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

PROJECT PROPOSALS: CHINA

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

Foam

- Release of final payment for the terminal umbrella project for the elimination of CFC-12 in manufacturing of EPE foam packaging nets at 30 enterprises — UNIDO

Process agent

- Sector plan for phase-out of ODS in the process agent sector — World Bank

Refrigeration

- Sector plan ODS final phase-out: domestic refrigeration and domestic refrigeration compressors — UNIDO

PROJECT EVALUATION SHEET
CHINA

SECTOR: Foam ODS use in sector: ODP tonnes

Sub-sector cost-effectiveness thresholds: Polystyrene/polyethylene US $8.22/kg

Project Titles:

(a) Release of the final payment of the terminal umbrella project for the elimination of CFC-12 in manufacturing of EPE foam packaging nets at 30 enterprises

Project Data	**Polystyrene/polyethylene**
Enterprise consumption (ODP tonnes)	849.27
Project impact (ODP tonnes)	849.27
Project duration (months)	30
Initial amount requested (US $)	5,815,233
Final project cost (US $):	5,482,200
Incremental capital cost (a)	523,220
Contingency cost (b)	6,005,420
Incremental operating cost (c)	-1,169,711
Total project cost (a+b+c)	4,325,709
Local ownership (%)	100%
Export component (%)	0%
Amount requested (US $)	4,325,709
Cost effectiveness (US $/kg.)	5.09
Counterpart funding confirmed?	Yes
National coordinating agency	SEPA
Implementing agency	UNIDO

Secretariat's Recommendations	
Amount recommended (US $)	4,325,709
Project impact (ODP tonnes)	849.27
Cost effectiveness (US $/kg)	5.09
Implementing agency support cost (US $)	485,828
Total cost to Multilateral Fund (US $)	4,811,537*

*The amount of US $1,697,000 including agency support cost of US $171,352 was disbursed to UNIDO at the 36th Meeting leaving a balance of US $3,114,537 including agency support cost of US $314,476.

Elimination of CFC-12 in manufacturing of EPE foam packaging nets at 30 enterprises (Terminal umbrella project), China

Note from the Secretariat

1. At the 36th Meeting of the Executive Committee UNIDO submitted the terminal umbrella project for 30 enterprises in the extruded polyethylene foam sector in China. The agreed grant of the project was US $4,325,709 and implementing agency support cost of US $485,528. In view of its business planning limitations, UNIDO requested approval of the amount in principle with payment in two tranches as follows:

March 2002	US $1,697,000	Against 2001 business plan
July 2002	US $3,114,537	Against 2002 business plan

2. Thus, the Executive Committee approved the amount of US $4,325,709 in principle and release of US $1,697,000 on condition that the final payment of the grant would be released based on confirmation by UNIDO that:

(i) CFC phase-out targets in the two previously approved EPE umbrella projects had been met;

(ii) Relevant project implementation milestones of the approved EPS umbrella projects had been met.

Extruded polyethylene (EPE) foam umbrella project for 25 enterprises approved at the 25th Meeting (July 1998)
Extruded polyethylene foam umbrella project for 27 enterprises approved at the 28th Meeting (July 1999)

3. UNIDO has submitted a report to the Secretariat which describes the status of implementation of the above two projects. A copy of the report is available on request. The first project with estimated duration of 18 months was completed in December 2000 about one year late due to unforeseen difficulties which are elaborated in the report. The second project which had a duration of 24 months was reported as completed in December 2001 although conversion of the foam production at the enterprises was completed in September to November 2001.

4. UNIDO reports that 100% phase-out of CFC-12 has been achieved in the projects and the enterprises are committed not to use ODS in their production. ODS-based equipment in the first project have been destroyed.

Extruded polystyrene (EPS) foam umbrella project for 9 enterprises approved at the 34th Meeting (July 2001)
Extruded polystyrene foam terminal umbrella project for 7 enterprises approved at the 35th Meeting (December 2001)

5. UNIDO also reports that all the tasks proposed in the implementation milestones of the two projects have been met. The Secretariat confirms that based on the information provided by UNIDO in its report, the milestones have been met.

