UNITED NATIONS

EP

United Nations Environment Programme

Distr.
LIMITED

UNEP/OzL.Pro/ExCom/37/39
19 June 2002

ORIGINAL: ENGLISH

EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Thirty-seventh Meeting
Montreal, 17-19 July 2002

# PROJECT PROPOSALS: INDIA

This document consists of the comments and recommendations of the Fund Secretariat on the following project proposals:

Foam

- Sectoral phase-out plan for elimination of CFCs in the foam sector — UNDP

Process agent

- Sector plan for phasing out of CTC consumption in the chlorinated rubber sub-sector — World Bank

## PROJECT EVALUATION SHEET
## INDIA

| | | | |
|---|---|---|---|
| SECTOR: | Foam | ODS use in sector (2000): | 2,391 ODP tonnes |
| Sub-sector cost-effectiveness thresholds: | | Integral Skin<br>Rigid | US $16.86/kg<br>US $7.83/kg |

***Project Titles***:

(a) Sectoral phase-out plan for elimination of CFCs in the foam sector

| **Project Data** | **Multiple-subsectors** |
|---|---|
| | |
| Enterprise consumption (ODP tonnes) | 639.00 |
| Project impact (ODP tonnes) | 611.00 |
| Project duration (months) | 48 |
| Initial amount requested (US $) | 8,473,050 |
| Final project cost (US $): | |
| Incremental capital cost (a) | 5,825,000 |
| Contingency cost (b) | 582,500 |
| Incremental operating cost (c) | 2,065,550 |
| Total project cost (a+b+c) | 8,473,050 |
| Local ownership (%) | 100% |
| Export component (%) | 0% |
| **Amount requested (US $)** | 8,473,050 |
| Cost effectiveness (US $/kg.) | 13.87 |
| Counterpart funding confirmed? | |
| National coordinating agency | Ministry of Environment & Forests |
| Implementing agency | UNDP |

| ***Secretariat's Recommendations*** | |
|---|---|
| Amount recommended (US $) | |
| Project impact (ODP tonnes) | |
| Cost effectiveness (US $/kg) | |
| Implementing agency support cost (US $) | |
| Total cost to Multilateral Fund (US $) | |

## PROJECT DESCRIPTION

**Sector Background**

| | |
|---|---|
| - Latest available total ODS consumption (2000) | 18,760.46 ODP tonnes |
| - Baseline consumption of Annex A Group I substances (CFCs) | 6,681.00 ODP tonnes |
| - Consumption of Annex A Group I substances for the year 2000 | 5,614.34 ODP tonnes |
| - Baseline consumption of CFCs in foam sector | 2,391.00 ODP tonnes |
| - Consumption of CFCs in foam sector in 2000 | 2,898.00 ODP tonnes |
| - Funds approved for investment projects in foam sector as of end of March 2002 | US $31,858,131.00 |
| - Quantity of CFC approved for investment projects in foam sector as of end of June 2002 | 4,400.90 ODP tonnes |
| - Quantity of CFC phased out from approved investment projects in the foam sector as of end of June 2002 | 3,665.40 ODP tonnes |
| - Quantity of CFC in approved investment projects in the foam sector not yet completed as of end of June 2002 | 736.30 ODP tonnes |
| - Quantity of CFC to be phased out in projects submitted to the 37th Meeting | 611.00 ODP tonnes |

1. As of June 2002, 155 projects (excluding 4 cancelled projects) worth US $31,858,131 have been approved for India to phase out 4,401 ODP tonnes of CFC. These projects are mainly for enterprises producing rigid, integral skin and flexible moulded polyurethane foam. Only five projects have been approved to phase out CFC in the other sub-sectors – one in the phenolic foam sub-sector and four in extruded polyethylene and polystyrene foam sub-sector. Five polyol production and system house activities worth a total of US $1.52 million have also been approved to support India's phase-out programme. Two of the system houses have projects that were approved as components of umbrella projects for SMEs.

2. UNDP's analysis of the sector consumption of CFCs shows a total consumption of 639 ODP tonnes of CFC-11 remaining in the sector, out of which 612 ODP tonnes consumed by 99 enterprises is considered to be eligible for funding. 27 ODP tonnes consumed by 27 SMEs is not considered as eligible for funding.

**Sectoral Phase-out Plan for of Elimination of CFCs in the Foam Sector in India**

3. UNDP has submitted on behalf of the Government of India a sectoral plan for the phase-out of the remaining fundable CFCs in the foam sector. The objectives of the plan are as follows:

(a) To achieve complete phase-out of CFCs in the foam sector in India within four years;

(b) To enable India to meet its obligations of phased ODS reductions in accordance with the control schedule of the Montreal Protocol;

(c) To ensure timely, sustainable and cost-effective CFC phase-out in the foam sector, through development and implementation of a combination of investment, technical support and management components.

4. A total amount of US $8,473,050 is requested to phase out 611.8 ODP tonnes CFC-11 with a residual ODP of 24.01 as a result of the use of HCFC-141b, resulting in a cumulative cost-effectiveness of US $14.42/kg. This amount is made up of:

| | **US $ (including 10% contingency)** |
|---|---|
| CFC phase-out project component | 6,592,050 |
| Systems house component | 891,000 |
| Technical support | 440,000 |
| Management component | 550,000 |
| **Total** | 8,473,050 |

Identification of Eligible Enterprises

5. Using resources from funds approved at the 13th Meeting in July 1994 for UNDP to prepare a strategy and action plan for ODS phase-out in the foam sector in India, UNDP in collaboration with the Ministry of Environment and Forests (MOEF) made a number of public and newspaper announcements to identify the remaining users of CFC in the sector. Surveys and workshops were carried out in the sector resulting in projects, some of which have already been submitted for funding. Status reports on the survey submitted by UNDP is available on request.

6. This sector plan is a result of continuing interactions involving upstream suppliers, government departments, foam manufacturers and UNDPs local and international experts. Two identification and technical assistance workshops were organized as a way of maximizing the identification of CFC user enterprises. Over 95% of the enterprises are reported to have been visited by UNDPs local and international consultants. Figures obtained through the survey were correlated with records of domestic ODS sales from distributors and traders, and upstream chemical suppliers to the extent available. UNDP expects the margin of error in the survey to be less than 5%. A total of 132 enterprises consuming 638.8 ODP tonnes CFC-11 of which 99 foam producing enterprises consuming 611 ODP tonnes and 6 system houses were identified as eligible for funding. The summary of the eligible enterprises by sub-sector is shown in Table 1 below. A list of all the eligible enterprises is attached.

**Table 1: Remaining Eligible CFC Consumption in the Foam Sector in India**

| Sub-sector | Number of remaining eligible enterprises | CFC consumption in 2001 (MT) |
|---|---|---|
| Rigid foam (general insulation) | 5 | 56.7 |
| Rigid foam (thermoware insulation) | 12 | 116.5 |
| Rigid foam (spray/in situ insulation) | 14 | 114.2 |
| Rigid foam (SMEs)* | 40* | 94.1 |
| Flexible moulded & integral skin foam | 28 | 230.3 |
| **Total** | 99 | 611.8 |

* Enterprises with less than 5 tonnes/year of CFC consumption

Enterprise Baseline

7. The five enterprises producing insulated boxes, pipes, slabs and panels and the 12 enterprises producing thermoware products all use low pressure dispensers. All the sprayfoam producers except one use high pressure Polycraft or Gusmer sprayfoam machines. However, all the 40 SME rigid foam producers use hand mixing operations. The 28 moulded foam producers use low pressure dispensers except two enterprises which use high pressure dispensers.

Phase-out Approach

8. The phase-out approach is based on the premise that:

- Fifty-four per cent of the foam enterprises in India for which investment projects have been approved have been part of six group projects, including four SME group projects indicating the viability of the approach;
- All enterprises covered in these projects are essentially small- or medium-sized with individual baseline consumption levels less than 20 tonnes/year, most of them with less than 5 tonnes/year;

9. Concluding that the group approach has been proven to be effective in terms of coverage of the enterprises, cost-effectiveness and CFC phase-out, this group approach based on project by project calculation is adopted as the modality for phasing out the remaining fundable consumption in the foam sector.

Choice of Technology

10. HCFC-141b technology is selected as the most appropriate technology for all the rigid and integral skin foam projects within the plan, while fully water-blown technology will be used in the flexible moulded foam projects. This involves the replacement of low pressure foam dispensers as well as hand mixing operations with high pressure dispensers for the rigid foam producers, and retrofit of the existing dispensers for the sprayfoam and flexible moulded foam producers.

Calculation of Project Costs

11. Based on the selected approach and technology choice the incremental capital costs were calculated for each individual enterprise using standard cost components, namely:

| | |
|---|---|
| New high pressure dispenser | US $20,000 - US $80,000 |
| Retrofit costs | US $7,500 - US $15,00 |
| Trials | US $2,500 - US $10,000 |
| Training | US $2,500 - US $10,000 |
| Technical assistance | US $5,000 - US $10,000 |

12. The incremental operating costs were also calculated for each group of projects based on chemical system prices used in approved Indian projects, and using average historical unit incremental operating cost for each sub-sector. These calculations resulted in the following amounts.

**Table 2: Calculated costs of the CFC Phase-out Projects Based on the Assumptions in the Phase-out Plan**

| Sub-sector | No of enterprises | Baseline CFC consumption (tonnes) | Project impact (tonnes) | ICC (US $) | IOC (US $) | ICC + 10% contingency (US $) | Total Project Cost (US $) | Project Cost-effectiveness (US $/kg) | Cost-effectiveness threshold |
|---|---|---|---|---|---|---|---|---|---|
| Rigid foam (general insulation) | 5 | 56.70 | 53.30 | 525,000 | 91,174 | 577,500 | 586,674 | 11.00 | 7.83 |
| Rigid foam (SMEs) | 40 | 94.10 | 87.33 | 1,200,000 | 157,712 | 1,320,000 | 1,477,712 | 16.92 | 7.83 |
| Rigid foam (spray/in situ) | 14 | 114.20 | 107.35 | 385,000 | 331,294 | 423,500 | 754,794 | 7.03 | 7.83 |
| Rigid foam (thermoware) | 12 | 116.50 | 109.51 | 840,000 | 203,060 | 924,000 | 1,127,060 | 10.29 | 7.83 |
| Flexible moulded & integral skin foam | 28 | 230.30 | 230.30 | 1,120,000 | 1,282,310 | 1,232,000 | 2,515,310 | 10.91 | 16.83 |
| **Total** | **99** | **611.80** | **587.79** | **4,070,000** | **2,065,550** | **4,477,000** | **6,461,550** | | |

Other Components of the Requested Grant

13. In addition to the cost of the CFC phase-out projects, funds are requested for 6 system house operations at US $135,000 per system house and technical and management support cost

of a total of US $990,000 including 10% contingency. The details of the additional costs are as follows:

| | US $ including 10% contingency |
|---|---|
| Funding for 6 system houses @ US $135,000 each | 891,000 |
| Technical support costs: | |
| Establishment of product and quality standards for various foam products and applications | 110,000 |
| User industry interactions for technology assistance for applications through technical workshops and meetings | 220,000 |
| Training, certification and licensing programme for foam technicians | 110,000 |
| Management costs: | |
| Management unit establishment and operation | 110,000 |
| Awareness creation and information dissemination activities | 110,000 |
| Verification and certification | 110,000 |
| Reporting | 55,000 |
| Monitoring mechanism | 165,000 |
| **Total** | 1,881,000 |

Summary

14. The table below provides a summary of the cost of the plan including amounts requested for system houses and for technical support and management costs based on the Secretariat's calculations above.

| | US $ |
|---|---|
| Cost of CFC phase-out projects | 6,461,550 |
| Amount requested for system houses | 891,000 |
| Amount requested for technical support | 440,000 |
| Amount requested management support | 550,000 |
| Total | 8,342,550 |
| Cumulative project impact: | 587.79 |
| Cumulative cost-effectiveness | 14.19 |

Implementation

15. The following performance and disbursement schedule has been proposed for the implementation of the plan.

**Table 3: Performance and Disbursement Schedule**

The total requested grant funding is US $8,473,050.

| Year | ODS phase-out target (MT) | | | Remaining ODS Consumption (MT) | Disbursement (US$) |
|---|---|---|---|---|---|
| | From approved ongoing projects | From Sectoral Phase-out Plan | Total | | |
| 2002 | 221 | 0 | 221 | 1,434 | 2,000,000 |
| 2003 | 497 | 0 | 497 | 937 | 2,500,000 |
| 2004 | 298 | 210 | 508 | 429 | 2,100,000 |
| 2005 | 0 | 301 | 301 | 128 | 1,500,000 |
| 2006 | 0 | 128 | 128 | 0 | 373,050 |
| **TOTAL** | **1,016** | **639** | **1,655** | **1,655** | **8,473,050** |

16. The plan foreshadows the following events:

- The first disbursement of US $900,000 covering the Management and Technical Support Components is due upon Plan approval (assumed by July 2002).
- The annual performance progress report for each year will be due for submission in the first quarter of the following year.
- The disbursement for each year shall be made in advance, due in the first quarter, upon receipt and acceptance of the annual performance progress report for the preceding year and implementation plan for the current year.

Justification for the use of HCFC-141b

17. UNDP stated that prior to the preparation of the proposal its experts apprised the prospective recipient participating enterprises in the rigid polyurethane foam sub-sector and had detailed discussions with the technical and managerial personnel of the enterprises, regarding the choice of technology for replacing the existing CFC-based technology, under the project. The enterprises were briefed in detail about the following:

1. The available interim (low ODP) and permanent (zero ODP) replacement technologies.
2. The techno-economic impact of each technology on the products manufactured, and the processes and practices employed by them.

3. The possible implication of each technology, in terms of its known impact on environment, health and safety, such as ozone depleting potential, global warming potential, occupational health, fire and explosion hazards.
4. It was emphasized to them that HCFC technologies are interim in nature due to their residual ODP and therefore may continue to adversely affect the environment, though at a lower scale than CFCs.
5. It was further explained that HCFCs use may become restricted under present or future international conventions and may also need to be phased out at a future date, and any investments required for their phase-out and for conversion to safer technologies, may have to be borne by them.

18. UNDP also indicated that the enterprises selected HCFC-141b-based technology after considering the commercial, safety and operational difficulties and costs of the hydrocarbon-based and water-based technologies. HCFC-141b assured them quicker phase-out while maintaining the competitiveness of their products and the properties at acceptable level. It was not found feasible to address Decision 36/56 (c) under this sector plan.

19. The Government of India has endorsed the use of the HCFC-141b by the enterprises.

## SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

### COMMENTS

20. In view of the fact that India chose to determine the eligible cost of the plan based on a project-by-project approach rather than any discernible strategy, where, for instance, a mix of regulatory and other instruments and investment activities lead to cost rationalization, the Secretariat advised UNDP that the plan would be reviewed on a project-by-project basis consistent with the rules of the Multilateral Fund. The plan was therefore reviewed against the background of foam projects approved for India as well as completion reports received from the implementing agencies on foam projects completed in India.

21. The Secretariat's analysis of the requested funds in relation to foam projects approved for India indicated that the cost-effectiveness values of the sub-sectors in the plan were much higher than the sub-sector cost-effectiveness thresholds or weighted average cost-effectiveness of similar projects approved for India in those sub-sectors. The table below shows a comparison between the weighted average cost-effectiveness and the cost-effectiveness of the funds being requested under the plan.

| Sub-sector | Weighted Average Cost-effectiveness of Approved Projects for India US $/kg | Cost-effectiveness in the India Foam Sector Plan US $/kg |
|---|---|---|
| Rigid foam (excluding SMEs) | 6.22 | 10.09 |
| Rigid foam (spray/in situ, umbrella projects) | 4.76 | 7.03 |
| Rigid foam (SMEs) | 6.01 | 16.92 |
| Integral skin foam | 9.16 | 10.91 |

22. Based on the analysis of available foam sector project completion reports (PCRs) the prices of the foam dispensers as indicated in the sector plan for rigid foam projects were endorsed and used in the Secretariat's calculation of eligible incremental costs. On the same basis, the costs of trials were established as US $3,000 - US $8,000, while those of technical assistance were US $2,000-US $4,000. The PCRs showed that there were generally no training costs. All the factors and assumptions used by UNDP to calculate the incremental operating costs were maintained by the Secretariat's calculations.

23. The Secretariat's calculation of the eligible incremental cost of CFC phase-out projects for the 99 enterprises in the plan based on the above considerations resulted in an amount of US $4,753,577 with an overall cost-effectiveness of US $8.09/kg. The breakdown is as follows:

| Project Component | No. of enterprises | CFC consumption ODP tonnes | Impact ODP tonnes | Project Grant US $ | Cumulative cost-effectiveness US $/kg |
|---|---|---|---|---|---|
| Rigid Foam: | | | | | |
| General insulation | 5 | 56.70 | 53.3 | 417,323 | 7.83 |
| Thermoware insulation | 12 | 116.50 | 109.51 | 853,106 | 7.79 |
| Spray/in situ | 14 | 114.20 | 107.35 | 600,799 | 5.60 |
| SME | 40 | 92.90 | 87.33 | 683,739 | 7.83 |
| Sub-total rigid foam | 71 | 380.30 | 357.49 | 2,554,967 | 7.15 |
| | | | | | |
| Integral skin/flexible moulded foam | 28 | 230.30 | 230.30 | 2,198,610 | 9.55 |
| **TOTAL** | **99** | **610.60** | **587.99** | **4,753,577** | **8.09** |

Other Cost Components

Systems House

24. Five systems house projects have been approved in support of India's CFC phase-out. Two of the projects were specifically approved as components of SME projects to provide systems and provide technical support to their identified downstream customer enterprises in order to expedite their CFC phase-out. Systems house activities by themselves do not result in

ODS consumption or phase-out. They are also not substitute production activities which are eligible for funding under the Protocol. Therefore systems house projects by themselves would not be eligible for funding except when such projects were used as instrument of project implementation and a means of enhancing project cost-effectiveness of downstream foam producers as well as their rate of CFC phase-out. This has been the case in systems house projects approved in countries such as Brazil, Colombia, India and Mexico. There is no evidence in the document that such is the case with the six system house projects proposed in the plan for funding at a total cost of US $891,000.

Technical Support and Management Costs

25. The Secretariat observed that some of the cost items such as establishment of product and quality standards may not be eligible or that project-by-project implementation modality could introduce some degree of double counting in funding of some of these ancillary costs. However, it was proposed that an amount of US $150,000 could be considered to assist the National Ozone Unit (NOU) in the monitoring of the programme.

Conclusion

26. On the basis of the foregoing, the amount of US $4,903,577, including US $150,000 to the NOU for monitoring activities was recommended to UNDP for consideration with the Government of India as the eligible incremental cost of the sector plan. As of this writing, the Secretariat had not received a response from UNDP.

**RECOMMENDATIONS**

27. Pending.

**INDIA – FOAM SECTOR: LIST OF REMAINING ELIGIBLE ENTERPRISES**

**Table A.1: Rigid foam (general insulation) sub-sector**

| No | Enterprise name | Location | Year established | Products | CFC Consumption (MT) | Baseline equipment |
|---|---|---|---|---|---|---|
| 1 | Aakriti Ice Box Co. | Delhi | 1989 | Insulated boxes | 12.1 | 1 LPD – Local |
| 2 | HR Innovations | Mumbai | 1991 | Insulated doors | 9.7 | 1 LPD – Polycraft |
| 3 | Kakar Trading Co. | Delhi | 1987 | Slabs, pipe/sect | 11.0 | 1 LPD – Local |
| 4 | Patton Tanks | Calcutta | 1982 | Insulated tanks | 7.8 | 1 LPD – Klowpur |
| 5 | Suchi Foams | Ahmedabad | 1994 | Panels | 16.1 | 1 LPD – Klowpur |
| **TOTAL** | | | | | **56.7** | **5 LPDs** |

**Table A.2: Rigid foam (thermoware insulation) sub-sector**

| No | Enterprise name | Location | Year established | Products | CFC Consumption (MT) | Baseline equipment |
|---|---|---|---|---|---|---|
| 1 | Aakar Industries | Noida | 1991 | Thermoware | 11.3 | 1 LPD – Local |
| 2 | Anmol Plast | Delhi | 1991 | Thermoware | 10.6 | 1 LPD – Local |
| 3 | Atul Marketing | Delhi | 1992 | Thermoware | 6.5 | 1 LPD - Local |
| 4 | Balaji Plastics | Delhi | 1987 | Thermoware | 8.0 | 1 LPD – Local |
| 5 | CL Plastics | Delhi | 1988 | Thermoware | 11.0 | 1 LPD – Local |
| 6 | Indus Plast | Sahranpur | 1990 | Thermoware | 9.8 | 1 LPD – Local |
| 7 | Jupiter Engineering | Vapi | 1991 | Thermoware | 9.5 | 1 LPD - Cannon |
| 8 | Mukesh Plastic Engineering | Delhi | 1984 | Thermoware | 8.5 | 1 LPD – Local |
| 9 | Neelam Plastic Industries | Mumbai | 1973 | Thermoware | 9.6 | 1 LPD – Local |
| 10 | Payal Products | Delhi | 1987 | Thermoware | 9.2 | 1 LPD – Local |
| 11 | Pradeep Polymers | Delhi | 1993 | Thermoware | 10.7 | 1 LPD – Local |
| 12 | Thermoplast Industries | Mumbai | 1995 | Thermoware | 11.8 | 1 LPD - Local |
| **TOTAL** | | | | | **116.5** | **12 LPDs** |

**Table A.3: Rigid foam (spray/insitu insulation) sub-sector**

| No | Enterprise name | Location | Year established | Products | CFC Consumption (MT) | Baseline equipment |
|---|---|---|---|---|---|---|
| 1 | Alpha Insulation | Ahmedabad | 1991 | Spray/Insitu | 6.5 | 1 HPD – Polycraf |
| 2 | Amijit Enterprises | Mumbai | 1994 | Spray/Insitu | 5.8 | 1 HPD – Polycraft |
| 3 | Bright Insulations | Delhi | 1979 | Spray/Insitu | 7.6 | 1 HPD – Polycraft |
| 4 | Enecon Engineers | Mumbai | 1987 | Spray/Insitu | 7.5 | 1 HPD – Polycraft |
| 5 | Insulations India | Vapi | 1988 | Spray/Insitu | 9.5 | 1 HPD – Gusmer |
| 6 | Insultech Enterprises | Yamunangr | 1989 | Spray/Insitu | 6.5 | 1 HPD – Polycraft |
| 7 | Jaya Enterprises | Mumbai | 1995 | Spray/Insitu | 8.4 | 1 HPD – Gusmer |
| 8 | Kwality Insulations | Delhi | 1990 | Spray/Insitu | 8.5 | 1 HPD – Polycraft |
| 9 | Narmada Insulations | Delhi | 1993 | Spray/Insitu | 10.5 | 1 HPD – Polycraft |
| 10 | Om Insulations | Mumbai | 1995 | Spray/Insitu | 8.0 | 1 HPD – Gusmer |
| 11 | Pravin Enterprises | Vadodara | 1991 | Spray/Insitu | 8.5 | 1 HPD – Polycraft |
| 12 | Professional Insulations | Gurgaon | 1990 | Spray/Insitu | 10.8 | 3 HPD – Gusmer |
| 13 | SD Polyurethane Enterp | Ghaziabad | 1987 | Spray/Insitu | 6.6 | 1 HPD - Polycraft |
| 14 | Witco | Vadodara | 1993 | Spray/Insitu | 9.5 | 1 LPD – Klowpur |
| **TOTAL** | | | | | **114.2** | **15 HPDs, 1 LPD** |

