant amount, so the total proposed mulitlateral fund financing is equal to total project incremental cost i.e. US $ 686,390.

Contingencies :

4.17 The calculations are based on the quotations received, no contangencies have been provided.

Unit Abatement cost (UAC) :

As in Annexure III, the UAC is US $ 7.86 per ODP weighted kilogram of ODS phased out per year. This number is derived from an annualised incremental cost of capital US $ 676,310 and first year incremental annual operating costs of US $ 3,180 and phasing out of 18 MT of CFC-113 (14.4 ODP tons) ODS per year.

Proposed MF Grant :

The proposed MF grant for this project was US $ 686,390 calculated below :

The total investment cost of US $ 676,310 was added with the net present value of the incremental operating costs over the first 04 years of the project which is US $ 10,080. The sum was then multiplied by the 100% Indian ownership ratio of HML Calcutta to yield the same grant of US $ 686,390.

MF Grant Calculation

Total investment cost US $	: 676,310
Incremental Operating costs over the first four years US $	: 10,080
Project preparation cost US $	: 686,390
Propsoed MF grnat US $	: 686,390

Financing Plan :

MF funding is a grant and is limited to the capital and incremental costs as calculated above.

Project Implementation :

The project will be carried out at HLM, Calcutta in co-operation with Ozone Cell, Ministry of Environment and Forests, Government of India. UNIDO will also provide technical assistance to the project during its implementation.

Required Regularory Action :

No regulatory action, other than routine permitting are required to implement this project.

Direct Project Impacts :

The project will eliminated annually 18 MT of ODS (14.4 MT O weighted) at HLM Calcutta.

Annexure I

Breakdown of total investment (capital) cost.

Sl. No	Description of cost item	Unit	Unit cost US $	Qty.	Total cos US $
1.	Cleaning & coating equipment				
	Heat Cleaning System				
1.1	Heat cleaning furnaces with gas supply, pressure system and sintering.	ea	415,000	1	415,000
1.2	Coating unit with attachments.	ea	150,000	1	150,000
	ANCILLARY EQUIPMENT				
1.3	Ammonia cracker for gas generation for firing the furnaces.	ea	40,000	1	40,00
1.4	Mixing tank with agitator	ea	Available	1	-
1.5	Drying Chamber	ea	4,100	1	4,100
1.6.	Homogenizer	ea	27,400	1	27,400
1.7	Exhaust Fan	ea	Available	10	-
1.8	Shaker	ea	1,370	1	1,370
1.9	Power supply	ea	Available	1	-
1.10	Water mist fire protection system	ea	12,000	1	12,000
1.10	Installation costs (Electrical, Piping, water, compressed gas supply, etc.)	ea	8,220	2	16,440
1.11	Training & Engineering material compatibility process developmen, reliability testing etc.	ea	10,000	-	10,000
	TOTAL				676,310

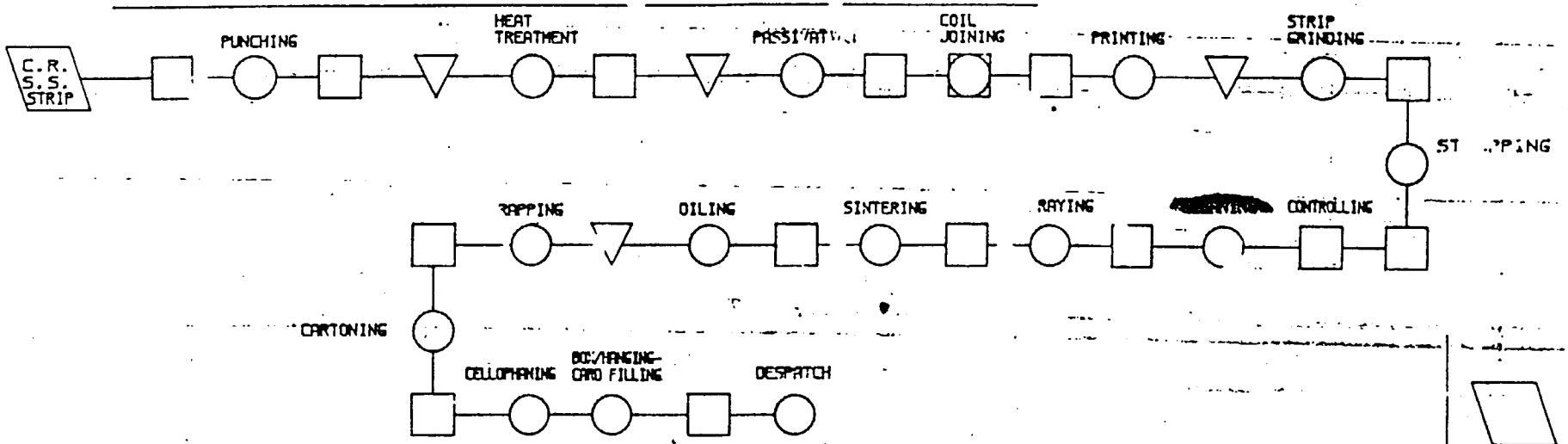
Annuexure II

Breakdown of incremental cost/ savings

	Description of cost item	Unit	Unit cost US$	Qty.	Pre-project cost US$	Post Project cost US$
A.	Solvent/media cost per year					
A.1	CFC-113 (cleaning & coating)	Kg.	4.0	18,000	72,000	-
A.2	Vydax-1000	Kgs.	30.0	750	22,500	22,500
A.3	Krytox	Kgs.	30.0	750	-	
A.4	IPA	Kgs.	2.2	30,000	-	66,000
	Sub Total				94,500	88,500
B.	Electricity cost per year					
B.1	Two systems (coating & cleaning)	KWH	0.10	81,000	8,100	-
B.2	Heat cleaning & IPA coating etc.	KWH	0.10	172,800	-	17,280
	Sub Total				8,100	17,280
C.	Labour costs					
C.1	Labour for cleaing (CFC) and coating system.	w/m	100	6	7,200	-
C.2	Labour for cleaing and coating system (ODS free)	w/m	100	6	-	7,200
	Sub Total				7,200	7,200
TOTAL					109,800	112,980

PROCESS CONTROL

FLOW PROCESS CHART OF DOUBLE EDGE BLADE DIVISION



FLOW PROCESS CHART OF TWIN BLADE DIVISION