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

6. The Fund Secretariat notes that the conditions stipulated in Decision 36/43 (c) for final payment of the approved grant have been met by UNIDO.

RECOMMENDATIONS

7. The Secretariat recommends final payment of the grant for the EPE terminal umbrella project for 30 enterprises as indicated in the table below.

	Project Title	Project Funding (US$)	Support Cost (US$)	Implementing Agency
(a)	Terminal umbrella project for the elimination of CFC-12 in manufacturing of EPE foam packaging nets at 30 enterprises: release of final payment	2,800,061	314,476	UNIDO

PROJECT EVALUATION SHEET
CHINA

SECTOR: Process Agent ODS use in sector (1999): 3,808 ODP tonnes

Sub-sector cost-effectiveness thresholds: n/a

Project Titles:

(a) Sector plan for phase-out of ODS in the process agent sector

Project Data	**Process conversion**
Enterprise consumption (ODP tonnes)	3,219.20
Project impact (ODP tonnes)	3,037.20
Project duration (months)	96
Initial amount requested (US $)	30,500,000
Final project cost (US $):	
Incremental capital cost (a)	
Contingency cost (b)	
Incremental operating cost (c)	
Total project cost (a+b+c)	115,410,000
Local ownership (%)	100%
Export component (%)	0%
Amount requested (US $)	30,500,000
Cost effectiveness (US $/kg.)	38.20
Counterpart funding confirmed?	
National coordinating agency	SEPA
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

Objective

8. On behalf of the Government of China, the World Bank has submitted to the 37th Meeting a sector plan for the phase out of ODS in the process agent sector in China. The stated objectives are:

(a) Based on the current consumption in the 25 applications of ODS process approved in Decision X/14, to formulate a sector plan for phase-out of consumption of ODS process agents in China consistent with Decision X/14;

(b) With financial support from the Multilateral Fund, to implement phase-out of the sector plan on schedule;

(c) To establish policies and set up a monitoring and management system to guarantee that phase-out activities are fully implemented in the most cost-effective manner.

9. A total of 3,202 ODP tonnes of CTC and 17.2 ODP tonnes of CFC-113 are proposed to be phased out at a total cost of US $115.41 million and a cost effectiveness of US $38.2 per kg.

10. The plan notes that a further 5,764 ODP tonnes of CTC is used in applications considered by China to be process agent applications but which are not included as such in Decision X/14. Phase out of this consumption is not addressed under the plan.

11. The complete sector plan as submitted to the Executive Committee is attached to this document (Annex I).

Implementation strategy

12. The proposal makes provision for industrial rationalisation, closure of small enterprises, the use of substitute technology where viable substitutes are available and emission abatement where no mature substitute technology is presently available worldwide.

13. It is advised that several policies relevant to phase-out in the process agent sector are already in place. These include prohibition of construction of new process agent facilities and prohibition of the import of CTC. New policies envisaged under the plan include a quota system for the production of CTC intended for process agent uses, annual verification of process agent consumption and new production specifications and standards.

14. The proposal makes provision for 1999 to be used as the base year for process agent consumption and proposes reductions in consumption from that year. Consumption will be reduced by 29 percent to 2,342 ODP tonnes by 1 January 2005 and by some 95 percent to 182 ODP tonnes by 2010. The residual consumption in 2010 is considered in the proposal to be the level reasonable achievable in a cost -effective manner without undue abandonment of infrastructure (Decision X/14).

15. On the basis of Decision X/14 of the Parties and Decision 27/78 of the Executive Committee, the proposal presumes that production capacity installed before 1 January 1999 is eligible for funding and costs are requested on that basis.

16. Conversion and closure projects will commence in 2003. For the first two years reductions will arise from plant closures. In the third year reductions from implemented plant conversions will commence.