**Table A.4: Rigid foam (SMEs) sub-sector**

| No | Enterprise name | Location | Year established | Products | CFC Consumption (MT) | Baseline equipment |
|---|---|---|---|---|---|---|
| 1 | Advance FRP | Mumbai | 1983 | RPUF General | 2.5 | Hand mixing |
| 2 | AG Insulators | Noida | 1994 | RPUF General | 2.1 | Hand mixing |
| 3 | Arci Engineers | Mumbai | 1985 | RPUF General | 2.4 | Hand mixing |
| 4 | Babylon Plast | Mumbai | 1995 | Thermoware | 2.4 | Hand mixing |
| 5 | Beegee Enterprises | Dadanagar | 1993 | Thermoware | 1.9 | Hand mixing |
| 6 | Bhagwati Plastics | Delhi | 1993 | Thermoware | 2.3 | Hand mixing |
| 7 | Bharat Traders | Mumbai | 1992 | RPUF General | 2.5 | Hand mixing |
| 8 | Bhoopaty Associates | Chennai | 1986 | RPUF General | 2.5 | Hand mixing |
| 9 | Chemisol Industries | Vapi | 1991 | RPUF General | 2.0 | Hand mixing |
| 10 | Citizen Industries | Ahmedabad | 1991 | Thermoware | 2.2 | Hand mixing |
| 11 | Craftway Engineers | Mumbai | 1990 | Thermoware | 2.4 | Hand mixing |
| 12 | Eaphael Industries | Delhi | 1981 | Thermoware | 2.6 | Hand mixing |
| 13 | Emcee | Ludhiana | 1981 | RPUF General | 2.0 | Hand mixing |
| 14 | Ethos Systems | Ahmedabad | 1995 | RPUF General | 2.2 | Hand mixing |
| 15 | Gautam Industries | Delhi | 1991 | Thermoware | 2.0 | Hand mixing |
| 16 | Gem Ply Systems | Mumbai | 1993 | RPUF General | 2.9 | Hand mixing |
| 17 | HPN Industries | Bangalore | 1991 | RPUF General | 2.0 | Hand mixing |
| 18 | Jain Plast | Mumbai | 1994 | Thermoware | 2.4 | Hand mixing |
| 19 | Jay Vee Cee Corporation | Mumbai | 1995 | RPUF General | 2.5 | Hand mixing |
| 20 | Jonex Rubber Industries | Jalandhar | 1989 | RPUF General | 2.0 | Hand mixing |
| 21 | Malabar Thermoware | Bangalore | 1994 | Thermoware | 3.0 | Hand mixing |
| 22 | Mayur Extrusions | Sarigam | 1992 | Thermoware | 3.0 | Hand mixing |
| 23 | Modern Flask | Mumbai | 1990 | Thermoware | 2.4 | Hand mixing |
| 24 | Nissan Doors | Mumbai | 1985 | RPUF General | 2.2 | Hand mixing |
| 25 | Palmline Plastics | Mumbai | 1994 | Thermoware | 2.5 | Hand mixing |
| 26 | Pawan Procast | Mumbai | 1995 | RPUF General | 1.8 | Hand mixing |
| 27 | Polyfoam Industries | Mumbai | 1995 | RPUF General | 1.8 | Hand mixing |
| 28 | Ram Enterprises | Bangalore | 1994 | RPUF General | 2.2 | Hand mixing |
| 29 | Reliance Engineers | Mumbai | 1987 | RPUF General | 2.4 | Hand mixing |
| 30 | Sanjay Metals | Mumbai | 1994 | Thermoware | 2.2 | Hand mixing |
| 31 | Sharda Construction | Mumbai | 1994 | RPUF General | 2.5 | Hand mixing |
| 32 | Sharp Industries | Mumbai | 1989 | RPUF General | 2.5 | Hand mixing |
| 33 | Sheth Fabricators | Mumbai | 1992 | RPUF General | 2,8 | Hand mixing |
| 34 | Shreya Insulations | Bilimora | 1990 | RPUF General | 2.7 | Hand mixing |
| 35 | SM Polymers | Faridabad | 1994 | RPUF General | 2.0 | Hand mixing |
| 36 | Spark Allied Industries | Bangalore | 1992 | RPUF General | 2.2 | Hand mixing |
| 37 | SS Enterprises | Mumbai | 1995 | Thermoware | 1.7 | Hand mixing |
| 38 | Sri Venkateshwara Ind | Bangalore | 1995 | RPUF General | 2.0 | Hand mixing |
| 39 | Toshbro Industries | Daman | 1994 | RPUF General | 2.7 | Hand mixing |
| 40 | Tristar | Mumbai | 1994 | RPUF General | 2.5 | Hand mixing |
| **TOTAL** | | | | | **94.1** | **No Foam Dispensers** |

**Table A.5: Flexible Molded/Integral Skin foam sub-sector**

| No | Enterprise name | | Year established | Products | CFC Consumption (MT) | Baseline equipment |
|---|---|---|---|---|---|---|
| 1 | ABH Industries | Valsad | 1994 | FMF | 4.5 | 1 LPD – Local |
| 2 | APL Corporation | Chennai | 1994 | FMF/ISF | 7.5 | 2 LPD – Cannon/SAIP |
| 3 | AS Polymers | Ambala | 1994 | FMF | 6.0 | 1 LPD – Local |
| 4 | Bhutani Industries | Gurgaon | 1994 | FMF | 10.5 | 1 LPD – Cannon |
| 5 | Crypton Industries | Calcutta | 1991 | FMF/ISF | 7.5 | 1 HPD – Hennecke |
| 6 | Durotex Polymers | Coimbatore | 1993 | FMF | 4.8 | 1 LPD – Local |
| 7 | Foam India | Tiruchirapali | 1994 | FMF | 9.5 | 1 LPD – Local |
| 8 | Foam Products | Bangalore | 1984 | FMF | 5.4 | 1 LPD – Local |
| 9 | Gopsy Rubber Industries | Mumbai | 1990 | FMF | 4.8 | 1 LPD – Local |
| 10 | Indrayani Udyog | Nagpur | 1994 | FMF | 12.5 | 1 LPD – Local |
| 11 | Jindal Petrofoams | Ambala | 1994 | FMF | 4.5 | 1 LPD – Local |
| 12 | Joginder Singh | Ludhiana | 1965 | FMF | 6.0 | 1 LPD – Local |
| 13 | Koyas Polymers | Coimbatore | 1971 | FMF | 11.0 | 1 LPD – Elastogran |
| 14 | Kvik Thermofoam | Mumbai | 1990 | FMF | 8.3 | 1 LPD – Local |
| 15 | Lux Autofoam | Coimbatore | 1994 | FMF | 6.6 | 1 LPD – Local |
| 16 | National Polymers | Mumbai | 1992 | FMF | 4.0 | 1 LPD – Local |
| 17 | Omega Lining | Coimbatore | 1992 | FMF | 13.5 | 1 LPD – Local |
| 18 | Poly Crafts | Delhi | 1987 | FMF | 10.4 | 1 LPD – Hennecke |
| 19 | Premier Industries | Medak | 1995 | FMF | 14.1 | 1 LPD/Local, 1 HPD Henn |
| 20 | Pyarelal Foams | Meerut | 1994 | FMF | 12.0 | 1 LPD – Local |
| 21 | Sigma Industries | Delhi | 1993 | FMF/ISF | 13.6 | 1 LPD – KWI |
| 22 | Siddhi Vinayak Polymers | Jalandhar | 1994 | FMF | 12.4 | 2 LPD – OMS/Indipuf |
| 23 | Sunpreet Engineers | Chennai | 1995 | FMF | 4.8 | 1 LPD – Local |
| 24 | Surbhi Polymers | Delhi | 1993 | FMF | 9.7 | 1 LPD – Local |
| 25 | Transval Manufacturing | Chennai | 1994 | FMF | 4.8 | 1 LPD – Local |
| 26 | Urethane Specialties | Hyderabad | 1993 | FMF | 9.0 | 1 LPD – OMS |
| 27 | Vam Polyplast | Hyderabad | 1989 | FMF | 8.0 | 1 LPD – Graco |
| 28 | Vicktra Polyfoams | Chennai | 1995 | FMF | 4.6 | 1 LPD – Local |
| **TOTAL** | | | | | **230.3** | **28 LPDs, 2 HPDs** |

**NOTES:**
1. All enterprises mentioned as established in 1995 in Tables 2.1 to 2.5, commenced operations prior to July 1995.
2. It has been ensured that there has been no double counting of enterprises.

**Table A.6: Summary**

| Sub-sector | Number of Enterprises | CFC Consumption (MT) |
|---|---|---|
| Rigid foam (general insulation) | 5 | 56.7 |
| Rigid foam (thermoware) | 12 | 116.5 |
| Rigid foam (spray/insitu) | 14 | 114.2 |
| Rigid foam (SMEs) | 40 | 94.1 |
| Flexible molded & integral skin foam | 28 | 230.3 |
| **TOTAL** | **99** | **611.8** |

# GOVERNMENT NOTE OF TRANSMITTAL OF INVESTMENT PROJECTS TO THE EXECUTIVE COMMITTEE OF THE MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL

## PROJECT OF THE GOVERNMENT OF INDIA

The Government of India requests UNDP to submit the Sectoral Phase-out Plan for elimination of CFCs in the Foam Sector in India to the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol for consideration at its 37th Meeting. (project copy is enclosed)

### Section I: ODS Consumption Data

1. The ODS consumption figure of the project has been validated by the National Ozone Unit (NOU).

2. The consumption data have been retained in the records of the NOU for reference and/or future verification.

3. The Government has been advised by the NOU that the agreement to the project indicates a commitment to ensure that the validated phase-out figure was realized and yielded a sustained reduction from the 2000 consumption of 2898 ODS metric tonnes for the foam sector.

**Table 1: Project Submitted to the 37th Meeting of the Executive Committee**

| No. | Name of Recipient Enterprise | Sector/Sub-Sector | ODS phaseout (ODP-MT) | Grant Requested (US$) | Imple-menting Agency |
|---|---|---|---|---|---|
| 1. | Sectoral Phase-out Plan for elimination of CFCs in the Foam Sector in India with an indicative list of industries. Remaining industries will be added to the list after the last date of registration of enterprises using ODS i.e. 19th July 2002. | Foam Sector | 611 | 8,473,050 | UNDP |

### Section II: Other Relevant Actions Arising from Decision 33/2

4. It is understood that, in accordance with the relevant guidelines, the funding received for a project would be partly or fully returned to the Multilateral Fund in cases where technology was changed during implementation of the project without informing the Fund Secretariat and without approval by the Executive Committee;

5. The National Ozone Unit undertakes to monitor closely, in cooperation with customs authorities and the environmental protection authorities, the importation and use of CFC and to combine this monitoring with occasional unscheduled visits to importers and recipient manufacturing companies to check invoices and storage areas for unauthorized use of CFC.

6. The National Ozone Unit will cooperate with the relevant implementing agencies to conduct safety inspections where applicable and keep reports on incidences of fires resulting from conversion projects.

**Section III: Projects Requiring the Use of HCFCs for Conversion**

7. In line with Decision 27/13 of the Executive Committee and in recognition of Article 2F of the Montreal Protocol, the Government

(a) has reviewed the specific situations involved with the project *(as per the indicative list of enterprises and additional enterprises which will be added after 19th July 2002)* as well as its HCFC commitments under Article 2F; and

(b) has nonetheless determined that, at the present time, the projects needed to use HCFCs for an interim period with the understanding that no funding would be available for the future conversion from HCFCs for the company/companies involved.

Name: Usha Chandrasekhar
Designation: Director (Ozone Cell)
Telephone: 91-11-4642176
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**E-mail:** **ozone@del3.vsnl.net.in**

Date: 24th April, 2002

# PROJECT EVALUATION SHEET
# INDIA

SECTOR: Process agent ODS use in sector (2000): 4,067 ODP tonnes

Sub-sector cost-effectiveness thresholds: n/a

***Project Titles***:

(a) Sector plan for phasing out of CTC consumption in the chlorinated rubber sub-sector

| **Project Data** | **Process conversion** |
|---|---|
| | |
| Enterprise consumption (ODP tonnes) | |
| Project impact (ODP tonnes) | 382.00 |
| Project duration (months) | 36 |
| Initial amount requested (US $) | 18,066,845 |
| Final project cost (US $): | |
| Incremental capital cost (a) | |
| Contingency cost (b) | |
| Incremental operating cost (c) | |
| Total project cost (a+b+c) | 22,533,153 |
| Local ownership (%) | 100% |
| Export component (%) | 30.4% |
| **Amount requested (US $)** | 18,066,845 |
| Cost effectiveness (US $/kg.) | 47.30 |
| Counterpart funding confirmed? | |
| National coordinating agency | Ministry of Environment and Forest |
| Implementing agency | World Bank |

| ***Secretariat's Recommendations*** | |
|---|---|
| Amount recommended (US $) | |
| Project impact (ODP tonnes) | |
| Cost effectiveness (US $/kg) | |
| Implementing agency support cost (US $) | |
| Total cost to Multilateral Fund (US $) | |

## PROJECT DESCRIPTION

Sector plan for phasing out of CTC consumption in the chlorinated rubber sub-sector

Objective

28. On behalf of the Government of India, the World Bank has submitted to the 37th Meeting a proposed sub-sector plan for completion of the phase out of CTC used as a process agent in the manufacture of chlorinated rubber in India.

29. The World Bank has advised that the objective of the sub-sector plan is to completely phase out the remaining CTC consumption of about 382 ODP tonnes, and avoid 2,878 ODP tonnes of projected CTC consumption, in the chlorinated rubber industry in India.

30. The plan proposes process conversions at two plants, Rishiroop Rubber International Limited (RRIL) and Rishiroop Polymers Limited (RPL) and closure of two smaller plants. Total incremental costs for conversion and closure of US$19,942,183 are proposed at a cost effectiveness of US $52.20 per kg. Phase out of 249 ODP tonnes of CTC at the fifth chlorinated rubber plant in India, Rishiroop Organics Limited (ROL), was addressed through a project approved at the 34th Meeting.

31. A copy of the complete proposal is attached to this document (Annex I).

Components and implementation

32. The plan has two components, plant closure and plant conversion as indicated above. The two components will be implemented by the end of 2004 to complete the phase-out. The sub-sector plan does not contain any supplementary technical assistance or management activities. It is indicated that the sub-sector plan will be implemented by the chlorinated rubber producers in India.

Incremental cost

33. The proposal presents calculation of costs for four options: plant closure, plant conversion, emission abatement and industrial rationalisation. The latter option, combining two plant closures and two plant conversions, at full installed capacity, is calculated to be the most cost-effective option.

34. Incremental costs of US $2,909,947 are requested for closure of two plants with a total capacity indicated in the proposal as 450 tonnes per year and actual production of 71 tonnes per year. The requested costs are based on lost profits and labour compensation. Lost profit calculations use a 1995-1997 production baseline, unconstrained growth until 2010 (12 percent), three percent inflation and a seven percent discount rate on the profit stream.

35. Incremental costs of US $18,260,359 are requested for the two plant conversions with a total production capacity of 5050 tonnes and actual production of 507 tonnes per year. These costs are before allowance for exports, which is applied to the overall sub-sector plan.

36. The plan includes separate sub-project proposals for conversion of RRIL and RPL. The proposals are based on replacement of most of the process equipment and infrastructure at a capital cost of US $15,496,083 for RRIL and US $2,612,447 for RPL. Incremental operating costs of US $161,829 are wholly associated with RRIL because RPL has not been in production since 1995.

37. The Government of India has requested full flexibility on how the proposed funds are utilised and distributed, providing that CTC consumption in the sub-sector is phased out as planned.

## SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

## COMMENTS

38. Funding of US $200,000 was provided for the World Bank and for UNIDO at the 33rd Meeting to prepare a sector plan for the process agent sector in India. The World Bank was to be responsible for assisting India in development of the overall sector plan, including all sub-sectors, with the aim of being able to submit it to the Executive Committee at its 35th Meeting. The World Bank was asked to indicate the status of preparation of the overall sector plan.

39. This proposal is for phase-out in one process agent sub-sector, namely chlorinated rubber. There will be no annually implemented performance agreement, other than the phase-out of consumption in the three enterprises now consuming CTC in the manufacture of chlorinated rubber, and payments are not sought in tranches. It is not therefore a sector plan as currently understood. Since the proposal is fundamentally a project for conversion of only one producing plant, RRIL (see below) and the closure of two small plants, the notion of flexibility may not be applicable here. The World Bank considers that all the characteristics of a sector plan are included and therefore it should have the same flexibility as other sector plans.

<u>Chlorinated rubber market: Chapters 1 to 3 of the project document</u>

40. The main purpose of these chapters appears to be to establish that the full capacity for production of chlorinated rubber in India, which has a maximum historic utilisation rate of 24 percent and a current utilisation rate of 12 percent, should be eligible for funding. Chlorinated rubber produced using CTC usually contains small quantities of CTC. It is proposed in the document that the lack of acceptability to users of chlorinated rubber containing CTC is due to the Montreal Protocol. It is further proposed that when the production process is converted and CTC-free chlorinated rubber becomes available, the market for the product will increase to take up the full production capacity theoretically available in India.

41. The Montreal Protocol controls production and consumption, not end use. Therefore the first proposition is not correct. The market for chlorinated rubber has declined through the adoption of alternative technologies using other products. The claims that this decline in the market could be reversed and that the availability of CTC-free chlorinated rubber would give effect to a market resurgence appear speculative. The Secretariat advised the World Bank that the provision of MLF resources to cater for these eventualities did not appear to be eligible. The World Bank provided further arguments in support of its position that growth in the market for CTC-free chlorinated rubber was likely, including suggestion that a non-article 5 producer proposed to expand its capacity.

Conversion of Rishiroop Polymers Limited (RPL)

42. The situation of this enterprise has not changed since March 2000 when the World Bank first submitted a proposal for conversion of both RPL and ROL. Subsequently the Secretariat advised that RPL was not eligible for funding because there had been no consumption for the previous three years. The World Bank revised the project for submission to the 34th Meeting to remove the request for funding for RPL, on the basis that the enterprise might recommence production and submit a project at a future date. As indicated in the current proposal there is still no consumption and the Secretariat advised the World Bank that conversion of RPL remains ineligible for funding. The World Bank suggested that if conversion was not eligible a closure option should be considered. However, with no consumption, the Secretariat does not see how closure costs could be considered eligible either.

Closure of Pauraj and Tarak

43. Under the Parties' Decision X/14, closure costs are eligible. The basis for these costs needs careful consideration. For instance, the use of production estimates on the basis of "unconstrained growth" from a base that represents the highest level of annual production achieved in India appears not valid. The very low current production levels will arise from a variety of factors including the adoption of alternative technologies referred to above and the conditions applicable in individual production enterprises. For instance at Pauraj, production is falling rapidly and now stands at only 33 tonnes per year, while at Tarak, production has averaged 140 tonnes over the last three years. This indicates that the viability of one plant may be different to that of the other, in which case compensation for lost profits would differ. The World Bank indicated its willingness to discuss these issues in more detail and to facilitate site visits if these were needed to establish the conditions on which calculation of compensation for closure should be based.

Industrial Rationalisation

44. The Pauraj and Tarak plants are to be closed to effect industrial rationalisation. The Secretariat pointed out that it may not be accurate to portray this rationalisation as being a response to Montreal Protocol control measures. It is also an economic response to over-capacity. The Executive Committee has indicated through previous decisions concerning other countries with significant over-capacity such as China, that incremental costs for a sub-sector or group of projects should be based on conversion of reasonable levels of industrial capacity, that

is, on the basis of the eligible incremental costs of enterprises remaining after economic rationalisation has taken place.

45. In this regard, as indicated in Table 6 of the plan (page 13), the theoretical production capacity for the manufacture of chlorinated rubber is more than eight times the current level of production and more than four times the highest level of production ever achieved since production capacity of 6050 tonnes was installed in 1993-94. Closure of Pauraj and Tarak would reduce total capacity from 6050 tonnes annually to 5600 tonnes annually, still 7.5 times the current production level.

46. The Secretariat advised the World Bank that it was unrealistic to suggest to the Executive Committee that the Multilateral Fund should provide compensation for conversion of this level of excess capacity on the basis of speculation about possible future growth in the chlorinated rubber market arising from the availability of CTC-free product. In this regard the plan should address the provisions of Decision 32/59(c) which state that if a project for conversion of Rishiroop Rubber International Limited was submitted later, the cost benefits arising from industrial rationalization in the sub-sector should be taken into account in determining the cost of the project.

47. The World Bank referred to the information provided about the international chlorinated rubber market and indicated that, in its view, it was inaccurate to conclude that future growth in the chlorinated rubber market was speculative.

Conversion projects

48. The incremental costs for the RRIL project will need to be determined in accordance with the rules and policies of the Multilateral Fund. This will include taking account of technological upgrade and exports to non-Article-5 countries of 55.8 percent. It will also be subject to considerations of cost-sharing to take account of over-capacity in the sector overall.

49. The information now contained in the proposal for RRIL does not provide any basis for assessing incremental costs. The World Bank was invited to provide comprehensive technical information about the current (baseline) installation at RRIL with particular reference to the plant layout, the current condition of process and auxiliary equipment (bearing in mind the consistently low utilisation rate), the parts of the plant intended to be replaced and those to be re-used.

Subsequent discussions

50. In regard to calculation of conversion costs for RRIL, the World Bank said that since the alternate technology was the same as that employed at Rishiroop Organics Limited (approved at the 34th Meeting) all the relevant information had already been provided to the Secretariat. On this basis the Secretariat advised the World Bank that it would be able to support an approach to the Executive Committee for approval of funding on the basis of the cost-effectiveness of the ROL project, after adjustment for technology transfer costs, which had already been paid via the ROL project. The adjusted cost-effectiveness is US $7.38 per kg. This cost effectiveness could be applied to the average total CTC consumption level for the last three years of all the

remaining chlorinated rubber plants in India, after accounting for the phase out approved for ROL. This consumption figure is 275.2 ODP tonnes. The resulting level of incremental costs would be US $2,030,976. The Secretariat pointed out that this methodology would provide funding for those enterprises still producing and which are proposed for closure, at the same cost-effectiveness as if they were to be converted, thus providing maximum flexibility to individual enterprises to decide whether to close or to convert.

51. The World Bank considered that this methodology did not capture eligible costs related to plant closure and reflected only a fraction of the total incremental costs to be incurred by the industry in India. In addition, it did not reflect the required production capacity for meeting the future demand of CTC-free chlorinated rubber. The World Bank wished to explore the issue further with the Secretariat in order to ensure that the funding level under the sector plan would allow the Indian industry to balance its production capacity with future demand.

52. The Sub-Committee on project review will be informed of any further developments.

**RECOMMENDATION**

53. Pending

**Annex I**

**37th MEETING OF THE EXECUTIVE COMMITTEE OF THE MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL**

# PROJECT COVER SHEET

| | |
|---|---|
| **COUNTRY:** India | **IMPLEMENTING AGENCY:** World Bank |
| **PROJECT TITLE:** | Sector Plan for Phasing Out of CTC Consumption in the Chlorinated Rubber Sub-Sector in India |
| **PROJECT IN CURRENT BUSINESS PLAN:** | Yes |
| **SECTOR/SUB-SECTOR:** | Solvents/Process agents |
| **ODS USE IN SUB-SECTOR:** | Baseline (1999-2001) 524 ODP tons<br>Current (2001) 305 ODP tons |
| **PROJECT IMPACT (ODS TO BE ELIMINATED):** | Projected Phase out 347 MT CTC or 382 ODP MT (2001 ODP tons) |
| **PROJECT DURATION:** | 36 months |
| **PROJECT COSTS:** | Option 4: Industrial Rationalization |
| Investment Activities | |
| Incremental Capital Cost | US$22,533,153 |
| Contingency (10%) | |
| Incremental Operating Cost | |
| Sub-total | US$22,533,153 |
| Non-investment Activities | US$0 |
| Total Project Costs | **US$22,533,153** |

| | |
|---|---|
| **LOCAL OWNERSHIP:** | 100% |
| **EXPORT COMPONENT:** | **USD 4,466,308** (30.38% deduction to non-article (5) countries). |
| **REQUESTED GRANT:** | US$18,066,845 |
| **IA SUPPORT COST:** | US$1,875,338 |
| **TOTAL COST TO MLF:** | US$19,942,183 |
| **COST EFFECTIVENESS:** | US$47.3 /kg ODP.<br>US$6.89/kg ODP based on Projected Consumption) |
| **PROJECT MONITORING MILESTONES INCLUDED:** | Yes |
| **NATIONAL COORDINATING AGENCY** | MoEF, National Ozone Unit |


**PROJECT SUMMARY**

The objective of this sub-sector plan is to completely phase out the remaining CTC consumption of about 382 ODP MT (based on 2001 consumption) and 2878 ODP MT of projected CTC consumption, in the chlorinated rubber industry in India. The phaseout plan will focus on actions to ensure sustainable phaseout of the use of CFC in the four remaining chlorinated rubber manufacturers in India. These are Rishiroop Polymers Pvt. Ltd. (RPL), Pauraj Chemicals Pvt. Ltd., Rishiroop Rubber International Ltd. (RRIL), and Tarak Chemicals Ltd.

This sub-sector plan entails conversions at RPL and RRIL, and closure of chlorinated rubber plants at Pauraj and Tarak. The total financial assistance requirement to carry out this sub-sector plan is US$19,942,183. With the ExCom's approval on the requested provision for flexibility for India to implement this proposed sub-sector plan, this sub-sector plan will contribute to the country's ability to meet the 85% reduction target for CTC in 2005 and 100% reduction target in 2010.


**Prepared by:** Indian Chemical Manufacturers Association and the World Bank **Date:** March 21, 2002

**Reviewed by:** W. Kenyon **Date:** April 22, 2002

# Sector Plan for Phasing Out of CTC Consumption in the Chlorinated Rubber Sub-Sector in India

Prepared jointly by Indian Chemical Manufacturers Association
and the World Bank

March 2002

# Table of Contents

# Chapter 1
# Introduction and Objective of the Sub-Sector Plan

**Introduction**

India became a Party to the Vienna Convention for Protection of the Stratospheric Ozone Layer on June 19, 1991, and the Montreal Protocol on Substances that Deplete the Ozone Layer on September 17, 1992. India was categorized by the Montreal Protocol as a country operating under paragraph 1 of Article 5 as India is a developing country with a per capita consumption of Annex A, Group I chemicals of less than 0.3 kg. India, as well as other countries operating under paragraph 1 of Article 5, is eligible for financial and technical assistance including transfer of technologies from the Multilateral Fund. The Multilateral Fund is a financial mechanism, which was established by the Parties of the Montreal Protocol in 1990. The objective of this Fund is to provide technical and financial assistance to countries operating under paragraph 1 of Article 5 in order to ensure their full compliance with the control measures stipulated in this global environmental treaty.

India began to phase out consumption of ozone depleting substances (ODSs) in 1994 under its National Program for Phaseout of ODSs with the support from the Multilateral Fund. The Executive Committee of the Multilateral Fund has approved a total of 276 ODP phase-out projects for India, with a funding level of some US$130 million. Of these, 226 are investment projects and 50 are non-investment and technical assistance activities. These 226 investment projects include one investment activity for phasing out the use of CTC in the production of chlorinated rubber at Rishiroop Organic Limited (ROL).

The total Bank funding commitments to India under the Montreal Protocol now stands at over $100 million, of which about $60 million has been disbursed. Implementation to date has resulted in the phaseout of over 3,000 MT of annual ODS consumption in the manufacturing sector and about 4,000 MT of CFC production.

With funding already provided by the Multilateral Fund, India was able to reduce its consumption of Annex A, Group I chemicals well under the interim phaseout target stipulated in the Montreal Protocol. India is expected to maintain its consumption of these chemicals under the baseline consumption as allowed by the Protocol. With the momentum initiated by the earlier action of the Government of India, India is expected to meet its upcoming 50% consumption reduction in 2005.

For Annex B, Group II chemical or CTC, the first obligation, that requires India to reduce its consumption of CTC by 85% of its baseline consumption level (average consumption during the period from 1998 – 2000), will become effective on January 1, 2005. By January 1, 2010, India is required to completely phase out its CTC consumption, except for feedstock applications.

The baseline of CTC consumption in India is 10,460 MT. It is expected that without further phaseout activities it is likely that India will have difficulty in meeting the 85% CTC consumption reduction in 2005. Basically, India will have to reduce its current CC consumption of 11,043 MT to 1,656 Mt within a period of about two years. The major consumption/emissions of CTC are in the chlorinated sub-sector and agro-chemical sub-sector where endosulfan and dicofol production facilities are in operation.

In the pharmaceutical sub-sector, available information indicates that CTC is used mainly for production of Bromehexine Hydrochloride, Cloxacilin, Chlorophenesin, Diclofenac Sodium, Ibuprofen, Isosorbid Mononitrate, Omeprazol, and Phenyl Glycine. A large part of CTC use in this sub-sector is in the small scale sector. It is estimated that CTC consumption in the pharmaceutical sub-sector is about 15 – 20% of overall CTC consumption in the process agent sector. Table 1 shows usage and emissions of CTC in India as estimated in 1995 for that same year and projected for 2000.

Table 1: Application –wise Usage and Emissions of CTC in India (in MT)*

| Product | 1995 Process Inventory | 1995 Emissions | 2000 Projected Process Inventory | 2000 Projected Emissions |
|---|---|---|---|---|
| **Chlorinated Rubber (CR)** | 8,100 | 800 | 22,000 | 1,800 |
| **Agricultural Chemicals** | | | | |
| Endosulfan | 14,400 | 590 | 14,715 | 604 |
| Dicofol | 1,200 | 110 | 2,500 | 250 |
| **Pharmaceuticals** | | | | |
| Bromehexine hydrochloride | 100 | 10 | 500 | 50 |
| Diclofenac sodium | 100 | 12 | 160 | 16 |
| Cloxacilin | 100 | 10 | 130 | 13 |
| Chlorophensin | 200 | 20 | 200 | 20 |
| Ibuprofen | 850 | 271 | 1,000 | 320 |
| Phenyl glycine | 2,400 | 240 | 2,500 | 250 |
| Isosorbid mononitrate | 70 | 7 | 100 | 10 |
| Omeprazol | 140 | 14 | 210 | 21 |
| Total | **27,660** | **2,084** | **44,015** | **3,354** |

*1997 TEAP Report, Volume II, pp. 103, Table 5.4

In 1993, when the India Country Program was formulated, the main source of emission of CTC was identified to be from the production of Ibuprofen. Many of the 14 Ibuprofen producers have phased out their use of CTC and converted their processes to non-ODS solvents. As a result, CTC emissions from Ibuprofen production have dropped significantly between 1993 and 1995. However other uses of CTC for production of chlorinated rubber, endosulfan and dicofol remained increasing sources of emissions of CTC in India during that period. It was projected by TEAP in 1995 that the CTC emissions from the chlorinated rubber sub-sector would grow from 800 MT in 1995 to 1,800 MT in 2000.

Due to the control measure stipulated in the Montreal Protocol, the industrial norm has become much more stringent against chlorinated rubber produced with and contained with CTC. This has had a direct impact on the growth of the chlorinated rubber industry in India. As a result, the actual consumption of CTC in the chlorinated rubber sub-sector in India, which is shown in Table 2, is lower than the value projected by TEAP.

Table 2: CTC Consumption in the Chlorinated Rubber Sub-Sector

| Year | CTC Consumption (MT) |
|---|---|
| **1995** | 460 |
| **1996** | 847 |
| **1997** | 878 |
| **1998** | 726 |
| **1999** | 602 |
| **2000** | 549 |

While the CTC consumption in the chlorinated rubber sub-sector in India is lower than the projected value made by the UNEP TEAP, to meet the 85% reduction target in 2005 India is still required to further reduce its CTC consumption in all applications.

To ensure its full compliance with this obligation, the Government of India would like to seek assistance from the Multilateral Fund to phase out the use of CTC in all major applications: CTC used as process agents in the pharmaceutical industry, CTC used for production of chlorinated rubber and agro-chemicals, CTC used as a solvent, and other uses.

Currently, the Government of India has assigned UNIDO to take lead in developing activities to phase out the use of CTC as process agents in the pharmaceutical companies. The World Bank is charged with responsibility to develop a strategy for phasing out the use of CTC in the production of chlorinated rubber and agro chemicals, while UNEP is developing a strategy to phase out the use of CTC as solvent cleaning agents.

As the Multilateral Fund has already approved one investment project with a total funding of $2,074,300 to phase out the use of CTC as a process agent for the production of chlorinated rubber at ROL, 226 MT of CTC will be permanently phased out when the proposed conversion is completed. Therefore, there are only four remaining chlorinated rubber producers that need financial assistance from the Multilateral Fund.

The proposed chlorinated rubber sub-sector plan is part of the overall CTC phaseout strategy for the process agent sector of the Government of India. The proposed plan for phasing out of CTC use as a process agent in the agro-chemical industry will be submitted separately to the ExCom at the last meeting of the ExCom in 2002.

**Objectives of the India Chlorinated Rubber Sub-Sector Plan**

The objective of this sub-sector plan is to completely phase out the remaining CTC consumption of about 347 MT, excluding the consumption level of ROL which will be automatically phased out by the investment project already approved by the Multilateral Fund, in the chlorinated rubber industry in India. The phaseout plan will focus on actions to ensure sustainable phaseout of the use of CTC in the four remaining chlorinated rubber manufacturers in India. These are: (1) Rishiroop Polymers Pvt. Ltd. (RPL); (2) Pauraj Chemicals Pvt. Ltd.; (3) Rishiroop Rubber International Ltd. (RRIL); and, (4) Tarak Chemicals Ltd. All enterprises are 100% locally owned.

The sub-sector plan aims to phase out 347 MT of CTC used as a process agent in the chlorinated rubber production process by 2005, with the financial support of $18,066,845 from the Multilateral Fund. Since the proposed sector plan involves conversion at two existing plants and the average implementation time frame of investment projects is approximately 3 years, the action should, therefore, be taken by the end of 2002 or early 2003 at the latest in order to ensure that the deadline of 2005 is met.

Moreover, since this project is submitted as a sector plan, the Government of India would like to request the Executive Committee to allow the Government of India with full flexibility on how these approved funds be utilized and distributed among all the four enterprise covered by this plan, providing that CTC consumption in this sub-sector is phased out as planned.

# Chapter 2
# Development of Chlorinated Rubber Market
# And Sub-Sector Profile

**Development of Chlorinated Rubber Market in India and Other Article 5 Countries**

Chlorinated rubber is a resin binder used as part of the formulations of paints and coating products, ink, adhesives, primers for oil and gas pipelines, coal tar coatings, fireworks and flares, and concrete curing components. Depending on the formulations used, approximately 16 – 20% by weight of chlorinated rubber is contained in those coating products. Common use of chlorinated rubber in these products is attributed to the following physical properties: water and chemical resistant properties, fast drying, ease of application, bonding property, and fire retardant property.

Table 3: Major products containing chlorinated rubber as part of their formulations

| Application | Preferred Properties |
|---|---|
| Paints<br>• Paints for marine and off-shore structures;<br>• Industrial anti-corrosive paints;<br>• Road marking paints;<br>• Swimming pool paints;<br>• Container paints;<br>• Fire retardant paints;<br>• Anti-fungal paints. | • Water and chemical resistance;<br>• Ease of application – recoating without much surface preparation and under any weather conditions;<br>• Chlorine compound helps prevent fouling which is important for marine and hospital applications;<br>• Fast drying is essential for road marking paints. It also provides long-lasting coating on concrete surface.<br>• Fire retardant is preferable for paints for sensitive facilities like nuclear power plants and hospitals. |
| Ink<br>• Rotogravure inks;<br>• Screen inks | • Fast drying is a key parameter for high speed and security printing. Major uses are inks for newspapers, packaging materials, stamps and currency notes, and other official documents and seals. |
| Adhesives<br>• Footwear adhesives;<br>• Rubber to metal bonding (automobile applications – engine mounting pads);<br>• Hot melts;<br>• Pressure sensitive. | • Bonding property is a desirable feature of chlorinated rubber particularly for bonding between rubber and metal components. |
| Primers and coatings for coal tar for oil & | • Water and chemical resistance is |

| | |
|---|---|
| gas pipelines | preferable for this type of applications. |
| Fireworks/Flares | • Fire retardant is an important feature for controlling the combustion process of these types of products. |
| Curing of concrete for large construction sites – dams, expressways, and etc. | • Coating material containing chlorinated rubber is preferable in a large construction sites. This application is normally required when water supply is scarce. This product is applied to the surface of uncured concrete in order to form a coating layer to slow down the evaporation rate of the water from the uncured concrete. This helps improve the strength of the concrete, and minimize water requirement, which is critical to construction sites in remote areas. |

All the applications mentioned above are common in both developed and developing countries. Among all the above applications, paints are the largest market for chlorinated rubber. Chlorinated rubber produced in India is, therefore, being supplied to both markets in Article 2 and Article 5 countries. The demand for this product in Article 5 countries during the last decade increased at a faster rate than the demand in Article 2 countries due to a significant increase in the development activities in Article 5 countries.

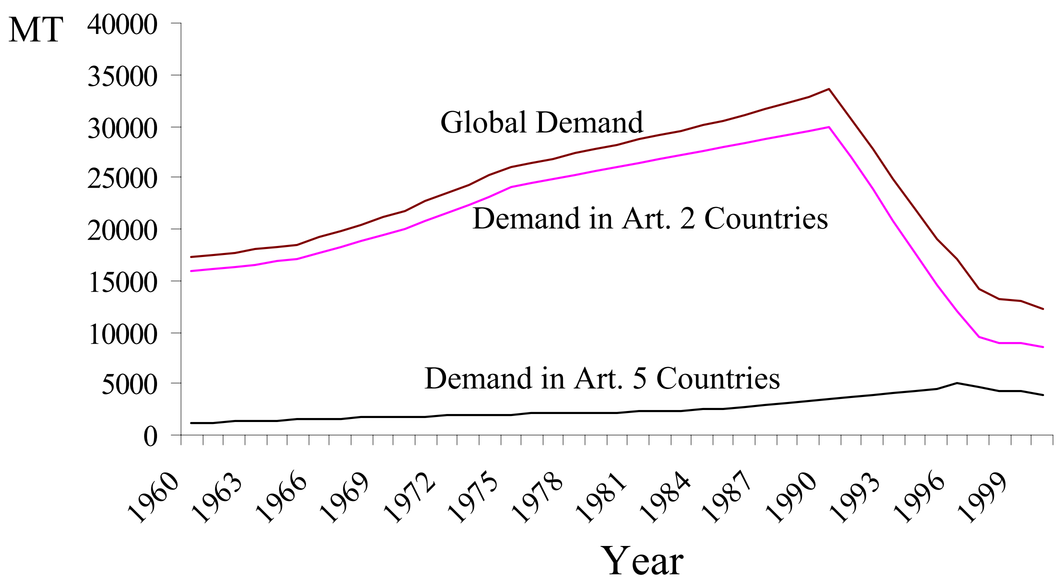

Fig. 1: Actual Global Demand of Chlorinated Rubber From 1960 – 2000.

The demand for chlorinated rubber in Article 2 countries had been increasing from about 15,000 MT in 1960 to about 30,000 MT in 1990. However, when the Montreal Protocol was established in late 1980s, the market of chlorinated rubber in Article 2 countries was seriously affected as shown by the sudden drop in demand starting from 1991 onwards. Chlorinated rubber producers in Article 2 countries that did not have technologies to reduce or replace CTC in their production process decided to shut down their operations. Because of the unavailability of CTC-free chlorinated rubber at that time, end users were compelled to change their formulations to alternatives such as polyurethane, epoxies or acrylics albeit at the cost of inferior performance in many applications.

While the total market of chlorinated rubber is expected to be more than 30,000 MT per year as applications for which chlorinated rubber is used has grown in correlation with the level of economic development, the current global capacity to supply non-CTC chlorinated rubber or chlorinated rubber with CTC content of less than 10 ppm, is less than 10,000 MT. This current capacity has only been available in mid 1990s. It has been recently reported that major producers in Article 2 countries are planning to set up a new non-CTC chlorinated rubber production facility with a capacity of at least 10,000 MT to capture the current significantly unmet demand.

The demand for chlorinated rubber in all Article 5 countries in 1970s was about 2,000 MT per annum. The demand of this product in India was projected to increase at an average rate of 18% during 1990s as reported by the TEAP 1997 Report. The conservative projection made by the coating industry indicates that the market for chlorinated rubber will grow 12% per annum or more during the next decade[1] [2]. Based on the historical data, it is expected that the demand for chlorinated rubber in Article 2 countries would continue to grow at a rate of 1.4% per annum during 2000s.

For example, the Indian Government announced in 1999 that extensive effort would be undertaken to upgrade, expand and build new expressways and highways throughout India. To meet this goal, the National Highways Authority of India (NHAI) has been charged with major responsibility together with that being taken up by the State Governments to improve and expand the road transportation system. The NHAI's plans include, among others, construction of four to six lane highways of about 14,000 km.

Development of this national infrastructure involves substantial increase in requirements of initial and annual recoating of these highways by road marking paints. The requirement of these marking paints will result in a sharp increase in demand for chlorinated rubber since chlorinated rubber is used in these products.

[1] Frost & Sullivan Analyst, *Indian Coating Markets*, September 2000.
[2] Frost & Sullivan Analyst, *Indian Inks Market – Part 1*, October 2000.

MT

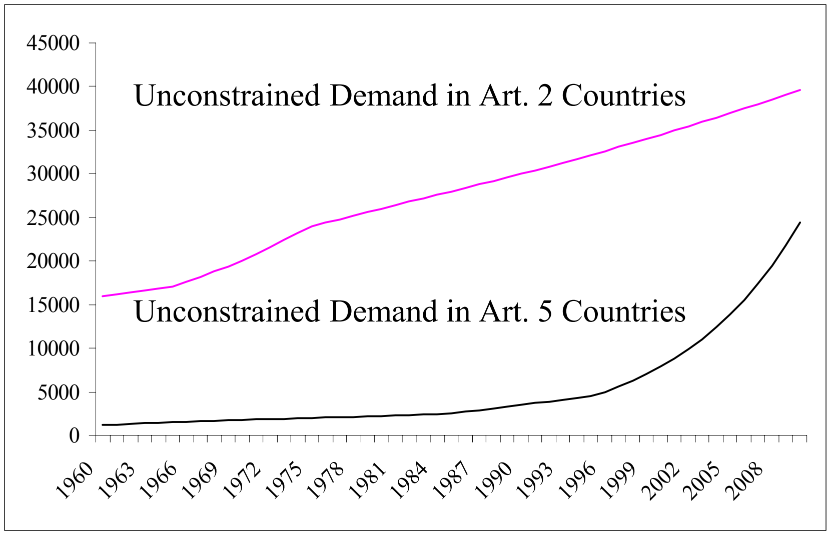


Fig. 2: Unconstrained demand of global market for chlorinated rubber.

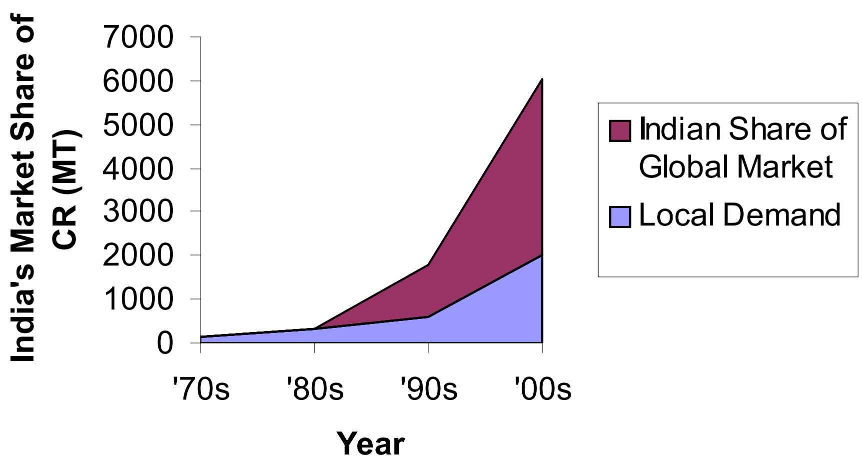


Fig. 3: Projected market share of Indian chlorinated rubber products

The total demand for chlorinated rubber in India in early 1970s was reported to be about 150 MT per year. This demand has continuously increased throughout the 1970s and 1980s. In 1996, the local demand of chlorinated rubber increased to about 600 MT. It was expected that the demand in India would continue to increase to 1,000 MT in 2000, and 2,875 MT in 2010. It was also expected that demand for this product would also increase in all other Article 5 countries. As shown in the above figure, the demand in all Article 5 countries was expected to reach the 8,000 MT level in 2000 (Fig. 2) and more than 34,000 MT in Article 2 countries. Since in early 1990s there were only a few chlorinated rubber manufacturers in Article 5 countries (two producers in India and one in China), India, therefore, expected to capture an increasing portion of the global market share. The existing chlorinated rubber production capacity of 6,000 MT in India (Fig. 3) is only 14% of the projected demand for 2000.

Due to the Montreal Protocol, the global market outlook of chlorinated rubber containing CTC has been seriously affected. Excess production capacity for chlorinated rubber as currently experienced in India is a direct result of this phenomenon.

**Sub-Sector Profile of the Indian Chlorinated Rubber Industry**

There are five chlorinated rubber manufacturers in India, all of whom use CTC as a process solvent. Details of these enterprises are described below:

Table 4: Chlorinated Rubber Manufacturers in India

| Serial No. | Enterprise | Start of commercial production | Installed capacity (MT/yr.) |
|---|---|---|---|
| 1. | Rishiroop Polymers Pvt. Ltd. (RPL) | 1973 | 550 |
| 2. | Pauraj Chemicals Pvt. Ltd. | 1980 | 150 |
| 3. | Rishiroop Organics Pvt. Ltd. (ROL) | 1991 | 550 |
| 4. | Rishiroop Rubber International Ltd. (RRIL) | 1993 | 4500 |
| 5. | Tarak Chemicals Ltd. | 1998 | 300 |

Chlorinated rubber production in India began in 1973 when Rishiroop Polymers Pvt Ltd. (RPL) installed the first production facility at Nasik. This first plant had an initial installed capacity of 150 MT per annum. The plant was de-bottlenecked in 1982 to increase production to 300 MT per annum and further expanded in 1988 to increase the installed capacity to the current level of 550 MT per annum on a three-shift basis. This expansion was required in response of the growing demand for chlorinated rubber products. The increasing demand of chlorinated rubber products had a direct correlation with the growth of economic development in developing countries.

Pauraj Chemicals set up its chlorinated rubber production facility at Tarapur in the State of Maharashtra in 1980. This second chlorinated rubber plant has a production capacity of 150 MT per annum.

Table 5: Chlorinated Rubber Production (MT) in India

| Financial Year Enterprise | 91-92 | 92-93 | 93-94 | 94-95 | 95-96 | 96-97 | 97-98 | 98-99 | 99-00 | 00-01 |
|---|---|---|---|---|---|---|---|---|---|---|
| **TOTAL** | **597** | **735** | **639** | **1014** | **1293** | **1392** | **1262** | **1175** | **987** | **751** |

In response of the continuing growth of local demand for chlorinated rubber, Rishiroop Group invested in its second plant with a 550 MT capacity at Vapi in Gujarat under the name Rishiroop Organics Pvt. Ltd (ROL) in 1991. By 1991, the total production capacity of chlorinated rubber in India reached the 1,250 MT level. The actual demand and production of this product during the financial year 1992 – 1993 was 735 MT, exceeding the capacity of the first two plants (RPL and Pauraj). Therefore, the decision of Rishiroop Group to set up a second plant (ROL) in 1991 was timely.

In mid1980s, other developing countries also experienced a noticeable growth in the demand of chlorinated rubber as experienced in India. It was projected that the demand for this product would reach the 10,000 MT level by 2000. To respond to this increasing demand and the high rate of economic growth in developing countries in 1990s, including the local economic reform policy adopted by the Government of India, the Rishiroop Group decided to set up a third plant with a capacity of 4,500 MT. This capacity would be used mainly for meeting the growing demand in developing countries. It was anticipated that by 2000 the Indian producers of chlorinated rubber would have about 40 – 60% of the market in developing countries.

Based on this projection, the Rishiroop Group applied for a factory license with the Ministry of Industry on September 10, 1990. At the time the application was submitted to the Ministry of Industry, India was not a Party to the Protocol. The Ministry of Industry approved the license for this new plant in April 1991 with a condition that 25% of the total production should be allocated for the local market while the remaining could be exported. The construction was completed and the commercial scale production at Rishiroop Rubber (International) Ltd. (RRIL) started in 1993. The company is owned by about 20,000 shareholders, and its shares are listed in the Bombay Stock Exchange. It was anticipated that production capacity would be fully utilized by 2000.

While it was known in late 1990 immediately after the Meeting of the Parties in London that CTC was included as one of the new controlled substances under the Montreal Protocol, at that time, however, the Government of India had not ratified the Montreal Protocol until September 1992, and at that time there was no other commercially available alternative technology for the production of chlorinated rubber. RRIL, therefore, decided to proceed with its original plan by adopting the only available CTC-based technology. Without the construction of the new RRIL plant, part of the growing demand for chlorinated rubber would have to be fulfilled by imports as the total demand in the financial years, 1995 – 1996 and 1996 – 1997, already exceeded the combined capacity (1,250 MT) of ROL, RPL and Pauraj. If there were no Montreal Protocol, the demand would have continued to grow in accordance with the market projection made in 1980s by the Indian chlorinated rubber industry.

In 1994, the Parties decided that for 1996 CTC consumption in the process agent applications should be treated akin to feedstock[3]. This exemption was further extended till 1998 at the Seventh Meeting of the Parties[4]. Because of these decisions, CTC used for the process agent applications was not considered as a controlled substance during 1996 – 1998. At the Tenth Meeting of the Parties, it was decided that CTC used for chlorinated rubber applications be reclassified under process agents as a controlled substance under the Montreal Protocol (Dec. X/14). Because of the labor dispute at RPL, the increasing demand of chlorinated rubber experienced in 1995 and 1996, and the fact that during 1996 – 1998 CTC consumed in the process agent applications was not considered as a controlled substance and was not subjected to any phaseout targets by the Montreal Protocol, Tarak started up its own production facility of 300 MT capacity in October 1998.