Cost of the sector plan

17. The annual costs for the sector plan together with the reductions in consumption proposed in it as advised by the World Bank are indicated in the following table:

	Baseline (1999)	2003	2004	2005	2006	2007	2008	2009	2010
Phase out targets (metric tonnes)									
Domestic consumption target	2,933 (net eligible consumption)	2,537	2,129	1,715	1,473	1,053	1,004	483	165
Funding Request (US$ million)									
Enterprise-level activities	113.4	30	30	25	10	7	6	5.4	0
Technical assistance	2.0	0.5	0.5	0.35	0.30	0.15	0.10	0.10	0
Total	115.4								

18. The total costs for each of the five eligible applications in which ODS process agents are used are indicated in the following table, together with the type of ODS process agent and the nature of the intervention proposed to achieve phase-out:

Application	Intended Intervention(s)	Funding requested (US$, mil.)	Capacity in 1999 (t/a)	Capacity in 2010 (t/a)
Chlorinated rubber (CR) Process agent: CTC	Closure	13.54	1,350	0
	Process change.	32.40	3,000	3000
	Subtotal	45.94	4,350	3,000
Chlorinated Paraffin (CP-70) Process agent: CTC	Closure	25.96	6,600	0
	Process change.	23.76	6,000	6000
	Subtotal	49.72	12,600	6,000
Chlorosulphonated Polyolefin (CSM) Process agent: CTC	Emission control	6.4	3,000	3,000
	Subtotal	6.4	3000	3000
Ketotifen (a pharmaceutical product) Process agent: CTC	Emission control	1	10.35	10.35
	Subtotal	1	10.35	10.35
PTFE (teflon) Process agent: CFC-113	Process change.	9.7	8000	8000
	Subtotal	9.7	8000	8000
Technical assistance		2		
	TOTAL	115.41		

Operating mechanisms and management

19. The proposal includes arrangements for submission of annual programmes, performance requirements for approval of annual tranches and remedial action in the event of non-performance. Management arrangements which centres on SEPA's Project Management Office are outlined, together with the roles of industrial organisations, local environmental protection bureaux and a proposed domestic implementation agent (to be selected). Arrangements for annual independent verification of ODS consumption and conversion under the management of the World Bank are included, as well as annual financial audits by an independent agency acceptable to the Bank.

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

Financial allocations in the 2002 business plan of the World Bank

20. There is a need for China to take action as a matter of urgency to reduce consumption of CTC for controlled uses, i.e. in the process agent sector, in order to comply with the Montreal Protocol control measures for CTC. For this reason the Secretariat has forwarded this proposal for submission to the Executive Committee, notwithstanding that there is currently no funding available for the project from within the World Bank's approved 2002 business plan.

Consumption

21. The World Bank has surveyed all likely process agent uses in China, including possible uses not included in Decision X/14. The survey has involved visits to all plants and data is provided about capacity and production levels (including those plants not currently producing or not using ODS in the process). However there is a need for information to be provided on the dates of establishment of capacity in relation to 25 July 1995 in order to implement relevant Executive Committee decisions on plant eligibility. Some other details remain to be settled on plant eligibility including four plants that have no current consumption because they have not operated since 1996.

22. Of the consumption identified in the proposal of 8,232 metric tonnes per year, some 3,008 metric tonnes, that is less than half, is for uses currently listed as process agent uses under Decision X/14, and eligible for consideration for funding. Where some enterprises are being funded to phase out and others using CTC are not required to phase out, it will be difficult to measure national CTC consumption as defined under the protocol. How this can be achieved is not explained in the plan. As a first step China will need to clarify what figures are to be reported to the Ozone Secretariat under Article 7 as process agent consumption. At the present time it appears that China has not reported on process agent consumption.

23. In regard to consumption for process agent use, the information in this document will need to be consistent with information provided to the Executive Committee on CTC process agent use at the enterprise level, still to be provided under the China solvent sector agreement.