Based on Dec. X/14, the residual emission of CTC from enterprises in Article 5 countries that started their operations before 1 January 1999 will not be counted against their national consumption or production level if they reduce the emission level down to the level agreed by the ExCom. Dec. X/14 also states that incremental costs of a range of cost-effective measures should be eligible for funding in accordance with the rules and guidelines of the ExCom. All chlorinated rubber producers in India started their operations before 1 January 1999. Therefore, all of them are eligible for funding from the Multilateral Fund, including RPL that has its idle capacity installed long before 1 January 1999, and the idle capacity can be reactivated in a short time if there were no Montreal Protocol.

With regard to Dec. 17/7 of the ExCom which states that in the light of technological advances, the ExCom will not to consider any projects to convert any ODS-based capacity installed after 25 July 1995, it is obvious that this decision is not applicable to the chlorinated rubber sub-sector as no alternative technologies for this sub-sector were available before 25 July 1995.

In fact, only in 1996 when one German chlorinated rubber producer was able to successfully modify its plant to reduce emission of CTC from its process and its chlorinated rubber products. Similarly, a Japanese enterprise, which decided to opt for a non-CTC conversion option, was only able to complete its development of its new process and have it commercialized in 1997.

[3] Decision VI/10
[4] Decision VII/10

# Chapter 3
# Impact of the Montreal Protocol on
# The Global Market of Chlorinated Rubber

**Impact of the Montreal Protocol on the Global Market of Chlorinated Rubber**

The TEAP 1997 report states that almost 50% of world's chlorinated rubber production capacity of some 40,000 MT/year was shut down in early 1990s in UK and USA as chlorinated rubber produced by most producers could not meet the more stringent CTC content requirement. With limited supply of low CTC content chlorinated rubber, producers of end products such as paints and inks which normally used chlorinated rubber as a main ingredient, had to change formulation of 50,000 to 100,000 MT of end products to alternative resin binders such as polyurethane, epoxies or acrylics, even if product performance has to be compromised, in order to maintain and to meet the growing demand of these end products.

Many product lines (such as marine paints) are being sold in the international market and their specification is dictated by the global standard established by parent multi-national companies or technology providers in Article 2 countries. The immediate change in the product specification made by such multi-national companies in mid 1990s in order to meet the stringent requirement on the CTC content, has caused immediate change in the specification of products manufactured in Article 5 countries. Prior to the Montreal Protocol, chlorinated rubber with 5 – 7% CTC content of more than 1.17 million tons had been produced and accepted by end users for the last 50 years. Because of the Montreal Protocol, this product is no longer acceptable.

In mid 1990s, developed countries adopted stricter norms for use of products containing CTC, restricting the market of chlorinated rubber having CTC content more than 1% due to labeling requirements of end products. Due to corporate policies of technology providers for end products in developed countries, discrimination against chlorinated rubber with a high content of CTC was also applied to manufacturers of end products in developing countries, which are the major exporting markets of the Indian chlorinated rubber manufacturers. In addition, uncertainty of the supply of CTC and chlorinated rubber has also made manufacturers in developing countries switch to alternatives.

Under these circumstances the chlorinated rubber market was seriously affected. Sales of chlorinated rubber started to decline after mid 1990s as more and more customers desiring to use chlorinated rubber with CTC content of below 1%. Since there is one company in Article 2 country producing chlorinated rubber with a CTC content of less than 10 ppm, market acceptance has then become even more stringent. The 10 ppm CTC content chlorinated rubber has become an industrial norm since 1996. Due to non-availability of technology know-how and the large investment capital required for modifying the production process, Indian producers were unable to comply with this stringent specification. This has resulted in a significant drop in the total production of chlorinated rubber in India as shown in Table 6. As a result, a large percentage of existing installed capacity in India was unutilized.

Table 6: Actual Production of Chlorinated Rubber as Percentage of Existing Installed Capacity

| **Financial Year** | **91-92** | **92-93** | **93-94** | **94-95** | **95-96** | **96-97** | **97-98** | **98-99** | **99-00** | **00'01** |
|---|---|---|---|---|---|---|---|---|---|---|
| Installed Capacity | 1250 | 1250 | 5750 | 5750 | 5750 | 5750 | 5750 | 6050 | 6050 | 6050 |
| Production | 597 | 735 | 639 | 1014 | 1293 | 1392 | 1262 | 1175 | 987 | 751 |
| Production as % to Installed capacity | 48% | 59% | 11% | 18% | 22% | 24% | 22% | 19% | 16% | 12% |

In addition to the reduction of CTC content in the final products, chlorinated rubber manufacturers in India will soon be subjected to additional requirements from the Government of India to reduce the consumption by 85% of the baseline consumption by 2005 and eventually phase out any CTC emissions from the process by 2010.

The production of chlorinated rubber increased from 597 MT in 1991 – 1992 to 1,392 MT in 1996 – 1997. This represented a 133% increase in five years giving an average annual growth rate of 27%. The CTC consumption also increased from 343 MT in 1991 – 1992 to 878 MT in 1996 – 1997, a 147% increase in consumption (Table 7). This represented an average annual growth rate of 29%. The increasing consumption of CTC has a direct correlation with the increasing production level of chlorinated rubber as India's industrial norm of CTC consumption per MT of chlorinated rubber is approximately 0.63 MT of CTC per MT of chlorinated rubber.

Table 7: CTC Consumption (MT)

| | **91-92** | **92-93** | **93-94** | **94-95** | **95-96** | **96-97** | **97-98** | **98-99** | **99-00** | **00-01** |
|---|---|---|---|---|---|---|---|---|---|---|
| **TOTAL** | **343** | **511** | **288** | **460** | **847** | **878** | **726** | **602** | **549** | **277** |

The chlorinated rubber production and CTC consumption in India would have continued to grow if there were no Montreal Protocol. The market pressure on chlorinated rubber containing CTC has depressed the global demand of this product. Because of the uncertainty of future supply of CTC and the more stringent requirement on the acceptable level of CTC in the final products, manufacturers of end products have converted to alternatives. While the demand for paints, inks, and those products that normally contain chlorinated rubber as part of their formulations, continues to grow as anticipated, the demand for conventional chlorinated rubber containing 3 – 7% of CTC is diminishing. Furthermore, the recent economic downturn in most developing countries has resulted in a further reduction in the demand of chlorinated rubber products. However, this factor is expected to be a short-term phenomenon.

India ratified the Montreal Protocol in 1992 and is obliged to phase out the use of CTC by 85% by 2005 and completely phase out by 2010. India's chlorinated rubber production has declined from 1,392 MT in 1996 – 1997 to 751 MT in 2000 – 2001. To preempt any further disruption in economic development in India, the Government of India would like to seek financial assistance from the Multilateral Fund to assist the Indian chlorinated rubber industry to undertake a smooth transition towards a complete phaseout of the use of CTC in the chlorinated rubber by 2005.

# Chapter 4
# Chlorinated Rubber Sub-Sector Strategy

The Government of India will phase out the use of CTC in the production of chlorinated rubber before 2005. The TEAP April 1997 report projected that CTC consumption in the chlorinated rubber sub-sector in India would be about 1,800 MT or 55% of the total projected quantity of CTC emissions in the process agent sector. This sub-sector strategy is part of the Government of India's overall action plan to meet its obligations under the Montreal Protocol with regard to the phaseout of Annex B, Group II chemical (CTC) – 85% reduction by 2005 and 100% reduction by 2010.

Major consumption of CTC in India is in the solvent and process agent sectors. However, the consumption of CTC in the solvent sector is scattering among a large number of small users. It is anticipated that meaningful phaseout of CTC use in the solvent sector will take a longer period to achieve. Moreover, the development of the sector strategy for the solvent sector is still being in a nascent stage. A final strategy for this sector is expected to be ready by next year at the earliest. Therefore, an accelerated phaseout schedule for the chlorinated rubber sub-sector is required in order to contribute to country's ability to meet the upcoming obligation in 2005. Since an average project implementation duration of investment projects is about 3 years, therefore, for the phaseout in this sub-sector to contribute to the national effort in meeting the 85% reduction target in 2005, implementation of CTC phaseout in the chlorinated rubber sub-sector should start, at the latest, at the end of 2002 or early 2003.

**Regulatory Measures**

Based on Rule 9 of the Ozone Depleting Substances (Regulation) Rules 2000, published in the Ministry of Environment and Forests' notification number S.O. 69 (E), dated January 25, 2000, no person shall establish or expand or cause to establish or expand any manufacturing facility, with a view to manufacturing products which contain, or are made with, any ozone depleting substance after July 19, 2000. In addition, all chlorinated rubber producers in India are registered with the Ozone Cell, Ministry of Environment and Forest, in accordance with Rule 13 of the Ozone Depleting Substances (Regulation and Control) Rules 2000. The registration numbers for the five enterprises eligible for funding from the Multilateral Fund are listed below:

Table 8: Registration Numbers of Chlorinated Rubber Producers

| Enterprise | Registration Number |
|---|---|
| Rishiroop Polymers Pvt. Ltd. | ODS/CS/17/2(23)/2001 |
| Rishiroop Rubber International Ltd | ODS/CS/17/2(22)/2001 |
| Rishiroop Organics Pvt. Ltd. | ODS/CS/17/2(21)/2001 |
| Pauraj Chemicals Pvt. Ltd. | ODS/CS/17/2(54)/2001 |
| Tarak Chemicals Ltd. | ODS/CS/17/2(36)/2001 |

The above rule will ensure that the implementation of this chlorinated rubber sub-sector plan will result in a permanent reduction of CTC from India's national aggregate consumption.

**Cost Models for CTC Emission Reduction Options**

The chlorinated rubber sub-sector phaseout strategy is developed on the basis of the cost-effective CTC emission abatement/phaseout measures specified by the Parties (Decision X/14). These cost-effective measures include process conversions, plant closures, emission control technologies, and industrial rationalization. Practicality of each of these options is examined under the current state of technology development and the existing technology absorption capacity within the country.

Option 1: Process conversions

It is important to note that the actual cost of conversion of chlorinated rubber plants could vary significantly depending on the conditions of the existing baseline equipment and the baseline process employed. Moreover, alternative technologies for chlorinated rubber have only recently emerged. There are only two known sources of alternative technologies. Due to the lack of experience with regard to these new technologies, it is extremely difficult to estimate on what the actual cost for conversion at each enterprise would be. Depending on which types of technologies and/or technology providers the enterprises will have an access to conversions may involve modifications of existing plants or rebuild the whole new plants, and additional costs will be required for technology licenses and fees. Moreover, not all existing plants will be able to access to the new non-CTC technologies. However, for the purpose for the development of cost-benefit analyses for all options recommended by the Parties of the Montreal Protocol, an estimate is made on the basis of the funding level approved by the Multilateral Fund for the ROL project (the only chlorinated rubber project that has been approved by the Multilateral Fund to date). Therefore, this estimate should be considered as indicative only.

Table 9: Indicative Cost of Option 1 – Conversion at the four enterprises

| | Installed Capacity (MT of CR) | Average CTC Consumption per year (MT/year) | Incremental Capital Cost ($) | Incremental Operating Cost ($) | Sub-Total ($) |
|---|---|---|---|---|---|
| **Total** | 5,500 | 475.66 | 20,287,230 | 230,901 | 20,518,131 |

The cost of conversion of the 5,500 MT installed capacity to non-CTC alternative technology is approximately $20.52 million assuming that alternative technology is available to all enterprises. With the overall export component to Article 2 countries of 30.38%, as shown in Annex II, the eligible cost of conversion of the whole chlorinated rubber sub-sector, after deduction of export component (30.38% minus 10%) becomes $16,336,536.

It is important to note that the actual cost of conversion, particularly for smaller factories, may likely be more expensive as unit cost of smaller plant capacity is normally higher. Depending on the existing process and plant design, some plants may require complete replacement of all existing equipment. Furthermore, the cost estimate provided in this document is based on a similar technology to be employed by ROL. If the cost calculation is based on available technology in Article 2 countries, the final cost estimate could have been higher by 200 – 300%. This statement is made on the basis of the following information:

Solvent Exchange Process (Emission Abatement)[5]: A German enterprise has adopted a two-stage procedure to reduce the emissions from its process and to eliminate the CTC contained as impurity in its chlorinated rubber products. It was reported that:

(a) The German enterprise spent about $25 million to reduce the emissions in its 7,000 TPA capacity plant from a level about 430 MT in 1989 to a level of about 0.3 MT in 1996. It took 7 years of intensive efforts to bring the emissions down to this level;
(b) In addition, this enterprise has spent about $40 million to modify its plant to reduce the impurity of CTC from its product, which was eventually being emitted to the atmosphere in the end use. This was done by adopting its own recently patented process for the solvent exchange;
(c) Furthermore, the German enterprise has stated that it is incurring an incremental operating cost for environmental operation of its plant of $0.8 million per year.

Non-ODS Japanese Process: A Japanese enterprise has developed a non-ODS process for chlorinated rubber and commercialized it in 1997. According to news reports the Japanese process costs the company an investment of about one billion Yen, approximately $10 million in order to set up a production facility of 800 MT of chlorinated rubber per annum. This option is clearly expensive and not cost-effective (a brief write-up on this subject from Japan Chemical Weekly (J.C.W. April 20, 1995 is available in the project file of the World Bank). RRIL, one of the beneficiaries of this sub-sector plan, had been in contact with this Japanese company, but an agreement for licensing its patent did not materialize due to conditions set up by the Japanese company for licensing of the process to RRIL. The conditions include high cost of technology transfer, royalty and operational restrictions regarding sales of non-ODS chlorinated rubber in specific markets, etc., which made it practically inaccessible to RRIL.

Estimation of Cost of Emission Reduction for Chemical Process Agents: The Process Agent Working Group constituted by TEAP reported in its May 1995 report (Annex 5) that to reduce emission from a 4,000 – 5,000 tons per annum of a chlorinated rubber plant

[5] Paper presented by Dr. Kerres, a member of PATF, at a workshop organized by ICMA in Mumbai, January 1997.

to an insignificant level will require a capital investment of about $70 - $100 million. It is clear then that this alternative is expensive and has other limitations as it presents an interim solution and an eventual conversion to a non-ODS process will be required later.

Option 2: Plant closures

The second scenario is to assume that all four enterprises opt for a closure option. To calculate the level of compensation, a financial model similar to the one used for the CFC production closure project for India is used. Profit streams foregone due to early closure of these facilities are calculated on the basis of unconstrained growth, which would be expected if there were no Montreal Protocol.

The actual selling price of chlorinated rubber (which is as competitive as international prices), variable costs and fixed costs in the baseline year, the financial year 1996 – 1997 are used for determining income and costs at various levels of projected production in subsequent years till the year 2010.

The baseline production level of the four enterprises is established by using the average combined production of these plants during the three financial years: 1995 – 1996, 1996 – 1997, and 1997 – 1998. Without the Montreal Protocol, the demand and production would have continued to increase at a rate experienced prior to the 1995 – 1996 financial year. However, for the purpose of this proposal, a growth rate of 12% per annum (as stated earlier in Chapter 2) for both the local and exporting markets in Article 5 countries is applied to the model.

In addition, a 3% annual inflation rate is applied over the period from 1996 – 2010. This model employs a discount rate of 7% per annum, similar to the CFC production closure project. For more detailed information pertaining to the financial model, please refer to Annex III.

Based on these key parameters, the total amount of profits forgone by early closure of these four remaining chlorinated rubber plants is projected to be $35,573,923 after deducting 20.38%. (The average level of export to Article 2 countries is 30.38%. Based on the ExCom guidelines, the funding level should, therefore, be reduced by 20.38%.) Distribution of the foregone profits is determined on the basis of the installed capacity of each enterprise. The distribution of foregone profits is shown in Annex III.

Table 10: Foregone Profits Induced by the Montreal Protocol

| | **Installed Capacity (MT of Chlorinated Rubber)** | **Forgone Profits ($)** |
|---|---|---|
| **Total** | **5,500** | **35,573,923** |

The Supreme Court of India has issued a ruling requiring that compensation for labor redundancy resulting from closure of business on environmental grounds be a minimum of six years' annual salary and admissible benefits. The total number of jobs lost as a result of plant closure is estimated to be 205, corresponding to a total labor compensation package of $1,857,600.

Therefore, the total cost for the closure option is the sum of profits foregone and labor compensation. This amounts to $37,431,523.

Option 3: Emission Abatement Technologies

An emission abatement system in principle consists of devices for collection, treatment, recovery, disposal, emission and quality control. This can be applied for various applications, including soil conservation, water purification, and air/vapor purification or recycling. An emission abatement system is characterized overall by strict control of operations, with detailed attention on operations. A large number of valves and joints in the plant need to be controlled for emissions/leakage; pumps and sealing systems of the reactors also need to be modified or replaced for sealing. Finally, it is also sensitive to power fluctuations/outage, which can lead to higher emissions of CTC.

Depending on the baseline equipment and the types of processes employed, an emission abatement system including maintenance practices could vary significantly. In certain cases, an emission abatement option may involve major plant overhaul. Therefore, costs of an emission abatement system could vary significantly. In certain cases, this may not even be a technically and financially feasible option.

The incremental capital cost of the emission abatement system of a 550 MT capacity at ROL has been previously worked out to be $2,199,230. The incremental operating cost of the same facility (NPV for four years) was worked out at $779,636. This provides a total cost for emission abatement of a 550 MT plant equal to $2,978,866. This estimate does not include the cost of licensing of technology or engineering consultancy charges over the period of commissioning of the emission abatement system. Such costs would have to be added to the incremental investment cost of this option.

With an emission abatement system alone, enterprises will not be able to completely phase out the use of CTC. Additional purification systems must be put in place in order to remove and recover CTC that is entrapped in the final product. Failure to do so will result in having about 3.5% of CTC used on chlorinated rubber remain in the product and eventually being emitted to the atmosphere. Furthermore, the product with this level of CTC content has become increasingly unacceptable as customers are discriminating against chlorinated rubber with a CTC content of more than 10 ppm. Finally, even if the Indian chlorinated rubber producers decide to exercise this option, they will not be able to do so because they do not have access to the product purification technology.

Therefore, the emission abatement technologies are clearly not an option for the Indian chlorinated rubber producers.

Option 4:  Industrial Rationalization

As pointed out in Option 1 not all enterprises will be able to access the new non-CTC chlorinated rubber production technologies.  Therefore, Option 1 scenario is not feasible. Similarly, Option 2 scenario, requiring that all chlorinated rubber producers in India completely stop their production, is also not desirable, as it would create abrupt disruption of the economic development of India.

Emission abatement option requires a long period for development and stabilization, and even in non-Article 5 (1) countries such systems are more effective only in large units with concerted efforts stretching over 10 years or more and involving large expenditures. Operation of these systems requires uninterrupted power supply, highly skilled man-power for preventive maintenance and upkeep of plant facilities and sustained training and experience.  Frequent power disruptions and consequent malfunctioning of abatement systems will, in fact, lead to higher emissions.  Such conditions are difficult to achieve in Article 5 countries.

The emission abatement system does not resolve the problem of substantial quantity of residual CTC in the end product.  Installation of a solvent exchange system to get over this problem is extremely costly and the required technology is not available.  Finally, adoption of emission abatement is at best an interim solution and continues to rely on CTC.

It is, therefore, considered much more desirable for India to undertake conversion at the two facilities that have access to the new non-CTC alternative technology, while the remaining producers have already decided to opt for a closure option. The total cost of $18,066,845 for the industrial rationalization option includes costs of conversion at RRIL and RPL, costs of closure plus labor compensation for Pauraj and Tarak.  With this level of funding, India will be able to completely phase out the use of CTC in this sub-sector without causing any disruption to its economic development.

Table 11:  Incremental Cost of Option 4

| | **CTC Phaseout Option** | **Incremental Cost ($)** |
|---|---|---|
| Conversion at two plants | Conversion | 14,538,898* |
| Closure at two plants | Closure | 2,909,947* |
| Labor Compensation for two plants | | 618,000 |
| **Total** | | **18,066,845** |

*Incremental cost after export deduction of 20.38 % (30.38% minus 10%) to Article 2 countries.

**Summary**

The costs of various options described above is summarized below:

Table 12: CTC Phaseout Costs for the Four Options Approved by the Parties

| Option | Incremental Cost ($) | CTC Phaseout (MT) | Cost Effectiveness ($/kg ODP) |
|---|---|---|---|
| Conversion | 16,336,536* | 347 | $42.80 |
| Closure | 37,431,523 | 347 | $98.07 |
| Emission Abatement | Not applicable | 325.25** | |
| Industrial Rationalization | 18,066,845 | 347 | $47.33 |

*Detailed cost calculation is provided in the project proposals for conversion of chlorinated rubber facility at RRIL and RPL. These proposals are attached as Annex VI of this document.
**Assuming that CTC emission during the process reduces to zero. CTC emissions are caused by the residual quantity of CTC entrapped in the final products (3% of the weight of the product).

**Proposed Strategy**

The Government of India and the chlorinated rubber producers in India agree to opt for Option 4 as their strategy for phasing out CTC consumption in this sub-sector. Based on this option, two enterprises that have access to a new non-CTC alternative technology will undertake conversions immediately after the Executive Committee approves the funds to support this strategy, and when the ROL facility, which is also funded by the Multilateral Fund, completes their non-CTC chlorinated rubber production conversion and becomes on-line.

Based on the historical data, the market of CTC chlorinated rubber has declined at a rate of 16 % per annum due to the Montreal Protocol. However, the demand for end products is growing at the rate of 12% per annum from 2002 to 2004. The demand in 2005 is further limited by the 85% reduction of CTC consumption. The declining market of CTC chlorinated rubber is being replaced by non-CTC chlorinated rubber and substitutes such as polyurethane, epoxies and acrylics.

Table 13: Projection of the Total Demand of Chlorinated Rubber and Alternative

| Year | Residual Demand for CTC chlorinated rubber (with MP) (MT) | CTC chlorinated Rubber Market that is Replaced by Substitutes (MT) | Total Demand for End Products (MT) |
|---|---|---|---|
| 2002 | 631 | 1,581 | 830 |
| 2003 | 530 | 1,454 | 1,984 |
| 2004 | 445 | 1,777 | 2,222 |
| 2005 | 171 | 2,317 | 2,488 |

Conversion and Closure Sequence: To preempt a significant shortfall of the supply of CTC chlorinated rubber a conversion and closure sequence of the four remaining producers must be carefully designed. Conversion and closure at the same time will create a sudden shortage of chlorinated rubber, which is not desirable.

Conversion and closure sequence shown as Option A in Annex V shows that by undertaking conversions at RRIL and RPL in 2003 or immediately after the approval of this proposed sub-sector plan, India will be able to optimize the contribution of this sub-sector plan to country's ability to meet the 85% reduction target for CTC and to minimize the shortfall of chlorinated rubber supply during the transition period from 2003 – 2005. Moreover, this option will enable India to recapture its previous years market that was taken away by non-CTC chlorinated rubbers and other substitutes. As shown by Option B, delaying the conversion at RRIL and RPL will result in a higher shortfall of the supply of chlorinated rubber during the transition period. In addition, this option will take India beyond 2005 before it can recapture its lost market.

The Government of India, therefore, proposes to convert and close the remaining production of CTC chlorinated rubber in accordance with Option A presented in Annex V.

**Implementation Timeframe**

The Project will be implemented by the CR producers in India. The proposed implementation schedule illustrated below becomes effective after the OTF grant is made available. The change over from the existing plant will entail a production shutdown of about 12 months.

**IMPLEMENTATION SCHEDULE**

| | **QUARTERS** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Year 2002** | | | | **Year 2003** | | | | **Year 2004** | | | |
| | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** |
| MF Project Approval | | | X | | | | | | | | | |
| Financial Appraisal | | | | X | | | | | | | | |
| Sub grant Agreement | | | | X | | | | | | | | |
| Equipment specification preparation | | | | | X | X | | | | | | |
| Equipment procurement | | | | | | X | X | | | | | |
| Installation of equipment | | | | | | | X | X | | | | |
| Civil work | | | | | | X | X | X | | | | |
| Testing and trials | | | | | | | | | X | X | | |
| Production Start-up | | | | | | | X | X | | X | X | |
| Project completed | | | | | | | | | | | | X |
| Plant Closure at Tarak and Pauraj | | | | | | | | | | | X | X |
| First Disbursement | | | | | X | | | | | | | |
| Final Disbursement | | | | | | | | | | | | X |
| Completion Report. | | | | | | | | | | | | X |

Annex I

CTC Consumption

Chlorinated Rubber Manufacturers in India

| Serial No. | Enterprise | Start of commercial production | Installed capacity (MT/yr.) | CTC consumption (MT/yr) | Process agent (CTC MT) inventory in plant equipment when inspected (Dec. 1999) |
|---|---|---|---|---|---|
| 1. | Rishiroop Polymers Pvt. Ltd. (RPL) | 1973 | 550 | (300)* | 65.0 |
| 2. | Pauraj Chemicals Pvt. Ltd. | 1980 | 150 | 82 | 26.0 |
| 3. | Rishiroop Organics Pvt. Ltd. (ROL) | 1991 | 550 | 226 | 65.0 |
| 4. | Rishiroop Rubber International Ltd. (RRIL) | 1993 | 4500 | 544 | 400.0 |
| 5. | Tarak Chemicals Ltd. | 1998 | 300 | 164 | 50 (estimated) |

*Projected consumption based on production records prior to the labor strike.