Compliance

24. As presented, the sector plan does not provide for compliance with the Protocol control measures, specifically the 85% percent CTC reduction by 2005. The Executive Committee has not so far provided funds for a programme of which non-compliance is an integral part.

Technology choice

25. The plan lists the various technology choices that may, in theory, be used to achieve phase-out and identifies the various problems that remain to be faced with each option. It is apparent that much more work is required to identify and put in place concrete proposals to achieve phase-out in the five sub-sector applications covered by the plan. In this regard it is noted that 99 percent of the eligible consumption occurs in only three major eligible sub-sectors: chlorinated rubber (CR); chlorosulphonated polyolefin (CSM) and chlorinated paraffin (CP-70), with one percent used for ketotifen and polytetrafluoroethylene PTFE. The Secretariat considers that the World Bank and China will need to determine and develop the specific mechanisms by which the necessary technology transfer will be achieved and the specific process changes to be effected. It will also be necessary to examine the potential for substitute technologies already in use (for CP-70 production, as indicated in Annex 6 in the plan) to be further developed to remove the remaining barriers as indicated in the plan (pages 23, 24).

Incremental costs

26. The issue of determination of incremental costs follows from the lack of certainty in technology choices and consequent lack of development of conversion options. While the proposal seeks to give the Executive Committee an indication of the likely incremental costs, the variables are currently so imprecise as to render the estimate little more than descriptive. There can be no basis for establishing the eligibility of funding until specific costs have been presented.

27. Currently the only precedents are the incremental costs for process agent projects in India. While sector plans generally are expected to provide more cost effective solutions than the project by project approach, the overall cost proposed in this sector plan is around four times less cost effective than the individual projects in India available for comparison.

28. Other issues affecting the level of incremental costs in the proposal include:

(a) the plan assumes that capacities in place before 1 January 1999 are eligible for funding. The decisions of the Executive Committee still apply, including that capacity not installed after 25 July 1995 is not eligible for funding;

(b) the closure compensation model will need additional examination: not all parameters indicated are eligible, such as remaining lifetime; rate of growth; discount rates; dismantling costs;

(c) baseline information about the plants is required to facilitate the determination of incremental capital costs;

(d) where emission controls are proposed, the requirements of Decision X/14 of the Parties, paragraphs 3 (b) and 5 will need to be observed, in regard to proposing cost-effective measures to reduce emissions to levels agreed by the Executive Committee to be reasonably achievable.

Implementation and monitoring

29. Provisions for implementation, management, monitoring and auditing are similar to those in other sector plans for China now approved by the Executive Committee. Some issues are not fully addressed, including:

(a) the action plans in the proposal are general in nature and do not contain details of the actual activities that will be undertaken each year, leading to achievement of consumption reductions;

(b) there is no mention of how the performance (i.e. the reductions in consumption) will be measured or corroborated: this will need special attention since CTC consumption will be ongoing at other plants not considered to be process agent applications;

(c) there are no indications of performance penalties.

<u>Summary</u>

30. There is a need for intervention in the process agent sector in China as soon as possible to facilitate compliance with the 2005 control measure for CTC. The information gained in the initial survey provides a basis for progress to be made. However there are many issues that need to be resolved before sector plan incremental costs can be established. The most important issues appear to be: (a) determination of the technology solutions for the five applications addressed in the plan; (b) on this basis, establishing the incremental cost, and: (c) determining the time that will be needed to implement the technological choices, that is, how and when the phase-out will be accomplished.

31. The Secretariat observes that most of the consumption arises from only three applications: CR, CSM and CP-70. Rather than striving for a complete package incorporating all applications in a sector plan, there may be merit in pursuing solutions in one or more of these major applications, and bringing them to the Committee on a sub-sector by sub-sector basis as soon as individual solutions become available. While this would reduce the flexibility available to the government, it may reduce substantially the time required to begin implementing phase-out, compared to the timing of a sector plan with complete information provided for all applications

32. The outcome of the Secretariat's review was communicated to the World Bank along the above lines. The World Bank indicated that it looked forward to further discussions on how to proceed on the overview of the sector plan, after the Executive Committee had provided some guidance on the next steps. The World Bank also indicated that the Government of China had contacted the Ozone Secretariat about the consumption in applications not currently classified as process agents in Decision X/14 and about China’s likely inability to comply with the 2005 CTC control measure. In regard to plant eligibility, the World Bank re-iterated China’s reasons for suggesting that the cut-off date for new capacity should be 1 January 1999

33. The Secretariat will continue to discuss the proposal with the World Bank and will advise the Sub-Committee on Project Review of any developments.

RECOMMENDATION

34. Pending.

PROJECT EVALUATION SHEET
CHINA

SECTOR:	ODS use in sector (1999):	15,953.80 ODP tonnes
Sub-sector cost-effectiveness thresholds:	Domestic refrigeration	US $13.76/kg

Project Titles:

(a) Sector plan ODS final phase-out: domestic refrigeration and domestic refrigeration compressors

Project Data	**Domestic**
	Domestic Refrigeration and Compressors
Enterprise consumption (ODP tonnes)	1,099
Project impact (ODP tonnes)	1,099
Project duration (months)	54
Initial amount requested (US $)	21,920,943
Final project cost (US $):	
Incremental capital cost (a)	18,659,319
Contingency cost (b)	1,551,861
Incremental operating cost (c)	1,709,762
Total project cost (a+b+c)	21,920,943
Local ownership (%)	100%
Export component (%)	0
Amount requested (US $)	21,920,943
Cost effectiveness (US $/kg.)	19.95
Counterpart funding confirmed?	Yes
National coordinating agency	SEPA
Implementing agency	UNIDO, Italy

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 (1999)	67,580.00 ODP tonnes
- Baseline consumption of Annex A Group I substances (CFCs)	57,818.70 ODP tonnes
- Consumption of Annex A Group I substances for the year 1999	42,983.40 ODP tonnes
- Baseline consumption of CFCs in refrigeration sector	Not Available ODP tonnes
- Consumption of CFCs in refrigeration sector in 1999	15,953.80 ODP tonnes
- Funds approved for investment projects in refrigeration sector as of March 2002	US $152,937,907.00
- Quantity of CFC to be phased out in investment projects in refrigeration sector as of March 2002	15,740.05 ODP tonnes
- Quantity of CFC phased out from approved investment projects in the refrigeration sector	8,230.45 ODP tonnes
- Quantity of CFC to be phased out in approved but not implemented refrigeration projects	7,410.40 ODP tonnes
- Quantity of CFC to be phased out in projects submitted to the 37th Meeting	1,099.00 ODP tonnes

35. In September 1995, the Government of China prepared a sector strategy in the domestic refrigeration sector. According to the Strategy, there were 70 and 30 production lines for manufacturing refrigerators and freezers respectively. The total installed production capacity was 15 million units per year calculated on the basis of two production shifts per day. The supply of hermetic compressors was provided by 18 compressor production lines with an annual capacity of 13 million units. The ODS consumption in the sector was reported to be 8,320 metric tonnes for manufacturing and 142 metric tonnes for servici ng.

36. Since then, the Executive Committee has approved 41 investment projects in the sector at a cost of US $79.3 million for the phase out of 10,874 ODP tonnes. Fourteen projects are still on-going to phase out 3,882.2 ODP tonnes.

37. In the compressor sub-sector, the installed production capacity was 13 million units in 1995. The Executive Committee approved nine projects for conversion of production of hermetic compressors to non-CFC-based technology. The converted annual production capacity is equal to about 10.7 million units of non-CFC-based compressors.