Breakdown of CTC Consumption (MT) at Each Chlorinated Rubber Producers in India

| | 91-92 | 92-93 | 93-94 | 94-95 | 95-96 | 96-97 | 97-98 | 98-99 | 99-00 | 00-01 |
|---|---|---|---|---|---|---|---|---|---|---|
| RRIL | - | - | | 184 | 625 | 575 | 456 | 346 | 352 | 130 |
| ROL | 52 | 227 | 12 | 7 | 141 | 262 | 221 | 196 | 123 | 69 |
| RPL | 222 | 223 | 219 | 235 | 31 | 0 | 0 | 0 | 0 | 0 |
| PAURAJ | 69 | 61 | 57 | 57 | 50 | 41 | 49 | 36 | 36 | 10 |
| TARAK | | | | | | - | - | 24 | 38 | 68 |
| **TOTAL** | **343** | **511** | **288** | **483** | **847** | **878** | **726** | **602** | **549** | **277** |

Average CTC consumption in last three years excluding ROL = 347 MT

# Annex II
# Cost Calculation for Conversion Option

The approved capital cost for the ROL project before applying 20% reduction on technology upgrade, is $2,284,742. This amount includes contingency of $155,968. In addition, the Multilateral Fund also approved a one-year incremental operating cost of $109,906. This funding level is for supporting the conversion of a 550 MT production capacity. The average CTC consumption during the period from 1996 – 1998 is 226.203 MT.

| Enterprise | Approved Incremental Capital Cost ($) | Technology Fee ($) | Installed Capacity (MT of CR) | Approved Capital Cost per MT of installed capacity ($/kg of CR)* | Approved Incremental Operating Cost for 344.33 MT CR production ($) | Approved Incremental Operating Cost per MT of CR produced ($/MT CR) |
|---|---|---|---|---|---|---|
| **ROL** | 2,140,987 | 238,000 | 550 | 3.46 | 109,906 | 316.84 |

*Excluding technology fee.

By taking the approved costs for the ROL project ($3.46/kg of installed capacity and $0.31684 /kg CR) plus a 10% contingency provision as standard costs, the conversion costs for the remaining four chlorinated rubber plants can be calculated as follow:

<u>Production of Chlorinated Rubber during the past three years</u>

| Enterprise | 1998 – 1999 | 1999 – 2000 | 2000 - 2001 | Avg. Level of Production (MT) | Avg. Level of Export to Art. 2 Countries |
|---|---|---|---|---|---|
| RRIL | 686 | 496 | 338 | 507 | 283 |
| ROL | 336 | 238 | 165 | 246 | 0 |
| RPL | 0 | 0 | 0 | 0 | 0 |
| Pauraj | 112 | 90 | 33 | 78 | 0 |
| Tarak | 41 | 163 | 215 | 140 | 12 |
| Total | 1,175 | 987 | 751 | 971 | 295 |

CTC Consumption (MT) during the past three years

| | 1998 -1999 | 1999 - 2000 | 2000 - 2001 | Average CTC Consumption (MT) |
|---|---|---|---|---|
| RRIL | 346 | 352 | 130 | 276 |
| ROL | 196 | 123 | 69 | 129 |
| RPL | 0 | 0 | 0 | 0 |
| PAURAJ | 36 | 36 | 10 | 27.33 |
| TARAK | 24 | 38 | 68 | 43.33 |
| TOTAL | **602** | **549** | **277** | **475.66** |

Export of Chlorinated Rubber to Non-Article 5 Countries during the last three years

| Enterprise | 1998 – 1999 | 1999 – 2000 | 2000 - 2001 | Avg. Level of Export to Non-Art. 5 Countries (MT) |
|---|---|---|---|---|
| RRIL | 415 | 255 | 178 | 283 |
| ROL | 0 | 0 | 0 | 0 |
| RPL | 0 | 0 | 0 | 0 |
| Pauraj | 0 | 0 | 0 | 0 |
| Tarak | 0 | 10 | 25 | 12 |
| Total | 415 | 265 | 203 | 295 |

The export component of the overall chlorinated rubber sub-sector is calculated on the basis of the average production level and the level of export to Article 2 countries during the period of 1999 – 2001.

For RRIL and RPL, conversion costs are determined on the basis of actual costs. The detailed cost breakdown for conversion at these two enterprises is shown in Annex VI, Parts A and B.

| Enterprise | ICC ($) | Contingency ($) | IOC ($) | Total |
|---|---|---|---|---|
| RRIL | 14,109,530 | 1,376,553 | 161,829 | 15,647,912 |
| RPL | 2,396,588 | 215,859 | 0 | 2,612,447 |

For Pauraj and Tarak, which do not have access to new non-CTC alternative, estimate for the conversion option is carried out as follow:

| Enterprise | Installed Capacity (MT of CR) | ICC* ($) | Technology Fee ($) | Total ICC ($) |
|---|---|---|---|---|
| Pauraj | 150 | 519,000 | 238,000 | 757,000 |
| Tarak | 300 | 1,038,000 | 238,000 | 1,276,000 |

*ICC does not include technology fee.

| Enterprise | ICC ($)* | Contingency ($)* | Production Level (MT of CR) | IOC ($) | Total ($) |
|---|---|---|---|---|---|
| Pauraj | 757,000 | 51,900 | 78 | 24,714 | 833,614 |
| Tarak | 1,276,000 | 103,800 | 140 | 44,358 | 1,424,158 |

*It is estimated that the actual conversion costs, without the technology fee, for Pauraj and Tarak are approximately $1 million and $1.7 million, respectively.
*No contingency provision for technology fee.

**Summary :**

| | |
|---|---|
| Incremental Capital Costs | $ 18,539,118 |
| Contingency | $ 1,748,112 |
| Sub-total | $ 20,287,230 |
| Incremental Operating Costs | $ 230,901 |
| Sub-total | $ 20,518,131 |
| Export to Article 2 Countries (30.38%) | $ (4,181,595) |
| Total Eligible Grant Amount | $ 16,336,536 |

With the average production level of 971 MT and the average level of export to Article 2 countries of 295 MT during the corresponding period, the component of export to Article 2 countries is equal to 30.38%. Therefore, the incremental cost should be reduced by 20.38% (30.38% minus 10%, in accordance with the ExCom decision). After deducting the export component, the total eligible cost for this option becomes $16,336,536.

# Annex III
# Cost Model for Plant Closure Option

**Methodology for Calculating the Compensation Level Under the Closure Option**

A financial model is developed for determining the level of profit foregone in case the chlorinated rubber manufacturers decide to opt for an early closure of their facilities. Assuming that there was no Montreal Protocol, unconstrained growth in the demand and production of chlorinated rubber with CTC would have been expected.

To calculate streams of profit foregone by the chlorinated rubber producers due to early phaseout of chlorinated rubber production, actual selling price, variable and fixed costs in the baseline year (the financial year 1996 – 1997), are used. Projected income and costs are determined on the basis of unconstrained growth until the year 2010.

The followings are key parameters employed by this financial model:

Installed Capacity

The installed capacity as reported by each enterprise is listed below. This listed capacity is calculated on a basis of 3 shifts a day.

| Enterprise | Installed Capacity (MT of Chlorinated Rubber) |
|---|---|
| RRIL | 4,500 |
| RPL | 550 |
| Pauraj | 150 |
| Tarak | 300 |
| **Total** | **5,500** |

Baseline Production

The annual production levels during the three consecutive financial years (1995 – 1996, 1996 – 1997, and 1997 – 1998) are used for establishing an average annual production level or baseline production level. With this assumption, the baseline production level is 1,005 MT.

Baseline Year

The financial year of 1996 – 1997, starting from April 1996 to March 1997, is used as a baseline year. Sales price and other costs prevailing during this financial year are used as a basis for calculating costs and income in the subsequent years.

Growth Rate

The market experts projected that considering the economic downturn experiencing in India and other developing countries the demand of paints and inks will grow at a rate of about 12% from 2001 onwards. This growth rate is used in this model in order to calculate streams of profit forgone by the enterprises. This 12% rate is applied from 1996 – 2010. This rate is considered to be conservative as the actual growth rate during the period of 1990 – 1996 was reported to be at the level of 27% per annum.

Sales Price

The selling price is based on actual export price realized by Indian producers plus 10% in order to arrive at an international price of chlorinated rubber during the baseline year (1996 – 1997). In the subsequent years, the sales price is increased by 3% to account for the inflation rate.

Variable Costs

Variable costs consisting of raw material cost, utilities costs, effluent treatment costs, and labor costs, are also adjusted by 3% a year to account for the inflation rate.

Material Costs

The two important items that are imported by chlorinated rubber producers in India are CTC and synthetic rubber. The international prices of these two items have been taken at actual import cost (CIF price) while local prices for other items like chlorine, stabilizers, and etc., are used in this model as these items are purchased locally. The quantities of raw materials used for different production levels are calculated by using the standard consumption norms.

Utility Costs

These consist mainly of cost of electricity and furnace oils. The costs of these items are calculated on the basis of the rates prevailing in the local market.

Selling Expenses

These expenses represent the cost of shipping and handling of the final products. A flat rate charge of 6% of the selling price is used for this model.

Salaries and Wages

These costs are based on the actual costs in the baseline year. Costs for subsequent years are adjusted by 3% in order to account for inflation.

Fixed Overheads

These consist mainly of administrative overheads and are based on actual overheads incurred in the baseline year. Overhead costs for subsequent years are also adjusted by 3%.

Net Present Value (NPV)

The net present value of the foregone profits are calculated by applying a 7% discounting rate on the profit stream prior to deduction of interest and depreciation.

Based on the above parameters, the followings are the foregone profits to be experienced by each enterprise if it decides to opt for a closure option.

| **Enterprise** | **Installed Capacity (MT of Chlorinated Rubber)** | **% of Market Share** | **Forgone Profits ($)** |
|---|---|---|---|
| RRIL | 4,500 | 81.82 | 36,556,875 |
| RPL | 550 | 10 | 4,467,963 |
| Pauraj | 150 | 2.73 | 1,219,754 |
| Tarak | 300 | 5.45 | 2,435,040 |
| **Total** | **5,500** | **100** | **44,679,632** |

Labor Compensation

The annual man-power costs for these enterprises are as follows:

| **Enterprise** | **No. of Employees** | **Annual Cost of Salary and Benefits** |
|---|---|---|
| Rishiroop Polymers | 15* | 39,600 |
| Rishiroop Rubber International | 120 | 167,000 |
| Pauraj Chemicals | 30 | 41,000 |
| Tarak Chemicals | 40 | 62,000 |
| **Total** | 205 | 309,600 |

*Rishiroop Polymers had about 85 employees and annual man-power cost was about $81,000 at the time of the labor dispute leading to temporary suspension of work.

Pursuant to the decision of the Indian Supreme Court, the compensation to be paid for labor redundancy resulting from closure of business on environmental grounds must be a minimum of six years of annual salary and admissible benefits.

There the total labor compensation for closing down these four enterprises amounts to $1,857,600.

## Analysis for Profits Foregone Due to the Montreal Protocol and Early Closure

| | QTY ( M.T. / CR ) | | UNIT RATE PER M.T. ( US $ ) | COST PER M.T. of CR ( US$ ) |
|---|---|---|---|---|
| PRODUCTION IN M.T. | | | | |
| SALES PRICE ( PER M.T./ CR ) | | | | |
| SALES ( value ) ( A ) | | * | 4125.00 | 4125.00 |
| LESS : VARIABLE COST | | | | |
| **MATERIAL COST** | | | | |
| CTC | 0.631 | * | 450.00 | 283.95 |
| SYNTHETIC RUBBER | 0.38 | * | 1275.00 | 484.50 |
| LIQUID CHLORINE | 1.2 | | 0.09 | 108.00 |
| STABILIZER | 0.01 | | 1.22 | 1.22 |
| CATALYST 1 | 0.00138 | | 0.003 | 0.004 |
| CATALYST 2 | 0.00043 | | 0.009 | 0.004 |
| PACKING COST | | | 37.40 | 37.40 |
| **UTILITIES COST** | | | | |
| CONSUMABLE STORES | | | 92.02 | 92.02 |
| POWER ( KWH ) | 3158 | | 0.07 | 209.67 |
| FURNACE OIL | 1100 | | 0.14 | 151.05 |
| EFFLUENT TREAT EXPENSES | 0.275 | | 0.04 | 0.01 |
| ( B ) | | | 1855.99 | 1367.83 |
| EXPORT CHARGES ( C ) | | | 247.50 | 247.50 |
| TOATL VARIABLE COST (D = B + C ) | | | 2103.49 | 1615.33 |
| **CONTRIBUTION ( E = A - D )** | | | **2021.509** | **2509.67** |
| LESS : FIXED EXPENSES | | | | |
| FIXED OVERHEADS ( F ) | | | | 619.48 |
| Depreciation | | | | |
| Net Profit before Tax | | | | |
| Tax | | | | |
| Net Profit after Tax | | | | |
| Depreciation | | | | |
| Cash accruals | | | | |
| **Cash accruals** | | | | **1890.19** |
| **NET PRESENT VALUE @ 7%** | | | | |

* Based on International Prices
Other items are based on Local Prices

# Annex IV
# Cost Model for Industrial Rationalization Option

As it is more desirable for India to undertake conversion at the two facilities that have access to the new non-CTC alternative technology, while the remaining producers will opt for a closure option, the cost estimate for this model is, therefore, the sum of the costs of conversion at RRIL and RPL, and the closure costs for Pauraj and Tarak. The closure cost will have to include a labor compensation for the corresponding plants.

| Enterprise | Installed Capacity (MT of Chlorinated Rubber) | % of Market Share | CTC Phaseout Option | Incremental Cost ($)* |
|---|---|---|---|---|
| RRIL | 4,500 | 81.82 | Conversion | 15,647,912 |
| RPL | 550 | 10 | Conversion | 2,612,447 |
| Pauraj | 150 | 2.73 | Closure | 1,219,754 |
| Tarak | 300 | 5.45 | Closure | 2,435,040 |
| **Total** | **5,500** | **100** | | **21,915,153** |

*Export deduction of 30.38-10.00 % is excluded.

The export deduction for the entire sub sector will be USD 4,466,308 and the eligible grant amount works out to USD 17,448,845.

| Enterprise | Labor Compensation ($) |
|---|---|
| Pauraj Chemicals | 246,000 |
| Tarak Chemicals | 372,000 |
| **Total** | 618,000 |

Taking into account the labor compensation of USD 618,000 for Pauraj and Tarak, the total cost for industrialization option works out to USD 18,066,845.

Therefore, the total cost for the industrial rationalization is equal to $18,066,845.

# Annex V
# Conversion and Closure Sequence

## Option A*

| | | | | | TOTAL | CR /CTC | CR /CTC | CR/CTC FREE | TOTAL | TOTAL | GAP** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **YEAR** | **RRIL** | **RPL** | **PAURAJ** | **TARAK** | **SUPPLY** | **DEMAND** | **GAP** | | **SUPPLY** | **DEMAND** | |
| | | | | | | | | | | | |
| **2003** | Conv. | Conv. | 150 | 300 | 450 | 530 | 80 | 1454 | 450 | 1984 | 1534 |
| **2004** | Conv. | Conv. | 150 | 300 | 450 | 445 | -5 | 1777 | 450 | 2222 | 1772 |
| **2005** | 4500 | 550 | 0 | 0 | 5050 | 171 | -4879 | 2317 | 5050 | 2488 | -2562 |

* All figures are in metric tons per year.
** Plus means unmet demand while minus means surplus.

**Option B***

| | | | | | TOTAL | CR /CTC | CR /CTC | CR/CTC FREE | TOTAL | TOTAL | GAP** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **YEAR** | **RRIL** | **RPL** | **PAURAJ** | **TARAK** | **SUPPLY** | **DEMAND** | **GAP** | | **SUPPLY** | **DEMAND** | |
| | | | | | | | | | | | |
| **2003** | 530 | Conv. | O | 0 | 530 | 530 | 0 | 1454 | 530 | 1984 | 1454 |
| **2004** | 445 | Conv. | 0 | 0 | 445 | 445 | 0 | 1777 | 445 | 2222 | 1777 |
| **2005** | Conv | 550 | 0 | 0 | 550 | 171 | -379 | 2317 | 550 | 2488 | 1938 |

* All figures are in metric tons per year.
** Plus means unmet demand while minus means surplus.

# Annex VI
# Detailed Project Proposal

## 37th MEETING OF THE EXECUTIVE COMMITTEE OF THE MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL

### Annex VI Part A

| | |
|---|---|
| **COUNTRY:** | India |
| **IMPLEMENTING AGENCY:** | World Bank |
| **PROJECT TITLE:** | Conversion of Chlorinated rubber manufacture from Carbon Tetra Chloride to non-ODS process at Rishiroop Rubber International Ltd India. |
| **PROJECT IN CURRENT BUSINESS PLAN:** | Yes |
| **SECTOR:** | Solvents |
| **SUB-SECTOR:** | Process agents |
| **ODS USE IN SECTOR:** | Baseline (1999-2001) 304 ODP tons<br>Current (1997) 7876 ODP tons (total CTC Consumption in 1997 as reported to the MP Ozone Secretariat) |
| **PROJECT IMPACT (ODS TO BE ELIMINATED):** | Projected Phase out 276 MT CTC (304 ODP tons) |
| **PROJECT DURATION:** | 24 months |
| **PROJECT COSTS:** | |
| Incremental Capital Costs | US$ 14,109,530 |
| Contingency (10%) | US$ 1,376,553 |
| Incremental Operating Costs (NPV for 1 year) | US$ 161,829 |
| Total Project Cost | US$ 15,647,912 |
| **LOCAL OWNERSHIP:** | 100% |
| **EXPORT COMPONENT:** | |
| **REQUESTED GRANT:** | Part of Sector Plan |
| **IA SUPPORT COST:** | Part of Sector Plan |
| **TOTAL COST TO MLF:** | Part of Sector Plan |
| **COST EFFECTIVENESS:** | Part of Sector Plan |
| **PROJECT MONITORING MILESTONES INCLUDED:** | Yes |
| **NATIONAL COORDINATING AGENCY** | MoEF, National Ozone Unit |


**PROJECT SUMMARY**

This project will lead to elimination of the use of 276 MT per year (304 MT ODP) of Carbon Tetra Chloride in the manufacture of Chlorinated Rubber by Rishiroop Rubber International Ltd. The proposed proprietary technology to be adopted has been developed in house by the enterprise using a non-ODS media for the chlorination reaction and is non-transitional.



**Prepared by:** Indian Chemical Manufacturers Association and the World Bank **Date:** March 21, 2002

**OORG review by:** William Kenyon **Date:** April 22, 2002

## 1. PROJECT OBJECTIVES

The objective of this project is to completely phase out the use of Carbon Tetra Chloride (CTC) as a process solvent in the production of Chlorinated Rubber (CR) by Rishiroop Rubber International Ltd-Ankleshwar. (RRIL). The installed capacity of the present production facility is 4500 MT per year and it is proposed that this capacity be converted.

The implementation of this project will contribute to helping India to meet its obligations to phase out use of Ozone Depleting Substances (ODS).

## 2. SECTOR BACKGROUND

The detailed information on the process agent sector is included in the main document.

## 3. DESCRIPTION OF PRODUCTION FACILITIES

RRIL is a 100% Indian owned public limited company, and was incorporated in 1990. Its shares are listed on Bombay stock exchange and it has about 20,000 shareholders. The company is promoted by Rishiroop group. It has production facility for manufacture of CR at Ankleshwar in the state of Gujarat. During the last three fiscal years RRIL exported on an average 55.7 % of its production to non- article (5) countries during 1998-2001.

The Ankleshwar production facility started commercial production of CR in 1993 with an installed capacity of CR of 4,500 MT per annum on three shift basis. In the fiscal year 1996-97 RRIL had achieved highest CR production of 966 MT. Since then the production sales have been decreasing due to constraint on the sale and use of products containing ODS. It presently employs 120 persons at the plant .

It uses CTC as an inert solvent in the manufacture of CR. The conventional process for production of CR involves using CTC as a solvent medium for chlorination of the rubber. The dry rubber is first dissolved in CTC, and this rubber solution is reacted with chlorine gas to produce chlorinated rubber, which stays dissolved in CTC. The solvent CTC is then recovered from this CR solution by flashing it in hot water and recycling it. Because CTC is required to be used as a process solvent and is handled in large quantities, the process causes emissive losses during storage, handling, and reaction, and there is also some presence of CTC as an impurity in the finished product; these factors cause CTC ‘consumption’. The various stages of the manufacturing process include feedstock preparation, chlorination, recovery of solvent, filtration, drying, blending and packing. They require media resistant equipment (glass-lined reactors, lead bonded carbon steel reactors, etc.) The facilities have utility sections, comprising boilers for steam generation, refrigeration systems, diesel-based generating power sets for standby power generation, air compressors, cooling towers, etc. Finally, the facilities also have primary and secondary effluent treatment systems for waste water treatment and solid-waste disposal.

The details of CR production and CTC consumption for the last three years of production are as follows:

**Table II: Average production and CTC consumption.**

| Year | CTC Consumed (MT) | CR Produced (MT.) |
|---|---|---|
| 98-99 | 346 | 686 |
| 99-00 | 352 | 496 |
| 00-01 | 130 | 338 |
| Average | 276 | 507 |

The average consumption of CTC for the last three years of operation as mentioned above, is 276 MT per annum, which is 544 kg per MT of CR.

## 4. OPTIONS UNDER DECISION X/14

For ODS free CR production, the following options are available under decision X/14, and the costs of the various options are assessed in the following discussion:

1. Total closure
2. ODS emission abatement
3. Conversion to non-ODS process

The first two options have already been discussed in details in the main document. This annex will focus on costing of Option 3.

### 4.1. OPTION 3: CONVERSION OF PRODUCTION FACILITY AT ANKLESHWAR.

The Executive Committee approved ROL Project for conversion to non ODS process for manufacturing of Chlorinated Rubber at its 34th Meeting. The ROL Project has installed capacity of 550 MT and was granted with an incremental cost of US$ 2.07 million after deduction of US$ 330,537 on account of provision of a new plant. Rishiroop Rubber International (RRIL) is proposing to use the same technology for converting its full capacity of 4,500 MT of chlorinated rubber per year. The detailed conversion process is described below.

## 5. Project Proposal:

Several modifications /additions are required for converting the existing plant equipment to the new process. These include installation of new process equipment, storage facilities, piping and infrastructure facilities (e.g. power, water, air), etc., with different construction materials to match the new process conditions.

A list of the equipments required to be added/replaced to replace the existing capacity of CR at Ankleshwar is given at **Annex 1**.

A brief description of the major additions in equipment required is given below:

- 60 KL capacity fiber-glass reinforced polyester (FRP) storage tanks to store both fresh and recovered acid.
- Storage tank of 30 KL capacity of Stainless Steel to store rubber latex as a new raw material.
- Glass-lined carbon steel reactors of 8 kl capacity for preconditioning prior to chlorination.
- Glass-lined carbon steel reactors of capacity of 8 kl to carry out the new chlorination process. The existing glass-lined reactors are unsuitable. The new process requires a different type of agitation system in the reactor, which does not exist in the existing reactors and has to have modification in the nozzles of the reactor to accommodate the photochemical lamps.
- A Photochemical system will be added to catalyze the reaction.
- Pumps of corrosion resistant material for various operations such as circulating the contents of the reactor during chlorination and transporting the chlorinated product.
- Glass-lined stirred tanks of 8 kl capacity to store the reaction product after the chlorination process.
- Replacement corrosion resistant filters to remove the acid from the reaction product. The material of the present filtration equipment does not render it suitable for use.
- The filtered reaction product must be conveyed to the dryer by a conveying system along with a storage bin and a feeder. At present, this is handled by a screw conveyor, which will be unsuitable since the CR from the conventional process has different flow characteristics.
- Spray dryers will be required to remove the moisture from the wet product. The existing spin flash dryers are not suitable for this purpose.
- A pneumatic conveying system to convey the chlorinated rubber powder obtained from the dryer to a blending and packing unit.

- The fume extraction system will consist of suction ducting, suction blower, lime absorption column and lime circulation pumps which will absorb any trace hazardous gases emanating in the new process from various reactors and storage tanks. Further, in order to remove final traces of acid and chlorine from the tail gases, it would be necessary to scrub these gases with dilute alkali in a column prior to final discharge to atmosphere.
- The acid absorption system of higher capacity will consist of an acid scrubber, corrosion resistant pumps and an acid storage tank and acid absorber.
- An enhanced effluent treatment facility will be installed consisting of neutralizer settling tank, aerators and sludge pumps to handle a larger quantity of waste water. This facility will treat the trace quantities of acid and chlorine gas and bring it within standard norms required by the local pollution control authorities.
- A major portion of the existing piping and valves has to be replaced due to new process conditions and acidic material. Most of the new piping will be of PVDF or stainless steel or Teflon-lined carbon steel.
- Additional safety equipment to supplement existing equipment will be procured. This will consist of hazardous gases leakage detection, sensing, alarm and control system.