ODS Phase out Plan in the Domestic Refrigeration and Compressor Sector

38. UNIDO submitted to the 37th Meeting a sector phase-out plan for the conversion of the remaining domestic refrigeration and compressor manufacture. The objective of the plan is to assist the Government of China to meet its 2005 and 2007 compliance targets for Annex A Group I substances. A total of 918 ODP tonnes will be phased out. This amount will be deducted from the total national aggregate consumption as determined for China at the 35th Executive Committee meeting.

39. The Plan indicates that there are 23 domestic refrigeration enterprises and 11 compressor manufacturing facilities eligible for support from the Multilateral Fund. The total incremental costs amounting to US $20.3 million are determined on the basis of incremental capital and operating costs related to conversion of 9 domestic refrigerator manufacturers and 9 compressor manufacturing enterprises. The Government is seeking flexibility to use sector funds for implementation of a rationalization scheme including closure of some of these enterprises. The overall cost-effectiveness of the new measures proposed in the plan is US $19.95 per kg ODP to be phased out.

40. The conversion of Guizhou Haier, a domestic refrigerator manufacturer, is included in the sector plan as a bilateral project submitted by Italy. The requested funding is US $1,802,106 to convert the enterprise from CFC-12 refrigerant and CFC-11 blowing agent to isobutane and cyclopentane technologies respectively. The project will phase out 181 ODP tonnes.

41. The sector plan will be implemented by national institutions under supervision of UNIDO according to an agreement to be formulated upon approval of the proposal. Management costs of US $220,000 are requested to enable national implementation of the plan. The implementing agency support cost is calculated at the level of 11% amounting to US $2,233,708.

42. The performance and disbursement schedule is shown in the table below.

Activity	Year	ODP Phased out (ODP tonnes)	Disbursement (US $)
Initial payment	2002	0	3,500,000
CFC phase out contracts are signed for phase out of 318 ODP tonnes	2003	0	6,000,000
Equipment procurement contracts are signed, compressor models are redesigned	2004	0	5,500,000
All equipment purchased, policies to ban manufacturing CFC-based appliances and compressors are in place	2005	600	5,306,000
Completion of projects, destruction of CFC- based equipment	2006	318	0
Total		918	20,306,433

43. The sector plan provides information on the roles and responsibilities of local institutions and UNIDO.

SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

COMMENTS

44. The Secretariat has sought additional information from UNIDO to clarify the remaining fundable consumption in the domestic refrigeration sector and the total impact of the sector plan on the remaining aggregate consumption in China. The Secretariat is still discussing these issues with UNIDO.

45. The Secretariat has requested additional information from UNIDO on baseline equipment and historical records of production for the manufacturing enterprises involved, in order to determine the eligibility of the requested funding. Some information has been provided and is currently being analysed by the Secretariat.

46. The Secretariat is also analysing the list of enterprises provided in the sector plan in light of information contained in document UNEP/Ozl.Pro/ExCom/28/Inf2, presented by the government of China to the 28th Meeting, in order to determine the eligibility of enterprises included in the sector plan. In this respect, UNIDO has been requested to provide a number of clarifications. The issue is still under discussion.

47. The sector plan requests maximum flexibility for the Government of China in the use of the allocated resources. The sector plan also indicates that the funding will be used for conversion of 9 enterprises in the refrigerator manufacturing sub-sector and for compensation for closure of the remaining 13 enterprises as part of a rationalisation scheme for the manufacture of domestic refrigerators in China. The Secretariat notes that there were only two companies producing CFC-based appliances in 2001, on a very small scale, that could be eligible for compensation for closure funding. The remaining 11 enterprises had no consumption in 2001 and may have already ceased to be operational. The Secretariat is of discussing this issue with UNIDO.

48. The installed production capacity in the compressor sub-sector was determined to be 13 million units in 1995. Since then, the Multilateral Fund has provided funds for the conversion of eligible compressor enterprises which would result in a production capacity of 10.7 million units per year of non-ODS compressors. Therefore, the liability of the Fund is limited to conversion of an additional 2.3 million unit capacity. The compressor component of the sector plan is formulated to seek assistance for the conversion of annual capacity of 6.6 million units of ODS-based compressors. Consequently, the capacity of 4.3 million units might not be eligible for funding.