### 5.1. Civil Works and Utilities

The existing civil structures at RRIL, Ankleshwar are expected to be inadequate for accommodating the equipment for the converted production facility. Additional structural facilities will be required to accommodate the additional reactors and other process equipment. Some changes will also be necessary to be incorporated to the existing civil and structural facilities..

- Additional civil works will have to be incurred for construction of new tank farms for acid and rubber latex storage, acid-proof tile lining in critical process areas, additional underground water storage tank, civil foundations for various new equipment, additional storage facility for finished goods, etc.
- The new process does not require use of steam, thus rendering the existing steam boilers redundant. The converted plant will, however, require a much larger quantity of water requiring additional water storage and handling facilities. Consequently the size of effluent treatment facility will be bigger.
- Sizable additional connected power requirements will primarily arise due to the photochemical system in the new process. This will include an increase in electrical load transformer capacity with attendant transmission connection charges and enhanced main power distribution center, etc. In addition, the standby diesel generation capacity will need to be suitably augmented so as to ensure continuous power supply during the critical reaction process.
- A higher capacity cooling system such as chilling plants will have to be installed to cater to the augmented capacity and the requirements of the new process.
- To meet additional requirements of air for process and instrumentation, compressors will have to be installed in combination with suitable air dryers.

### 5.2. Redundant Equipment

The equipment becoming redundant or to be replaced in this project is given in **Annex 3**. The used equipment is generally more than 8 years old and has low book value. Having been used in chemical process plants, the equipment has virtually no salvage or resale value,.

## 6. JUSTIFICATION FOR THE SELECTION OF ALTERNATIVE TECHNOLOGY

Three alternative technologies exist for conversion to ODS free production of CR, as follows:

1. A solvent exchange process developed and patented by a German company.
2. A non-ODS process developed by a Japanese company.
3. A non-ODS developed indigenously in India by RRIL.

Solvent Exchange Process : A German enterprise has adopted a two stage procedure to reduce the emissions from their process and to eliminate the CTC contained as impurity in the CR produced by them as under:

a) The German enterprise spent about US$25 million to reduce the emissions in their **7,000 TPA capacity** plant from a level of about 430 MT in 1989 to a level of about 0.3 MT in 1996 and that too over a period of 7 years of intensive efforts.
b) In addition, this enterprise has spent about US$40 million to modify its plant to reduce the impurity of CTC from its product, which was eventually being emitted to the atmosphere in the end use. This was done by adopting a patented process for the solvent exchange by it.
c) Furthermore, the German enterprise has stated that they are incurring an incremental operating cost for environmental operation of their plant of US$0.8 million per year

These details are consistent with the description on chlorinated rubber applications provided in the Report of the Chemical Process Agents Working Group of the TEAP, May 1995 . It seems to be clear that this alternative is expensive and has other limitations as it presents an interim solution and an eventual conversion to a non ODS process will be later required to be carried out.

Non-ODS Japanese process: A Japanese enterprise has developed a non-ODS process for CR and commercialized it in 1997. According to some news reports the Japanese process cost the company an investment of about Yen 1 billion to set up a production facility of 800 MT of CR per annum, which is expensive and not very cost effective, (a brief write up on this subject from Japan Chemical Weekly (J.C.W. April 20, 1995 is available in the project file in the Bank. RRIL had contacted this Japanese company, but an agreement for licensing their patent did not materialize.

Non-ODS RRIL process : The new RRIL process of chlorination of rubber through aqueous media completely eliminates the usage of CTC, and the CR produced by this process does not contain any entrapped CTC. **RRIL applied for a domestic patent for their process in December 1998, and have registered a provisional patent under Indian law on January 8, 1999.** By changing over to technology, RRIL will achieve complete elimination of CTC usage in their integrated converted facility at Ankleshwar.

**PROJECT COST:**

The incremental capital cost includes major components as follow:

| | |
|---|---|
| Process Equipment | $ 8,830,530 |
| Effluent Treatment Facility | $ 300,000 |
| Process Utility and Piping | $ 1,195,000 |
| Electrical Equipment | $ 280,000 |
| Instrumentation, Dismantling and Erection Costs, Insultation & Painting, Safety Equipment, Civil and Structural Work, Consultant's fees for detailed Engineering | $ 1,800,000 |
| Know-how development | $ 344,000 |
| Trial and Training | $ 300,000 |
| Change-over Costs | $ 460,000 |
| Start-up and Commissioning | $ 600,000 |
| Sub-total | $14,109,530 |
| Contingencies (10%)* | $ 1,376,553 |
| Total | $15,486,083 |

*Contingency of 10% does not apply to the cost of know-how development.

Details of the incremental capital costs are given in **Annex 1**.

The incremental operating costs are expected to be US$ 161,829 for one years operation based on 507 TPA production level as given in **Annex 2.**

Thus the total incremental project cost is expected to be about US$ 15,647,912.

## 7. PROJECT IMPLEMENTATION

The Project will be implemented by M/s RRIL in Ankleshwar. The proposed implementation schedule illustrated below becomes effective after the OTF grant is made available. The change over from the existing plant will entail a production shutdown of about 12 months.

**IMPLEMENTATION SCHEDULE**

| | **QUARTERS** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Year 2002** | | | | **Year 2003** | | | | **Year 2004** | | | |
| | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** |
| MF Project Approval | X | | | | | | | | | | | |
| Financial Appraisal | | X | | | | | | | | | | |
| Sub grant Agreement | | X | | | | | | | | | | |
| Equipment specification preparation | | X | X | | | | | | | | | |
| Equipment procurement | | | X | X | | | | | | | | |
| Installation of equipment | | | | X | X | | | | | | | |
| Civil work | | | X | X | X | | | | | | | |
| Testing and trials | | | | | | X | X | | | | | |
| Production Start-up | | | | | | | X | X | | | | |
| Project completed | | | | | | | | | X | | | |
| First Disbursement | | X | | | | | | | | | | |
| Final Disbursement | | | | | | | | | X | | | |
| Completion Report. | | | | | | | | | X | | | |

**Direct Benefits**:

During the first 12 months of operation of the converted plants, the quantity of ODS phased out will total 276 MT of Carbon tetrachloride (304 ODP Tons)

**Indirect Benefits**:

There are no indirect benefits from this project.

## ANNEX 1

| | I NCREMENTAL CAPITAL COST FOR 4500 TPA PLANT AT RRIL | | | |
|---|---|---|---|---|
| Sr.No. | Item | Unit Cost (USD) | Nos. | Total (USD) |
| A | **PROCESS FACILITY** | | | |
| | | | | |
| 1 | FRP storage tanks (50kl) | 16500 | 4 | 66,000 |
| 2 | PVDF lined magnetic sealless pump | 3300 | 6 | 19,800 |
| 3 | Stainless steel storage tank 30 kl | 27500 | 2 | 55,000 |
| 4 | Air operated PTFE-lined diaphragm pump | 10670 | 5 | 53,350 |
| 5 | Stainless steel blending reactor(1kl) | 11000 | 4 | 44,000 |
| 6 | Air operated PTFE-lined diaphragm pump | 6600 | 16 | 105,600 |
| 7 | Glass-lined Carbon Steel Reactors(8kl) | 66000 | 8 | 528,000 |
| 8 | Glass-lined Carbon Steel Reactors(8kl) | 98000 | 16 | 1,568,000 |
| 9 | PVDF Lined Carbon Steel housing in photo-chemical system | 3300 | 32 | 105,600 |
| 10 | Photochemical System | 25,300 | 32 | 809,600 |
| 10.1 | Spare equipment for photochemical system start up | 88000 | 1 | 88,000 |
| | Cooling system photo chemical systems exchanger (2.5 m2) | | | |
| 11.1 | Stainless steel heat exchanger (2.5 m2) | 770 | 32 | 24,640 |
| 11.1 | Stainless steel centrifugal pump (1m3/hr) | 770 | 32 | 24,640 |
| | | | | |
| 12 | Static Mixer | 4400 | 16 | 70,400 |
| 13 | Graphite heat exchanger (10 m2) | 15400 | 16 | 246,400 |
| 14 | PVDF/PTFE AOD pumps. | 13200 | 32 | 422,400 |
| 15 | Glass-lined Stirred tanks (8 kl) | 66000 | 10 | 660,000 |
| 15a | Air Operated PVDF-lined diaphragm pump | 10450 | 4 | 41,800 |
| 15b | PVDF Surge Suppressor | 3850 | 4 | 15,400 |
| 16 | FRP belt filter system (350 kg/hr) | 495000 | 2 | 990,000 |
| 17 | Wet product conveying system | 88000 | 2 | 176,000 |
| 18 | Stainless steel feed bins(15kl) | 38500 | 2 | 77,000 |
| 19 | PTFE-LINED stainless steel dryer system consisting of hot oil generator, radiator, air filter, dust collector, blower etc. | 495000 | 2 | 990,000 |
| 20 | PVDF lined magnetic pump, $2m^3/hr$, 20 mH | 4400 | 4 | 17,600 |
| 21 | Piping – PVDF, Stainless steel, FRP, PP, CPVC, ABS pipes, valves and fittings. | 440000 | 1 | 440,000 |
| 22 | Pneumatic conveying system | 440000 | 1 | 440,000 |
| 23 | Stainless steel 316 Feed bins (30 KL) | 30250 | 2 | 60,500 |
| 24 | UPS system for photochemical system | 15400 | 32 | 492,800 |
| 25 | Stainless steel blender (5 kl) | 27500 | 2 | 55,000 |

| | | | | |
|---|---|---|---|---|
| 26 | FRP Fume Extraction system with alkali scrubber | 143000 | 1 | 143,000 |
| | | | | |
| | | | | |
| | **Sub-total group A** | | | **8,830,530** |
| | | | | |
| **B** | **EFFLUENT TREATMENT FACILITY** | | | |
| | | | | |
| 1 | Reinforced concrete tank – Neutralizer | 40000 | 2 | 80,000 |
| 2 | Reinforced concrete settling tank | 20000 | 2 | 40,000 |
| 3 | Reinforced concrete tank –Aerator | 20000 | 2 | 40,000 |
| 4 | Sludge Pumps | 1000 | 10 | 10,000 |
| 5 | Acid proof lined reinforced concrete sludge drying beds | 20000 | 3 | 60,000 |
| 6 | Effluent Tank | 30000 | 2 | 60,000 |
| 7 | Consultant’s fees for designing ETP system | 10000 | 1 | 10,000 |
| | **sub-total group B** | | | **300,000** |
| | | | | |
| **C** | **PROCESS UTILITY & PIPINGS (Annex 9)** | | | |
| | **Utility** | | | |
| 1 | Air dryers 40 $m^3$/min | 45000 | 2 | 90,000 |
| 2 | Air Compressors 40 $m^3$/min | 75000 | 2 | 150,000 |
| 3 | Cooling Tower( 1500 TR) | 35000 | 1 | 35,000 |
| 4 | Underground water storage tank | 25000 | 1 | 25,000 |
| 5 | Overhead Tank | 10000 | 1 | 10,000 |
| 6 | Chilling plants ( 150 TR) | 125000 | 2 | 250,000 |
| 8 | Diesel Generators 1700 KVA | 225000 | 2 | 450,000 |
| 9 | Water softeners | 20000 | 2 | 40,000 |
| 10 | Air Receiver | 25000 | 1 | 25,000 |
| 11 | Mild steel/ABS pipes, valves & fittings for above | 120000 | 1 | 120,000 |
| | | | | |
| | **Sub-total group C** | | | **1,195,000** |
| | | | | |
| **D** | **ELECTRICALS** | | | |
| 1 | Transformer | 50000 | 1 | 50,000 |
| 2 | Additional Powerline cost | 40000 | 1 | 40,000 |
| 3 | Power Control Centre | 60000 | 1 | 60,000 |
| 4 | Capacitors | 30000 | 1 | 30,000 |
| 5 | Electrical Cables, switches, starters etc. | 100000 | 1 | 100,000 |
| | | | | |
| | **Sub-total group D** | | | **280,000** |
| | | | | |
| **E** | **INSTRUMENTATION** | 250000 | 1 | **250,000** |
| | Control panels, Instruments such as rotameters, pressure gauges, temp gauges, Control valves, Misc. items (cables, etc) and labor charges | | | |
| | | | | |

| | | | | |
|---|---|---|---|---|
| F | **DISMANTLING OF SURPLUS ITEMS** | 150000 | 1 | **150,000** |
| G | **ERECTION COSTS** | 250000 | | **250,000** |
| H | **INSULATION & PAINTING** | 150000 | 1 | **150,000** |
| | | | | |
| I | **SAFETY EQUIPMENTS** | 100000 | 1 | **100,000** |
| | Continuous chlorine monitoring system | | | |
| | HCL monitoring system | | | |
| | | | | |
| J | **CIVIL WORKS** | 250000 | 1 | **250,000** |
| | Consists of equipment foundations, tank farms, acid-proof tile lining, civil costs of power control centers, process control rooms and warehouse expansion and architects fees. | | | |
| | | | | |
| J | **STRUCTURAL WORK** | 400000 | 1 | **400,000** |
| | | | | |
| K | **KNOW HOW DEVELOPMENT COST** | 344000 | 0 | **344,000** |
| | | | | |
| L | Consultant's fees for detailed engineering @ 2.5% | 250000 | 1 | **250,000** |
| | **Total (E to L)** | | | **2,144,000** |
| | | | | |
| M | **Pre- operative Cost** Trial, Training and commissioning. | | | |
| | Insurance | | | |
| | Traveling | | | |
| | Training | | | |
| | Salaries of project team | | | |
| | Communication expenses | | | |
| | sub-total group M | | | **300,000** |
| | | | | |
| N | **Changeover costs** | | | **460,000** |
| | Fixed Overhead cost for twelve months | | | |
| | | | | |
| O | **Start up & commissioning** | | | **600,000** |
| | Cost of materials and variable costs | | | |
| | Commissioning | | | |
| | | | | |
| | **TOTAL** | | | **14,109,530** |
| | | | | |
| | **Contingencies @10%*** | | | **1,376,553** |
| | **TOTAL INCREMENTAL INVESTMENT COST** | | | 15,486,083 |

*Contingency does not apply to know-how development.

**ANNEX 1.1**

**JUSTIFICATION FOR INVESTMENT COST FOR CONVERSION PROJECT OF 4500 TPA**

| | **NEW EQUIPMENT** | **CAPACITY** | **UNITS** | **JUSTIFICATION/APPLICATION** |
|---|---|---|---|---|
| | **A. PROCESS FACILITY** | | | |
| | | | | |
| 1 | Fiber reinforced polyester (FRP) | 50 kl | 4 | Required for storing fresh HCL as well as recovered HCL |
| | storage tanks (new) | | | |
| 2 | Polyvinyldene fluoride resin | | 6 | Required for transfer of HCL at various stages |
| | (PVDF) lined magnetic sealless | | | |
| | pumps (new) | | | |
| 3 | Stainless Steel (SS) 316 Storage | 30 kl | 1 | Required for rubber latex storage |
| | Tank (new) | | | |
| 4 | Air operated diaphragm pump | | 5 | Required for transfer of latex from storage tank to latex |
| | (new) | | | blending vessel. |
| 5 | SS 316 Blending Reactor (new) | 1 kl | 4 | Required to blend latex with additives. |
| 6 | Air operated Diaphragm Pump | | 16 | Required for transfer of process fluid from blending |
| | (new) | | | reactor to hold tank. |
| 7 | Glass-lined Carbon Steel | 8 kl | 8 | Required to precondition the feedstock for |
| | Reactor (replacement) | | | chlorination. |
| 8 | Glass-lined Carbon Steel | 8 kl | 16 | Required for chlorination |
| | (replacement) | | | |
| 9 | PVDF lined Carbon Steel | | 32 | Required to encase the photochemical system. |
| | housing for photochemical | | | |
| | system (new) | | | |
| 10 | Photochemical system (new) | | 32 | Required for the reaction |
| 11 | Cooling System consisting of | | | |
| | 11.1 and 11.2 (new) | | | |
| 11 | SS 316 Heat Exchanger (new) | 2.5 m2 | 32 | Cooling equipment for photochemical system |
| 11 | SS 316 Centrifugal Pump (new) | | 32 | Cooling equipment for photochemical system |
| 12 | Static mixture (new) | | 16 | Required to introduce the chlorine gas in the process |
| | (FRP) | | | solution |
| 13 | Graphite Heat Exchangers | 10 m2 | 16 | Required to remove the heat of reaction |
| 14 | PVDF/PTFE AOD Pumps | | 32 | Required for circulation of HCL + Latex slurry in |
| | | | | photochemical system loop. |
| 15 | Glass-lined Carbon Steel reactor | 8 kl | 10 | Required for hold up of the product prior to filtration |
| 15a | Air operated PVDF lined | | 4 | Required for slurry circulation |
| | diaphragm pump with surge | | | |
| | impressors. | | | |
| 16 | Filter system (replacement) | 350 kg/hr | 2 | Required to separate the reaction product from HCL |
| 17 | Filtered reaction product | | 2 | Required to transfer the filtered product to the |
| | conveying system (new) | | | dryer feed bins |
| 18 | SS 316 Feed bins | 15 kl | 2 | Required for feeding the wet product to the dryer |
| 19 | Dryer system consisting of hot | | 2 | Required for drying of the wet CR |
| | oil thermic fluid generator, radiator | | | |
| | dryer, bag filter, | | | |
| | blower etc (new) | | | |
| 20 | PVDF-lined magnetic pump | | 4 | Required fro acid circulation |
| 21 | Corrosion resistant piping, valves and | | | Required for interconnecting the various equipment |

| | | | | |
|---|---|---|---|---|
| | fittings (new) (PVDF/CPVC/ABS/PTFE) | | | in the process. |
| 22 | Pneumatic conveying system | | 1 | Required to transfer the dried product from the dryer |
| | (new) | | | to the hold bin for blending/packing |
| 23 | SS 316 feed bins | 30 kl | 2 | Required to hold the dried product for blending/packing |
| 24 | Uninterrupted Power Supply | 50 KVA | 32 | To protect the photochemical system from |
| | | | | breakdown |
| 25 | SS 316 Ribbon Blender | 5 kl | 2 | For dry blending of the product |
| 26 | FRP flume extraction systems | | 1 | Required to absorb any fumes of HCL or chlorine |
| | (new) | | | exhausted from various process equipment from the |
| | | | | plant area. |

**ANNEX 2**

**INCREMENTAL OPERATING COSTS WITH NON ODS RRIL CR PROCESS**

**Figures in USD**

| **Item of operating cost** | **Incremental cost per MR/CR** | **Incremental cost for 507 MT of CR*** |
|---|---|---|
| Power | 271.67 | 137,737 |
| Fuel (Annex 3.1) | (43.23) | (21,918) |
| Materials (Annex 3.2) | 69.97 | 35,475 |
| Effluent Treatment (Annex 3.3) | 20.78 | 10,535 |
| **TOTAL (USD)** | **319.19** | **161,829** |

*Average production level for the last three years.

## ANNEX 2.1

## INCREMENTAL OPERATING COST

### FUEL CONSUMPTION COST

### CURRENT CTC PROCESS

1. Quantity of furnace oil consumed / MT CR = 1100 liters.

2. Out of which, approximate quantity consumed in various processes is as under:

a) Dissolver : 110 liters
b) Precipitator : 330 liters
c) Dryer : 660 liters

**TOTAL : 1100 liters**

### NEW PROCESS

1. There will be no requirement of steam in dissolution or precipitation processes. So there will be net savings of 440 liters of furnace oil in the new process.
2. There will be a change in the drying process and furnace oil will be required to heat the air but no steam generation will be required. However, due to higher heat losses through hot air, there will be an overall increase in energy requirements for the new drying process by about 10 % over the old drying process. So the furnace oil requirements for drying in the new process will be about 770 liters / MT of CR.

Net savings of furnace oil/MR CR = 1100 – 770 = 330 liters

Net incremental cost of furnace oil consumed per Mt CR = 330 x USD 0.31/liter
**= ( USD 43.23/MT)**

**Net incremental cost of furnace oil for 507 MT /year = USD 21,918**

## ANNEX 2.2

## INCREMENTAL OPERATING COSTS

### MATERIALS CONSUMPTION COSTS

### A. REQUIREMENTS OF RAW MATERIALS FOR NON ODS PROCESS

| NAME OF RAW MATERIAL | QTY. (KG./MT OF CR) | UNIT RATE (USD/KG.) | COST (USD/MT CR) |
|---|---|---|---|
| 1. LATEX 60 % | 635.0 | 0.762 | 483.87 |
| 2. LIQUID CHLORINE | 1200 | 0.107 | 128.40 |
| 3. CAUSTIC LYE 50 % | 450 | 0.143 | 64.35 |
| 4. STABILIZERS | 40 | 1.571 | 62.84 |
| 5. SURFACTANT | 25 | 2.619 | 65.48 |
| | | **TOTAL** | **804.94** |

### B. REQUIREMENTS OF RAW MATERIALS WITH CTC PROCESS

| NAME OF RAW MATERIAL | QTY. (KG./MT OF CR) | UNIT RATE (USD/KG.) | COST (USD/MT CR) |
|---|---|---|---|
| 1. SYNTHETIC RUBBER | 380 | 1.048 | 398.24 |
| 2. LIQUID CHLORINE | 1200 | 0.107 | 128.40 |
| 3. CTC | 544 | 0.3 | 189.3 |
| 4. STABILIZERS | 10 | 1.571 | 15.71 |
| 5. CATALYST 1 | 1.38 | 2.976 | 4.11 |
| 6. CATALYST 2 | 0.43 | 8.69 | 3.74 |
| | | **TOTAL** | **739.49** |

Net incremental cost of raw materials/MT of CR (B-A) = USD 69.97

Net incremental cost of raw materials for 507 MT /year = USD 35,475

## ANNEX 2.3

## INCREMENTAL OPERATING COST

### EFFLUENT TREATMENT COST

A. **UNDER EXISTING PROCESS**

| MATERIAL | QTY REQUIRED KG/ MT OF CR | UNIT RATE (USD/KG.) | COST (USD/KG.) |
|---|---|---|---|
| LIME | 275 | 0.071 | 19.52 |

B. **UNDER NEW NON ODS PROCESS**

| MATERIAL | QTY REQUIRED KG/ MT OF CR | UNIT RATE (USD/KG.) | COST (USD/KG.) |
|---|---|---|---|
| LIME | 400 | 0.071 | 28.40 |
| OTHER CHEMICALS | - | - | 11.90 |
| | | **TOTAL** | **40.30** |

Incremental effluent treatment cost per MT of CR produced = USD 20.78

Hence, incremental effluent treatment cost for 507 MT of CR produced per year = USD 10,535.

| ANNEX - 3 | | |
|---|---|---|
| LIST OF REDUNDENT EQUIPMENTS | | |
| | | |
| Sr No. | Equipments | No. |
| 1 | Rubber Crusher | 1 |
| 2 | Lead bonded jacketted steel reactor (10KL) | 3 |
| 3 | S.S. Pump(10m3/hr, 20mH) | 2 |
| 4 | Glasslined Carbon Steel reactor (8KL) | 8 |
| 5 | S.S. Centrifugal Pump (10m3/hr, 20mH) | 4 |
| 6 | Hatelloy C CentrifugalPump (3m3/hr, 30mh) | 2 |
| 7 | Hastelloy C Stirred reactors (6KL) | 3 |
| 8 | Glass fibre reinforced polyester tanks (10KL) | 3 |
| 9 | S.S. Centrifugal slurry pump (10m3/hr, 25mH) | 2 |
| 10 | S.S. Centrifugal pump (10m3/hr, 10mH) | 2 |
| 11 | Agitated Nutsche filter (6 KL) | 2 |
| 12 | Vacuum Pump | 2 |
| 13 | S.S. Screw Conveyor | 2 |
| 14 | S.S. feed bin (10 KL) | 3 |
| 15 | Spin flash dryer | 2 |
| 16 | Spin flash dryer | 2 |
| 17 | Pneumatic conveying system | 1 |
| 18 | Pulveriser | 1 |
| 19 | S.S. Ribbon blender(2 KL) | 1 |
| 20 | PVDF lined magnetic sealless pumps (2m3/hr) | 4 |
| 21 | Exhaust blowers | 2 |
| 22 | Air compressors | 3 |
| 23 | GRP cooling tower (100TR) | 1 |
| 24 | Chilling plant 25 TR | 2 |
| 25 | Water softner | 1 |
| 26 | Boilers | 2 |
| 27 | HCL storage pump | 2 |
| 28 | Caustic Pumps | 2 |
| 29 | CTC pump | 2 |
| | | |

## 37th MEETING OF THE EXECUTIVE COMMITTEE OF THE MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL

**Annex VI Part B**

| | |
|---|---|
| **COUNTRY:** | India |
| **IMPLEMENTING AGENCY:** | World Bank |
| **PROJECT TITLE:** | Conversion of Chlorinated Rubber manufacture from Carbon Tetra Chloride to non-ODS process at Rishiroop Polymers Pvt. Ltd. India |
| **PROJECT IN CURRENT BUSINESS PLAN:** | Yes |
| **SECTOR:** | Solvents |
| **SUB-SECTOR:** | Process agents |
| **ODS USE IN SECTOR:** | Baseline (1999-2001) 304 ODP tons<br>Current (1997) 7876 ODP tons (total CTC consumption as reported to the MP ozone secretariat). |
| **PROJECT IMPACT (ODS TO BE ELIMINATED):** | Phase out 225 MT CTC (248 ODP tons) |
| **PROJECT DURATION:** | 24 months |
| **PROJECT COSTS:** | |
| Investment Capital Costs | US$ 2,396,588 |
| Contingencies (10%) | US$ 215,859 |
| Incremental Operating Costs (NPV for 1 year) | US$ 0 |
| Total Project Cost | US$ 2,612,447 |
| **LOCAL OWNERSHIP:** | 100% |
| **EXPORT COMPONENT:** | |
| **REQUESTED GRANT:** | Part of Sector Plan |
| **IA SUPPORT COST:** | Part of Sector Plan |
| **TOTAL COST TO MLF:** | Part of Sector Plan |
| **COST EFFECTIVENESS:** | Part of Sector Plan |
| **PROJCT MONITORING MILESTONES INCLUDED:** | Yes |
| **NATIONAL COORDINATING AGENCY** | MoEF, National Ozone Unit |

**PROJECT SUMMARY**

This project will lead to elimination of the use of 225 MT per year (248 MT ODP) of Carbon Tetra Chloride in the manufacture of Chlorinated Rubber by Rishiroop Polymers Pvt. Ltd. (RPL). The proposed proprietary technology to be adopted has been developed indigenously by an associated enterprise, Rishiroop Rubber (International) Ltd. using a non-ODS media for the chlorination reaction, and is non-transitional.

**Prepared by:** Indian Chemical Manufacturers Association and the World Bank **Date:** March 21, 2002
**OORG review by:** William Kenyon **Date:** April 22, 2002

## 1. PROJECT OBJECTIVEES

The objective of this project is to completely eliminate the use of Carbon Tetra Chloride (CTC) as a process solvent in the production of Chlorinated Rubber (CR) by Rishiroop Polymers Pvt. Ltd. (RPL) at their plant at Nasik, India.

The implementation of this project will contribute to helping India to meet its obligations to phase out use of Ozone Depleting Substances (ODS).

## 2. SECTOR BACKGROUND

The detailed information on the process agent sector is included in the main document.

## 3. DESCRIPTION OF PRODUCTION FACILITIES

RPL is a 100% Indian owned private limited company, and was incorporated in 1971, with a production facility at Nasik (Maharashtra state), mainly for the manufacture of CR, and also for a small quantity of aromatic resin. The production facility started commercial production in 1973, with an initial installed production capacity for CR of 150 MT per annum; the plant was debottlenecked and expanded in 1988 to increase the installed production capacity to the current level of 550 MT per annum calculated on a three shift basis (continuous production), to meet growing market demand. The maximum production of CR attained by RPL was 532 MT in the fiscal year 1990-91. RPL is a pioneer in developing the indigenous technology for manufacture of CR in India, and have received a national Government award in 1978 for import substitution for developing the process for CR indigenously.

Production at RPL was suspended in September 1995 because of a labor dispute, which was referred to an Industrial Court. It was resolved in October 1999, and RPL has serviced its plant and kept it ready to restart production at short notice.

RPL uses CTC as an inert solvent in the manufacture of CR. The conventional process for production of CR involves using CTC as a solvent medium for chlorination of the rubber. The dry rubber is first dissolved in CTC, and this rubber solution is reacted with chlorine gas to produce chlorinated rubber which stays dissolved in CTC. The solvent CTC is then recovered from this CR solution by flashing it in hot water and recycling it. Because CTC is required to be used as a process solvent and is handled in large quantities, the process causes emissive losses during storage, handling, and reaction, and there is also some presence of CTC as an impurity in the finished product; these factors cause CTC ‘consumption’. The various stages of the manufacturing process include feedstock preparation, chlorination, recovery of solvent, filtration, drying, blending and packing. They require media resistant equipment (glass-lined reactors, lead bonded carbon steel reactors, etc.) The facility has utility sections, comprising boilers for steam generation, refrigeration systems, diesel-based generating power sets for standby power generation, air compressors, cooling towers, etc. Finally, the facility also has primary and secondary effluent treatment systems for waste water treatment and solid waste disposal. A detailed description of the conventional CR process is at **Annex 1.**

The details of CR production and CTC consumption for RPL for the last three years of production are as follows:

**Table I: Average Production and CTC Consumption**

| RPL | | |
|---|---|---|
| Year* | CTC consumed (MT) | CR Produced (MT) |
| 92-93 | 222. | 376. |
| 93-94 | 219. | 365. |
| 94-95 | 235. | 372 |
| | | |
| Average | **225** | **371.** |

*: The production and consumption data for RPL are for 3 years prior to Sept. 95 when the industrial lock-out began.

The total average consumption of CTC for RPL, based on their average consumption for the last three years of operation as mentioned above, is 225 MT per annum.

## 4. OPTIONS UNDER DECISION X/14

For ODS free CR production, the following options are available under decision X/14, and the costs of the various options are assessed in the following discussion:

1. Total closure
2. ODS emission abatement
3. Conversion to non-ODS process

The first two options have already been discussed in details in the main document. This annex will focus on costing of Option 3.

### 4.1. OPTION 3: CONVERSION OF PRODUCTION FACILITY

The Executive Committee approved ROL Project for conversion to non ODS process for manufacturing of Chlorinated Rubber at its 34$^{th}$ Meeting. The ROL Project has installed capacity of 550 MT and was granted with an incremental cost of US$ 2.07 million after deduction of US$ 330,537 on account of provision of a new plant. Rishiroop Polymers (RPL) is proposing to use the same technology for converting its full capacity of 550 MT of chlorinated rubber per year. The detailed conversion process is described below. Details of these costs are at **Annex 2**.

## 5. Project Proposal:

Several modifications /additions are required for converting the existing plant equipment to the new process. These include installation of new process equipment, storage facilities, piping and infrastructure facilities (e.g. power, water, air), etc., with different construction material to match the new process conditions.

A list of the equipments required to be added/replaced to replace the existing capacity of CR at RPL is given at **Annex 2**.

A brief description of the major additions in equipment required is given below:

- 15 KL capacity fiber glass reinforced polyester (FRP) storage tanks to store both fresh and recovered acid.
- Storage tank of 15 KL capacity of Stainless Steel to store rubber latex as a new raw material.
- Glass-lined carbon steel reactors of 8 kl capacity for preconditioning prior to chlorination.
- Glass-lined carbon steel reactors of capacity of 8 kl to carry out the new chlorination process. The existing glass-lined reactors have smaller capacity and are unsuitable. The alternative option of using a larger number of smaller existing reactors will require use of more procurement of more expensive imported additional equipment for each reactor. In addition, the new process requires a different type of agitation system in the reactor which does not exist in the existing reactors.
- A Photo chemical system will be added to catalyze the reaction.
- Pumps of corrosion resistant material for various operations such as circulating the contents of the reactor during chlorination and transporting the chlorinated product.
- Glass-lined stirred tanks of 8 kl capacity to store the reaction product after the chlorination process.
- Replacement corrosion resistant filters to remove the acid from the reaction product. The material of the present filtration equipment does not render it suitable for use.

- The filtered reaction product must be conveyed to the dryer by a conveying system along with a storage bin and a feeder. At present this is handled manually since the CR from the conventional process has different flow characteristics.
- Fluidized bed dryers will be required to remove the moisture from the wet product. The existing rotary vacuum dryers are not suitable for this purpose.
- a pneumatic conveying system to convey the chlorinated rubber powder obtained from the dryer to a blending and packing unit.
- The fume extraction system will consist of suction ducting, suction blower, lime absorption column and lime circulation pumps which will absorb any trace hazardous gases emanating in the new process from various reactors and storage tanks. Further, in order to remove final traces of acid and chlorine from the tail gases, it would be necessary to scrub these gases with dilute alkali in a column prior to final discharge to atmosphere.
- The acid absorption system of higher capacity will consist of an acid scrubber, corrosion resistant pumps and an acid storage tank and acid absorber.
- An enhanced effluent treatment facility will be installed consisting of neutralizer settling tank, aerators and sludge pumps to handle larger quantity of waste water. This facility will treat the trace quantities of acid and chlorine gas and bring it within standard norms required by the local pollution control authorities.
- A major portion of the existing piping and valves have to be replaced due to new process conditions and acidic material . Most of the new piping will be of either stainless steel or Teflon-lined carbon steel.
- Additional safety equipment to supplement existing equipment will be procured. This will consist of hazardous gases leakage detection, sensing, alarm and control system.

### 5.1. Civil Works and Utilities

With some extensions and modifications, the existing civil structures at RPL, Nasik are expected to be adequate for accommodating the equipment for the converted aggregate production facility. Some changes will however be necessary.

- Additional civil works will have to be incurred for construction of new tank farms for acid and rubber latex storage, acid-proof tile lining in critical process areas, additional underground water storage tank, civil foundations for various new equipment, additional storage facility for finished goods, etc.
- The new process does not require use of steam, thus rendering the existing steam boilers redundant. The converted plant will, however, require a much larger quantity of water requiring additional water storage and handling facilities. Consequently the size of effluent treatment facility will be bigger.
- Sizable additional connected power requirements will primarily arise due to the photochemical system in the new process. This will include an increase in electrical load transformer capacity with attendant transmission connection charges and enhanced main power distribution center, etc. In addition, the standby diesel generation capacity will need to be suitably augmented so as to ensure continuous power supply during the critical reaction process.
- A higher capacity cooling system such as chilling plants will have to be installed to cater to the augmented capacity and the requirements of the new process.
- To meet additional requirements of air for process and instrumentation, compressors will have to be installed in combination with suitable air dryers.

### 5.2. Redundant Equipment

The equipment becoming redundant or to be replaced in this project for RPL is given in **Annex 3**. The used equipment is generally more than 8 years old and has low book value. Having been used in chemical process plants, the equipment has virtually no salvage or resale value.

## 6. JUSTIFICATION FOR THE SELECTION OF ALTERNATIVE TECHNOLOGY

Three alternative technologies exist for conversion to ODS free production of CR, as follows:

1. A solvent exchange process developed and patented by a German company.

2. A non-ODS process developed by a Japanese company.
3. A non-ODS developed indigenously in India by RRIL.

Solvent Exchange Process : A German enterprise has adopted a two stage procedure to reduce the emissions from their process and to eliminate the CTC contained as impurity in the CR produced by them as under:

a) The German enterprise spent about US$25 million to reduce the emissions in their **7,000 TPA capacity** plant from a level of about 430 MT in 1989 to a level of about 0.3 MT in 1996 and that too over a period of 7 years of intensive efforts.
b) In addition, this enterprise has spent about US$40 million to modify its plant to reduce the impurity of CTC from its product which was eventually being emitted to the atmosphere in the end use. This was done by adopting a patented process for the solvent exchange by it.
c) Furthermore, the German enterprise has stated that they are incurring an incremental operating cost for environmental operation of their plant of US$0.8 million per year

**These details are consistent with the description on chlorinated rubber applications provided in the Report of the Chemical Process Agents Working Group of the TEAP, May 1995 (Annex 6). It seems to be** clear that this alternative is expensive and has other limitations as it presents an interim solution and an eventual conversion to a non ODS process will be later required to be carried out.

Non-ODS Japanese process: A Japanese enterprise has developed a non-ODS process for CR and commercialized it in 1997. According to some news reports the Japanese process cost the company an investment of about Yen 1 billion to set up a production facility of 800 MT of CR per annum, which is expensive and not very cost effective, (a brief write up on this subject from Japan Chemical Weekly (J.C.W. April 20, 1995 is available in the project file in the Bank. RRIL has been in contact with this Japanese company, but an agreement for licensing their patent did not materialize, due to licensing of the process, cost of technology transfer, availability of the license without any operational restrictions, etc., which made it practically inaccessible to RRIL.

3. Non-ODS RRIL process : The new RRIL process of chlorination of rubber through aqueous media completely eliminates the usage of CTC, and the CR produced by this process does not contain any entrapped CTC. The new process will be licensed from RRIL, who have developed it through their in-house research. RRIL applied for a domestic patent for their process in December 1998, and have registered a provisional patent under Indian law on January 8, 1999; they expect to be able to complete the patent process by April 2003, by which time they also expect to be able to receive an international patent for the process. RPL will achieve in complete elimination of CTC usage in its converted facility at Nasik

**PROJECT COST:**

The incremental capital cost includes major components as follow:

| | |
|---|---|
| Process Equipment | $ 1,409,100 |
| Effluent Treatment Facility | $ 59,400 |
| Process Utility and Piping | $ 214,288 |
| Electrical Equipment | $ 60,500 |
| Instrumentation, Dismantling and Erection Costs, Insultation & Painting, Safety Equipment, Civil and Structural Work | $ 175,000 |
| Consultant's fees for detailed Engineering | $ 60,000 |
| Know-how development | $ 238,000 |
| Trial and Training | $ 108,800 |
| Change-over Costs | $ 0 |
| Start-up and Commissioning | $ 71,500 |

| | |
|---|---|
| Sub-total | $ 2,396,588 |
| Contingencies (10%)* | $ 215,859 |
| Total | $ 2,612,447 |

*Contingency of 10% does not apply to the cost of know-how development.

Details of the incremental capital costs are given in **Annex 2**.

No provision for incremental operating costs is made for RPL as there has been no production for the last three years.

Thus the total incremental project cost is expected to be about US$ 2,612,447.

## 7. PROJECT IMPLEMENTATION

The Project will be implemented by M/s RPL in Nasik with the technical assistance and know how from M/s Rishiroop Rubber (International) Ltd.. The proposed implementation schedule illustrated below becomes effective after the OTF grant is made available. The change over from the existing plant will entail a production shutdown of about 6 months.

**IMPLEMENTATION SCHEDULE**

| **Activity** | **Quarters** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 2003 | | | | Year 2004 | | | | Year 2005 | | | |
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| MF Project Approval | | | X | | | | | | | | | |
| Financial Appraisal | | | | X | X | | | | | | | |
| Sub grant Agreement | | | | X | X | | | | | | | |
| Equipment specification preparation | | | | | X | | | | | | | |
| Equipment procurement | | | | | | X | X | | | | | |
| Installation of equipment | | | | | | | X | X | | | | |
| Civil work | | | | | X | X | X | | | | | |
| Testing and trials | | | | | | | | X | X | X | | |
| Production Start-up | | | | | | | | | | X | X | |
| Project completed | | | | | | | X | X | | | X | |
| First Disbursement | | | | | X | | | | | | | |
| Final Disbursement | | | | | | | | | | | | X |
| Completion Report. | | | | | | | | | | | | X |

**Direct Benefits**:

During the first 12 months of operation of the converted plants, the quantity of ODS phased out will total 225 MT of Carbon tetrachloride (248 ODP Tons).

**Indirect Benefits**:

There are no indirect benefits from this project.

## CONVENTIONAL CTC-BASED CR MANUFACTURING PROCESS

Natural/Synthetic Rubber is first mechanically degraded on a two roll mill and then charged to a depolymerising reactor where it is mixed with a large quantity of CTC and subjected to further depolymerising by chemical and thermal means. The resultant depolymerised hydrocarbon becomes completely dissolved in CTC and is used as a feed-stock solution for the chlorination process.

The rubber solution is thereafter subjected to reaction with chlorine gas in the glass-lined reactors to produce chlorinated rubber, at which time HCL gas is produced as a by-product, and is carried away in the off gas from the reactors. Each of the chlorination reactors is equipped with a series of graphite condensers where the vapors emanating from the reactors are first cooled with cooling water and thereafter with chilled brine solution circulating at minus15 degrees Celsius. This results in the condensation and recycling of the CTC vapors going off from the chlorination reactors with the off gas. The off gases escaping from the condensers are introduced into a primary effluent treatment system for scrubbing down the HCL gas and converting it into 30% w/w hydrochloric acid. The tail gas from the HCL scrubbers is further subjected to treatment in lime towers to neutralize it with lime solution followed by scrubbing with caustic soda solution.

The chlorinated rubber thus formed remains dissolved in the CTC and this solution is subjected to purging with air/nitrogen to remove the residual entrapped HCL /chlorine in the solution. The CR solution is then transferred to hold tanks from where it is drawn into lead bonded reactors equipped with a series of graphite heat exchangers. In these reactors, the CTC is flashed by pumping the CR solution under hot water and CTC is thus condensed and sent back to process CTC storage tanks for recycling back to the rubber dissolution stage. During the process of CTC recovery, CR is formed as a particulate slurry in water. The product is recovered as a granular wet cake containing about 60% moisture by separating it from the CR slurry in nutsch filters / centrifuges.

The wet cake of CR is then charged to a series of rotary vacuum driers from where the product is obtained as a dried powder containing less than 0.2% moisture content. The dried CR powder is discharged into bins and thereafter taken up for sieving and blending for meeting the grade wise quality requirements. The product is thereafter packed and shipped out.

**ANNEX 2**

## INCREMENTAL COSTS SUMMARY FOR PLANT CONVERSION RPL,NASIK

This annex provides a summary of Incremental Costs (US$) of converting the RPL plant at Nasik to non-ODS manufacture.
Details are provided in the tables that follow.

| | |
|---|---|
| Capital Costs: | $2,612,447 |
| Operating Costs: | $ 0 |
| Total for one plant: | $2,612,447 |

**Annex Table 2A: INCREMENTAL CAPITAL COSTS**

| Sl. | ITEM | UNIT COST | Units | Total | |
|---|---|---|---|---|---|
| | | | | | |
| A. | PROCESS FACILITY | | | | |
| 1 | FRP Storage Tank 15KL | 3,850 | 4 | 15,400 | |
| 2 | PVDF Lined magnetic seal-less Pump | 3,300 | 6 | 19,800 | |
| 3 | Stainless Steel Storage Tank | 17,050 | 1 | 17,050 | |
| 4 | Air operated PTFE – lined diaphragm pump | 6,600 | 5 | 33,000 | |
| 5 | Stainless Steel Blending Reactor 1KL | 7,920 | 1 | 7,920 | |
| 6 | Air operated PTFE – lined diaphragm pump | 6,600 | 2 | 13,200 | |
| 7 | Glass lined Carbon Steel Reactor | 66,000 | 1 | 66,000 | |
| 8 | Glass lined Carbon Steel Reactor | 107,800 | 2 | 215,600 | |
| 9 | PVDF Lined Carbon Steel Housing for photo chemical systems | 3,300 | 4 | 13,200 | |
| 10 | U. V. Lamp Systems | 25,300 | 4 | 101,200 | |
| 11 | Cooling Systems for photo chemical systems | | | | |
| 11 | Stainless Steel Heat Exchange | 770 | 4 | 3,080 | |
| 11 | Stainless Steel Centrifugal Pump | 770 | 4 | 3,080 | |
| 12 | Static Mixer | 4,400 | 2 | 8,800 | |
| 13 | Graphite heat exchanger (10m2) | 15,400 | 2 | 30,800 | |
| 14 | PVDF lined magnetic seals pump | 6,270 | 7 | 43,890 | |
| 15 | Glass-lined Stirred Tanks | 66,000 | 1 | 66,000 | |
| 16 | FRP belt filter (100 kg/hr) | 203,500 | 1 | 203,500 | |
| 17 | Paste Conveying systems | 31,900 | 1 | 31,900 | |
| 18 | Stainless Steel 316 Feed Bins (10KL) | 8,800 | 2 | 17,600 | |
| 19 | Two stage PTFE lined SS316 Fluidized bed dryer system | 183,700 | 1 | 183,700 | |
| 20 | PVDF FRP Tanks, 10KL | 23,100 | 2 | 46,200 | |
| 21 | PVDF lined magnetic Pump 2m3/hr, 20MH (heads in meters) | 2,200 | 2 | 4,400 | |
| 22 | Piping, PVDF, SS, FRP,PP Pipes valves and fittings | 66,000 | 1 | 66,000 | |
| 23 | Pneumatic conveying system | 74,800 | 1 | 74,800 | |

| | | | | | |
|---|---|---|---|---|---|
| 24 | Stainless Steel 316 Feed bins(10KL) | 8,800 | 2 | 17,600 | |
| 25 | UPS Systems for photo chemical systems | 15,400 | 4 | 61,600 | |
| 26 | Stainless Steel Blenders 2KL | 16,500 | 1 | 16,500 | |
| 27 | Chimney for Exhaust gases | 5,280 | 1 | 5,280 | |
| 28 | FRP fume extraction systems with alkali scrubber | 22,000 | 1 | 22,000 | |
| | **Sub-total** | | | | **1,409,100** |
| B | EFFLUENT TREATMENT FACILITY | | | | |
| 1 | Reinforced concrete tank – Neutralizer | 6,600 | 2 | 13,200 | |
| 2 | Reinforced concrete settling Tank | 3,300 | 2 | 6,600 | |
| 3 | Reinforced concrete Tank – Aerator | 8,800 | 1 | 8,800 | |
| 4 | Sludge Pumps | 330 | 10 | 3,300 | |
| 5 | Acid proof lined Reinforced concrete Sludge Drying Beds | 2,200 | 2 | 4,400 | |
| 6 | Acid proof lined Reinforced concrete Sludge Storage with shed | 4,400 | 1 | 4,400 | |
| 7 | RCC treated Effluent Storage tank | 6,600 | 2 | 13,200 | |
| 8 | RCC Floculator | 3,300 | 1 | 3,300 | |
| 9 | Consultant fees for designing ETP system | 2,200 | 1 | 2,200 | |
| | **Sub-total** | | | | **59,400** |
| | | | | | |
| C | PROCESS UTILITY PIPING | | | | |
| | Utility | | | | |
| 1 | Air Dryers 8m3/min | 11,000 | 2 | 22,000 | |
| 2 | Air Compressor 8m3/min | 22,000 | 2 | 44,000 | |
| 3 | Underground Water storage | 5,500 | 1 | 5,500 | |
| 4 | Overhead Water tank | 3,850 | 1 | 3,850 | |
| 5 | Chilling plant | 17,600 | 2 | 35,200 | |
| 6 | Diesel generators | 68,537.7 | 1 | 68,537.7 | |
| 7 | Water softeners | 5,500 | 2 | 11,000 | |
| 8 | Air Receiver | 7,700 | 1 | 7,700 | |
| 9 | Mild Steel pipes valves & fittings for above | 16,500 | 1 | 16,500 | |
| | **Sub-total** | | | | **214,287.7** |
| | | | | | |
| D | ELECTRICAL | | | | |
| 1 | Transformer | 8,800 | 1 | 8,800 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | Power line cost | | 8,800 | 1 | 8,800 | |
| 3 | Power Control Center | | 16,500 | 1 | 16,500 | |
| 4 | Capacitors | | 4,400 | 1 | 4,400 | |
| 5 | Electrical Cables, switches starters etc. | | 22,000 | 1 | 22,000 | |
| | **Sub-total** | | | | | **60,500** |
| | | | | | | |
| E | INSTRUMENTATION | | | Unit | 80,000 | **80,000** |
| | Control panels, instruments (including rota-meters, pressure gauges, temperature gauges, control valves) misc. items, and labor charges | | | | | **0** |
| | | | | | | **0** |
| F | ERECTION & DISMANTLING | | | Unit | 20,000 | **20,000** |
| | | | | | | **0** |
| G | INSULATION & PAINTING | | | Unit | 20,000 | **20,000** |
| | | | | | | **0** |
| H | SAFETY EQUIPMENTS | | | Unit | 20,000 | **20,000** |
| | Continuous chlorine and HCL monitoring systems | | | | | **0** |
| | | | | | | **0** |
| I | CIVIL WORKS | | | Unit | 15,000 | **15,000** |
| | Equipment Foundations, tank farms, acid-proof tile lining, and civil costs of power control center, process control room and expansion of warehouse, architect's fee | | | | | **0** |
| | | | | | | **0** |
| J | STRUCTURAL WORK | | | Unit | 20,000 | **20,000** |
| | | | | | | **0** |
| K | TECHNICAL KNOW HOW FEE | | | Unit | 238,000 | **238,000** |
| | | | | | | **0** |
| L | Consultants fees for detailed engineering | | | Unit | 60,000 | **60,000** |
| | | | | | | |
| M | Pre operative Cost | | | Unit | | |
| | Insurance | | | | 20,000 | |
| | Travelling | | | | 28,800 | |
| | Training | | | | 12,000 | |
| | Salaries of project team | | | | 38,800 | |
| | Communication expenses | | | | 9,600 | |
| | **Sub-total** | | | | | **108,800** |
| | | | | | | |
| | | | | | | |
| N | Changeover costs (fixed overheads for six months) | | | Unit | 0 | **0** |
| | | | | | | |
| O | Start up & commissioning (incl. Materials costs) | | | Unit | 71,500 | **71,500** |
| | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | **TOTAL** | | | | **2,396,588** |
| | **Contingencies** | | | | **215,859** |
| | **TOTAL INCREMENTAL INVESTMENT COST (US$)** | | | | **2,612,447** |

**Annex Table 2B: INCREMENTAL OPERATING COSTS**

| Item | Unit | Before Conversion (US$, per MT of CR produced) | | | After Conversion (US$, per MT of CR produced) | | | Net Incremental Cost (US$/yr.) |
|---|---|---|---|---|---|---|---|---|
| | | Qty | Rate | Amount | Qty | Rate | Amount | |
| Power | KWH | 3,158 | 0.107 | 337.906 | 5,697 | 0.107 | 609.579 | 271.673 |
| Furnace oil | Liters | 1,100 | 0.131 | 144.1 | 770 | 0.131 | 100.87 | -43.23 |
| Materials[1] | Kg | various | | 739.49 | various | | 804.94 | 69.97 |
| Consumable Stores[2] | | | | | Various | | 0 | 0 |
| Effluent Treatment | | | | | | | | |
| Lime | Kg. | 275 | 0.071 | 19.525 | 400 | 0.071 | 28.40 | 8.875 |
| Other chemicals | Kg. | | | | | | 11.90 | 11.90 |
| **Total IOC /MT of CR produced** | | | | | | | | **319.19** |
| **Total C.R. Production,** | | | | | | | | **0** |
| **Total incremental operating costs/year** | | | | | | | | **0** |
| **Incremental operating costs (NPV for ONE year)** | | | | | | | | **0** |

[1] Before: Synthetic rubber /Polyolefin, liquid chlorine, CTC, stabilizers, and three catalysts.
After: Latex, liquid chlorine, Caustic lye, stabilizers and additives.