49. The sector plan also includes allocations for conversion of a compressor manufacturing facility (Embraco-Snow Flake), which was submitted to the 27th Meeting as a retroactive project. The Executive Committee decided that project proposals for retroactive funding should be submitted only when the factory concerned had converted all its production to non-CFC

technology and destroyed the CFC-12 - specific equipment (Decision 27/16). The Sector Plan does not provide the necessary information indicating that conditions of Decision 27/16 have been fulfilled. The Secretariat has requested clarification on the above. UNIDO suggested that funds could be released to this enterprise as part of the later funding tranches of the sector plan contingent on the company meeting the conditions of the above decision. To this effect a proviso could be incorporated in an agreement with China.

50. Seventy-five per cent of the cost of the plan amounting to US $15 million would be requested in the first three years. It is to be noted that there will be no corresponding ODS phase-out during these three years as indicated in the table in paragraph 8 above. Almost all the funding would be approved before any significant phase-out took place. The Secretariat has indicated that guarantees, including financial penalties similar to other phase-out plans, should be incorporated, to ensure that the Fund is protected in the event that implementation is delayed or that elements of the programme prove not to be successful.

51. The Secretariat is still discussing with UNIDO the issues outlined above related to the baseline production and consumption figures, date of installation of production capacity, choice of technology, operating mechanism and eligible capital and operating costs.

52. The Sub-Committee on Project Review will be advised accordingly.

RECOMMENDATIONS

53. Pending.

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

PROJECT COVER SHEET

COUNTRY:	China	**IMPLEMENTING AGENCY:**	The World Bank
PROJECT TITLE:		SECTOR PLAN FOR PHASEOUT OF ODS IN THE PROCESS AGENT SECTOR IN CHINA	
PROJECT IN CURRENT BUSINESS PLAN:			YES
SECTOR:		Process Agents	
SUB-SECTORS COVERED:		CR; CP-70; CSM; PTFE; Ketotifen	
ODS USE IN SECTOR: (1999)		17.2 MT ODP CFC-113;	3,202 MT ODP CTC
PROJECT IMPACT :		17.2 MT ODP CFC-113;	3,020 MT ODP CTC
PROJECT DURATION:		8 years	
PROJECT COSTS:		**US$115,410,000**	
LOCAL OWNERSHIP:	100 %	**EXPORT COMPONENT:**	~5%

REQUESTED GRANT:	**US$ 115,410,000**		
IA SUPPORT COSTS:	**T.B.D.**		
TOTAL COST OF PROJECT TO MULTILATERAL FUND:	**T.B.D.**		
COST EFFECTIVENESS (weighted average):	**N/A**		
STATUS OF COUNTERPART FUNDING:	N/A		
PROJECT MONITORING MILESTONES INCLUDED:	**YES**	**X**	**NO**

NATIONAL COORDINATING AGENCY: State Environmental Protection Administration

PROJECT SUMMARY: This sector plan, will assist China to phase out all CFC-113 and CTC consumption in the process agents sector except for residual (emissions control) applications. The fundin g request targets the eligible consumption of 3,219.2 ODP MT of CFC-113 and CTC, and will be carried out through a series of annual programs, starting with 2003. The sector plan was prepared on the basis of a detailed analysis of eligible applications in China, and will eventually cover all enterprises and production units. The sector plan proposes a mix of applications including emissions control (for applications where mature substitutes are not known), conversion to substitute processes where economical, and closure where other options are not suitable. Conversion projects will be accompanied by associated policy actions to ensure that phaseout proceeds on schedule, and that ineligible enterprises not being financed under the project are also compelled to stop use of ODS PA. An action plan indicating annualized phaseout targets is included in the proposal, and the first annual program for 2003 is submitted along with this sector plan.