[2] Photochemical System, pumps for transfer of reaction products, and air-operated diaphragm pumps. Per MT costs derived from calculations at $117,000 for 550 TPA

**ANNEX 3**

REDUNDANT EQUIPMENT LIST

| Sr. No. | **Item** | Nos |
|---|---|---|
| 1 | Rubber Mixing Mill | 1 |
| 2 | Acid proof brick lined tank (10KL) | 2 |
| 3 | Graphite tile lined steel tank (10KL) | 2 |
| 4 | Lead bonded carbon steel tanks (10kl) | 2 |
| 5 | Pumps | |
| | a) Silica Epoxy centrifugal Pump (2m3/Hr, 20mH | 1 |
| | b) Silica Epoxy centrifugal Pump (10m3/Hr, 20mH | 4 |
| | c) S. S. centrifugal Pump (10m3/Hr, 20mH | 2 |
| | d) S. S. centrifugal Pump (2m3/Hr, 10mH | 2 |
| | e) S. S. centrifugal Pump (5m3/Hr, 10mH | 2 |
| | f) Cast S. sludge Pump (5m3/Hr, 10mH | 2 |
| 6 | Glasslined Carbon steel Reactor (5kl) | 2 |
| 7 | Glasslined Carbon steel Reactor (4kl) | 0 |
| 8 | Glasslined Carbon steel Reactor (3kl) | 0 |
| 9 | Lead bonded Carbon Steel Reactors (10KL) | 4 |
| 10 | Glass fiber carbon steel stirred vessel 10KL) | 1 |
| 11 | Graphite Heat Exchanger (5m2) | 12 |
| 12 | Rotary Vacuum S316 dryers (2m3 cap) | 4 |
| 13 | Nutsch Filter (15KL) | 2 |
| 14 | Oil fired steam boilers | 2 |
| 15 | Centrifuges | 0 |
| 16 | Brine chilling plants ( 10 TR) | 2 |
| 17 | Air compressors ( 3m3/min) | 2 |
| 18 | Diesel generator (250 KVA) | 1 |
| 19 | Horizontal Glass fiber reinforced polyster tanks (5KL) | 3 |
| 20 | Graphite acid absorption system (60kg/hr) | 1 |
| 21 | Water softeners (5m3.Hr) | 1 |
| 22 | Carbon steel vertical storage tanks (10KL) | 1 |
| 23 | Air receivers (3m3) | 1 |
| 24 | Transformer (500 KVA) | 1 |
| | | |

# OORG TECHNICAL REVIEW REQUEST

India

## Sector Plan for Phasing Out of CTC Consumption in the Chlorinated Rubber Sub-Sector in India

(OORG Reviewer: W. G. Kenyon)

# OORG TECHNICAL REVIEW REQUEST

## China

### Sector Plan for Phasing Out of CTC Consumption in the Chlorinated Rubber Sub-Sector in India

(OORG Reviewer: W. G. Kenyon)

The following review of the "Sector Plan for Phasing Out of CTC Consumption in the Chlorinated Rubber Sub-Sector in India" (received 21 March 2002) was conducted at the request of the World Bank.

1. **Country of Origin**: India

2. **Project Title**: " Sector Plan for Phasing Out of CTC Consumption in the Chlorinated Rubber Sub-Sector in India"

3. **Sector/Subsector Covered:** Solvents/Process Agents

4. **Relationship to Country Programme:** Project documentation provided indicates that while not required to meet the 1999 freeze for CTC, and is thus consistent with the country's action plan.

5. **Technology:**

   a) The CTC in use in the Process Agents subsector is generally used as a solvent for the chemical processes used in the manufacture of chlorinated rubber, chlorinated paraffin, various other halogenated resins and polymers plus a variety of pharmaceuticals and agricultural products.

   There are three options permitted under decision X/14. These are:
   a. Total Closure
   b. ODS Emission Abatement
   c. Conversion to a non-ODS Process.
   (In addition, various combinations of these options are generally allowed)

   Alternatives for ODS CTC are often difficult to identify. Thus, while alternatives are generally readily available in other sectors, this is not the case when the CTC is an integral part of the manufacturing process. In some cases, it may not be possible to totally eliminate the CTC, but instead the sub-sector may have to consider other pathways for ozone layer protection, such as stringent emission abatement, plant closures or implementing CTC alternatives. In some nations, several of these options are combined.

In general, the non-ODS processes tend to be aqueous or proprietary, which would tend to preserve the manufacture of materials and products of value to society.
The phase out alternatives of either stringent emission abatement or plant closure are generally used only when a non-ODS alternative cannot be identified. In some cases, a cluster of enterprises making like product may elect to rationalize production to facilitate production yield and purity optimization; with several enterprises serving their established customer base from a common manufacturing operation.

In addition, workplace time-weighted averages (TWA), if any, for the proposed aqueous or other types of formulations may not be regulated in all provinces in India.

b) Enterprises prefer to choose a technology that is not currently transitional, since it does not depend upon a solvent or chemicals that, at this time, face future bans. In addition, the technology chosen must balance product quality vs cost of alternative process or technology implementation.

In this sector plan, the enterprises involved using CTC to manufacture chlorinated rubber (CR) have selected a combination of conversion to an indigenous proprietary CR manufacturing process, while two enterprises will undergo plant closure (rationalization).

c) Feasibility of transfer to the country of concern:

i) Technology transfer and training are not applicable, since the technology was developed by one of the Rishiroop Group enterprises. This technology has already been approved for one partner enterprise (ROL Chlorinated Rubber (CR) project at the 34th Meeting of the ExCom), and this sector plan proposes the same process be implemented at two others.

ii) There appears to be no licensing agreement required since the technology was developed in India by the enterprise.

iii) Other options (plant closure or continued use of CTC combined with stringent emission control) were investigated but discarded in favour of the new proprietary technology for certain plants and full closure for two other enterprises.

Other technology systems utilizing ozone safe chemistries may have been investigated but discarded when CR product quality was inferior to the current ODS process. The enterprises did not want to continue use of CTC (combined with stringent emission abatement), even in low concentrations in the CR, as it could prove to be a disadvantage in the marketplace, resulting in loss of market share. GWP issues due to increased energy costs were checked but no comprehensive calculations were performed.

iv) See paragraphs 5 b, 5 c ii and 5 c iii above.

**6. Environmental Impact:**

a) The ODP is zero for the proprietary process chosen. However, there is an increase in the furnace oil and electrical power requirements, resulting in a modest indirect GWP increase. However, with the closure of two other CR producing enterprises, efficient overall operation of the remaining CR producers may result in minimal GWP impact.

b) The proposed proprietary process provides adequate safety from an environmental, safety and health perspective- within the limits of any process employing liquid chlorine. (The workforce has had experience handling liquid chlorine with the present process; so periodic refresher training combined with vigilance should minimize any workplace hazards.) Appropriate waste stream protection systems are incorporated in the various pieces of equipment to minimize contamination of the aquifers.

c) The proposed various aqueous cleaning systems provide adequate safety from an environmental, safety and health perspective. Appropriate filtration and waste water systems are incorporated in the various pieces of equipment to minimize contamination of the aquifers. Special case will be required in the case of stringent emission abatement systems, since the possibility of aquifer contamination is still possible, albeit to a lesser degree.

d) It is often very difficult to assess the waste stream increase generated by alternative processes. Such increases can be the result of making large volumes of sub-standard product, increased HCl waste, waste activated carbon or other emission control media. (For example, certain of the alternatives will involve use of stringent emission controls employing activated carbon to recover CTC. In such cases, it would be preferable to incinerate the activated carbon and any remaining CTC, since steam stripping the activated carbon could provide a pathway for CTC to enter the groundwater.

**7. Project Cost**:

a) All the cost components identified in the project are essential to the conversion. The proposed equipment should provide an up to date, efficient, zero-ODP CR manufacturing process incorporating proper waste stream management with capacity levels equivalent to current production levels.

b) Existing equipment similar to the proposed new equipment would be expected to be found in the existing facilities, since both the old and new processes involve the chlorination of rubber to make CR. However, the scale of the equipment and the capacity of the pumps (for example) will quite different, as larger equipment is needed to handle dilute solutions or slurries, compared with concentrated solutions or slurries. (This is a materials handling and not a capacity issue.)

c) Cost of equipment

i) The base line costs are properly addressed. The suggested equipment costs appear consistent with current industry pricing practices.

ii) The proposed equipment and technology listed is claimed to be readily available from local suppliers. All requested equipment is consistent with the project plan. (see also 7. b)

iii) It appears that the various pieces of equipment requested should meet the conversion requirements for replacing CTC with the proprietary new non-ODS CR manufacturing processes requested. (There is a possibility that water pre-treatment systems not cited in the document for treating and upgrading any incoming water may be required. If this is the case, the costs shall be borne by the enterprise.)

iv) The existing baseline CTC process equipment in this enterprise cannot be modified/converted for use in the new process, due to issues of scale.

v) While dismantling of baseline equipment was noted as a line item in the budgets, especially for the two plants being closed, a detailed plan for the scrapping out and disposition of the current baseline solvent equipment to prevent re-deployment is not provided. [See however, 7. c) vi) below.]

vi) Projected salvage value of the ca 8 yr old scrapped equipment was given as low book value. Also, the scrapped equipment has virtually no value since it was used in a chemical process plant. (Project commissioning personnel should carefully monitor final destruction and disposition of all the surplus/scrapped equipment from all the enterprises listed in this sector plan.)

vii) The proposed project equipment and quantity listed for the proprietary process gave no obvious indication there would be an increase in existing capacity.

d) Appropriateness of training and related costs, if any:

The individual project budgets contain line items for training with the new equipment, as well as commissioning. Since the enterprise will be converting from CTC to an entirely new proprietary process, these costs are warranted.

e) Operating Costs

i) The Incremental Operating Costs (IOC) projected after the conversion are much higher than the existing costs. The increased costs appear to be associated with the additional utilities (especially heating oil), raw materials and effluent treatment chemicals. Increased energy consumption is to be expected with the utilization of new processes involving heating and transfer of dilute solutions.

ii) The new process and equipment, while minimizing environmental, health and safety impacts associated with the new chemistry are projected to result in increased operating costs due to higher raw materials cost, higher effluent treatment costs and additional energy consumption. No reduction in defects that could translate into cost savings is apparent.

iii) The operating costs given and their relation to the technology chosen appear to be consistent with projects already approved by ExCom for implementation (e.g. ROL, approved at 34$^{th}$ meeting).

**8. Implementation Time Frame:** The implementation time frame proposed appears feasible however since this is a new proprietary process installation, it may be too aggressive.

**9. Recommendation:**

a) **Approval is endorsed.**

**10. Special Concerns:** Due to the proprietary process information contained in this project proposal, the review of this project was carried out only by the World Bank and OORG review personnel.

**OORG Technical Reviewer:** ________________________________
W. G. Kenyon

**Date Review Completed:** 23 April 2002 .

# OORG TECHNICAL REVIEW REQUEST

India

## Conversion of Chlorinated Rubber Manufacture from Carbon Tetrachloride to non-ODS process at Rishiroop Polymers Pvt. Ltd. India

(OORG Reviewer: W. G. Kenyon)

# OORG TECHNICAL REVIEW REQUEST

## India

## Conversion of Chlorinated Rubber Manufacture from Carbon Tetrachloride to non-ODS process at Rishiroop Polymers Pvt. Ltd. India

(OORG Reviewer: W. G. Kenyon)

The following review of the "Conversion of Chlorinated Rubber Manufacture from Carbon Tetrachloride to non-ODS process at Rishiroop Polymers Pvt. Ltd. India" (received 16 April 1999) was conducted at the request of Mr. Viraj Vithoontien, World Bank.

1. **Country of Origin**: India

2. **Project Title**: "Conversion of Chlorinated Rubber Manufacture from Carbon Tetrachloride to non-ODS process at Rishiroop Polymers Pvt. Ltd. India"

3. **Sector/Subsector Covered:** Solvents/Process Agents

4. **Relationship to Country Programme:** Project documentation provided indicates that while not required to meet the 1999 freeze, project is consistent with the country's action plan.

5. **Technology:**

a) There are three options permitted under decision X/14. These are:
   a. Total Closure
   b. ODS Emission Abatement
   c. Conversion to a non-ODS Process.

The enterprise has elected to pursue Conversion to a non-ODS Process, as was chosen by the ROL Chlorinated Rubber (CR) project at the 34$^{th}$ Meeting of the ExCom. This new proprietary process was developed by an associated enterprise in the Rishiroop group, namely Rishiroop Rubber International Ltd. India.

Since the alternative non-ODS process requires significant volumes of heated water, and greater utility demands, a GWP greater than the present CTC process would be anticipated.

In addition, time-weighted averages (TWA), if any, for the proposed new proprietary process are not know. Thus, not all the chemicals in this process may be regulated in India.

b) The proprietary technology chosen is not currently transitional since it does not appear to depend upon chemicals that, at this time, face future bans.

c) Feasibility of transfer to the country of concern:

   i) Technology transfer and training are not applicable, since the technology was developed within the enterprise.

   ii) There appears to be no licensing agreement required since the technology was developed in India by the enterprise.

   iii) Other options (plant closure or continued use of CTC combined with stringent emission control) were investigated but discarded in favour of the new proprietary technology. The enterprise did not want to continue use of CTC, even in low concentrations in the CR, as it could prove to be a disadvantage in the marketplace, resulting in loss of market share.

   iv) Yes, see paragraphs 5 b, 5 c ii and 5 c iii above.

**6. Environmental Impact:**

a) The ODP is zero for the proprietary process chosen. However, there is an increase in the furnace oil and electrical power requirements, resulting in a modest indirect GWP increase.

b) The proposed proprietary process provides adequate safety from an environmental, safety and health perspective- within the limits of any process employing liquid chlorine. (The workforce has had experience handling liquid chlorine with the present process; so periodic refresher training combined with vigilance should minimize any workplace hazards.) Appropriate waste stream protection systems are incorporated in the various pieces of equipment to minimize contamination of the aquifers.

**7. Project Cost**:

a) All the cost components identified in the project are essential to the conversion. The proposed equipment should provide an up to date, efficient, zero-ODP CR manufacturing process incorporating proper waste stream management with capacity levels equivalent to current production levels.

b) Existing equipment similar to the proposed new equipment would be expected to be found in the existing facilities, since both the old and new processes involve the chlorination of rubber to make CR. However, the scale of the equipment and the capacity of the pumps (for example) will quite different, as larger equipment is needed to handle dilute solutions or slurries, compared with concentrated solutions or slurries. (This is a materials handling and not a capacity issue.)

c) Cost of equipment

i) The base line costs are properly addressed. The suggested equipment costs appear consistent with current industry pricing practices.

ii) The proposed equipment and technology listed is claimed to be readily available from local suppliers. All requested equipment is consistent with the project plan. (see also 7. b)

iii) It appears that the various pieces of equipment requested should meet the conversion requirements for replacing CTC with the proprietary new non-ODS CR manufacturing processes requested. (There is a possibility that water pre-treatment systems not cited in the document for treating and upgrading any incoming water may be required. If this is the case, the costs shall be borne by the enterprise.)

iv) The existing baseline CTC process equipment in this enterprise cannot be modified/converted for use in the new process, due to issues of scale.

v) While dismantling of baseline equipment was noted as a line item in the budgets, a detailed plan for the scrapping out and disposition of the current baseline solvent equipment to prevent re-deployment is not provided. [See however, 7. c) vi) below.]

vi) Projected salvage value of the ca 8 yr old scrapped equipment was given as low book value. Also, the scrapped equipment has virtually no value since it was used in a chemical process plant.

vii) The proposed project equipment and quantity listed for the proprietary process gave no obvious indication there would be an increase in existing capacity.

d) Appropriateness of training and related costs, if any:

The individual project budgets contain line items for training with the new equipment, as well as commissioning. Since the enterprise will be converting from CTC to an entirely new proprietary process, these costs are warranted.

e) Operating Costs

i) The Incremental Operating Costs (IOC) projected after the conversion are much higher than the existing costs. The increased costs appear to be associated with the additional utilities (especially heating oil), raw materials and effluent treatment chemicals. Increased energy consumption is to be expected with the utilization of new processes involving heating and transfer of dilute solutions.

ii) The new process and equipment, while minimizing environmental, health and safety impacts associated with the new chemistry are projected to result in increased operating costs due to higher raw materials cost, higher effluent treatment costs and additional energy consumption. No reduction in defects that could translate into cost savings is apparent.

iii) The operating costs given and their relation to the technology chosen appear to be consistent with projects already approved by ExCom for implementation (e.g. ROL, approved at 34$^{th}$ meeting).

**8. Implementation Time Frame:** The implementation time frame proposed appears feasible however since this is a new proprietary process installation, it may be too aggressive.

**9. Recommendation:**

a) **Approval is endorsed.**

**10. Special Concerns:** Due to the proprietary process information contained in this project proposal, the review of this project was carried out only by the World Bank and OORG review personnel.

**OORG Technical Reviewer:** ______________________________

W. G. Kenyon

**Date Review Completed:** 22 April 2002 .

# OORG TECHNICAL REVIEW REQUEST

India

## Conversion of Chlorinated Rubber Manufacture from Carbon Tetrachloride to non-ODS process at Rishiroop Rubber International Ltd. India

(OORG Reviewer: W. G. Kenyon)

# OORG TECHNICAL REVIEW REQUEST

## India

## Conversion of Chlorinated Rubber Manufacture from Carbon Tetrachloride to non-ODS process at Rishiroop Rubber International Ltd. India

(OORG Reviewer: W. G. Kenyon)

The following review of the "Conversion of Chlorinated Rubber Manufacture from Carbon Tetrachloride to non-ODS process at Rishiroop Rubber International Ltd. India" (received 16 April 1999) was conducted at the request of Mr. Viraj Vithoontien, World Bank.

1. **Country of Origin**: India

2. **Project Title**: "Conversion of Chlorinated Rubber Manufacture from Carbon Tetrachloride to non-ODS process at Rishiroop Rubber International Ltd. India"

3. **Sector/Subsector Covered:** Solvents/Process Agents

4. **Relationship to Country Programme:** Project documentation provided indicates that while not required to meet the 1999 freeze, project is consistent with the country's action plan.

5. **Technology:**

a) There are three options permitted under decision X/14. These are:
   a. Total Closure
   b. ODS Emission Abatement
   c. Conversion to a non-ODS Process.

The enterprise has elected to pursue Conversion to a non-ODS Process, as was chosen by the ROL Chlorinated Rubber (CR) project at the 34th Meeting of the ExCom.

Since the alternative non-ODS process requires significant volumes of heated water, and greater utility demands, a GWP greater than the present CTC process would be anticipated.

In addition, time-weighted averages (TWA), if any, for the proposed new proprietary process are not know. Thus, not all the chemicals in this process may be regulated in India.

b) The proprietary technology chosen is not currently transitional since it does not appear to depend upon chemicals that, at this time, face future bans.

c) Feasibility of transfer to the country of concern:

   i) Technology transfer and training are not applicable, since the technology was developed within the enterprise.

   ii) There appears to be no licensing agreement required since the technology was developed in India by the enterprise.

   iii) Other options (plant closure or continued use of CTC combined with stringent emission control) were investigated but discarded in favour of the new proprietary technology. The enterprise did not want to continue use of CTC, even in low concentrations in the CR, as it could prove to be a disadvantage in the marketplace, resulting in loss of market share.

   iv) Yes, see paragraphs 5 b, 5 c ii and 5 c iii above.

**6. Environmental Impact:**

a) The ODP is zero for the proprietary process chosen. However, there is an increase in the furnace oil and electrical power requirements, resulting in a modest indirect GWP increase.

b) The proposed proprietary process provides adequate safety from an environmental, safety and health perspective- within the limits of any process employing liquid chlorine. (The workforce has had experience handling liquid chlorine with the present process; so periodic refresher training combined with vigilance should minimize any workplace hazards.) Appropriate waste stream protection systems are incorporated in the various pieces of equipment to minimize contamination of the aquifers.

**7. Project Cost**:

a) All the cost components identified in the project are essential to the conversion. The proposed equipment should provide an up to date, efficient, zero-ODP CR manufacturing process incorporating proper waste stream management with capacity levels equivalent to current production levels.

b) Existing equipment similar to the proposed new equipment would be expected to be found in the existing facilities, since both the old and new processes involve the chlorination of rubber to make CR. However, the scale of the equipment and the capacity of the pumps (for example) will quite different, as larger equipment is needed to handle dilute solutions or slurries, compared with concentrated solutions or slurries. (This is a materials handling and not a capacity issue.)

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iii) It appears that the various pieces of equipment requested should meet the conversion requirements for replacing CTC with the proprietary new non-ODS CR manufacturing processes requested. (There is a possibility that water pre-treatment systems not cited in the document for treating and upgrading any incoming water may be required. If this is the case, the costs shall be borne by the enterprise.)

iv) The existing baseline CTC process equipment in this enterprise cannot be modified/converted for use in the new process, due to issues of scale.

v) While dismantling of baseline equipment was noted as a line item in the budgets, a detailed plan for the scrapping out and disposition of the current baseline solvent equipment to prevent re-deployment is not provided. [See however, 7. c) vi) below.]

vi) Projected salvage value of the ca 8 yr old scrapped equipment was given as low book value. Also, the scrapped equipment has virtually no value since it was used in a chemical process plant.

vii) The proposed project equipment and quantity listed for the proprietary process gave no obvious indication there would be an increase in existing capacity.

d) Appropriateness of training and related costs, if any:

The individual project budgets contain line items for training with the new equipment, as well as commissioning. Since the enterprise will be converting from CTC to an entirely new proprietary process, these costs are warranted.

e) Operating Costs

i) The Incremental Operating Costs (IOC) projected after the conversion are much higher than the existing costs. The increased costs appear to be associated with the additional utilities (especially heating oil), raw materials and effluent treatment chemicals. Increased energy consumption is to be expected with the utilization of new processes involving heating and transfer of dilute solutions.

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iii) The operating costs given and their relation to the technology chosen appear to be consistent with projects already approved by ExCom for implementation (e.g. ROL, approved at 34th meeting).

**8. Implementation Time Frame:** The implementation time frame proposed appears feasible however since this is a new proprietary process installation, it may be too aggressive.

**9. Recommendation:**

a) **Approval is endorsed.**

**10. Special Concerns:** Due to the proprietary process information contained in this project proposal, the review of this project was carried out only by the World Bank and OORG review personnel.

**OORG Technical Reviewer:** ______________________________

W. G. Kenyon

**Date Review Completed:** 22 April 2002 .