Annex I

Prepared by: SEPA and the World Bank **Date:** April 1, 2002

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

Sector Plan for Phaseout of ODS in Chemical Process Agent Applications in China

State Environmental Protection Administration of China

and

Beijing University of Chemical Technology

Revised April 23, 2002

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I. INTRODUCTION

A. BACKGROUND

1.1 The Government of China ratified the Montreal Protocol (MP) on Substances that Deplete the Ozone Layer in 1991, and finalized China's Country Program (CP) for Ozone Depleting Substances Phaseout in January 1993. This CP, which was submitted to the 9th Executive Committee (ExCom) of the MP Multilateral Fund (MLF) in March 1993, was updated by China in November 1999. During this period, several phaseout projects and sector plans have been developed and implemented, reaffirming China's commitment to meeting its obligations for phaseout of ODS consumption with the support of MLF.

1.2 In the Country Program Update, China indicated that a phaseout of ODS process agent applications would be developed in the near future. Consequently, following the Decision X/14 of the tenth meeting of the Parties in 1998 accepting the eligibility of 25 process agents applications, the ExCom has issued guidelines for preparation of projects and strategies to cover process agent phaseout. In compliance with the Decision X/14, coordinated with the State Development and Planning Commission, State Economy and Trade Commission, and State Industry and Commerce Bureau, the State Environmental Protection Administration of China (SEPA) issued a regulation in 1999. In the regulation any of the expansions and constructions of new facilities using ODS as chemical process agents (ODS PA) were banned, with effect from June 30, 1999.

1.3 Project preparation funding for China to initiate ODS PA phaseout was approved by the ExCom in two installments in 2000 and 2001.

B. OBJECTIVE

1.4 The objective of this sector plan proposed are:

a. Based on current consumption of 25 applications of ODS PA approved in Decision X/14, to formulate up a Sector Plan for phaseout of consumption of ODS PA in China consistent with Decision X/14;

b. With financial support of MLF, to implement phaseout of the ODS PA sector plan on schedule.

c. To establish policies and set up a monitoring and management system to guarantee that phaseout activities are fully implemented in the most cost-effective manner.

II. SECTOR PROFILE AND FORECAST OF DEMAND

A. BACKGROUND

2.1 In keeping with the provisions of Decision X/14 of the Parties and the guidelines subsequently issued in this regard by the ExCom, China has determined to formulate its phaseout of ODS process agent applications within the framework of a sector plan.

2.2 As a prelude to its request to the ExCom for project preparation funds, SEPA had commissioned a preliminary study to obtain general information on the applications in China that used ODS as process agents. From a variety of sources, the study[1] revealed that diversified domestic processes, including petro-chemical, chlor-alkali, agro-chemical and pharmaceutical sectors, were involved in using ODS, mainly CTC, as process agents. However, the information on ODS consumption in the applications could not be collected in a form that would permit preparing the sector phaseout plan. For this reason, the terms of reference prepared jointly by SEPA and the local implementing agency, the World Bank, for the development of the phaseout plan included a comprehensive data survey as the basis for further preparation.

2.3 The survey was carried out between December 2000 and May 2001, based on a detailed questionnaire developed jointly by SEPA, the work team of Beijing University of Chemical Technology (BUCT), and the World Bank. An initial list of approximately 100 enterprises was assembled, using official statistical sources, industry association lists and sources available on the Internet[2]. The questionnaire was pre-tested in three typical enterprises in Shenyang, Jilin and Shanghai in late 2000, and after minor adjustments to the questionnaire, the main survey was launched in early 2001.

2.4 The survey team consisted of BUCT, SEPA staff and representatives of the industrial associations. During the survey, some regional headquarters were geographically established to invite representatives from the enterprises around the areas for task training. After that, the survey teams visited most of the enterprises for data collection, facility inspection and initial discussions on phaseout options. Some enterprises who had never used ODS as a process agent, provided official certification attesting to that fact to the survey team, and were dropped from the survey list. Some others, who claimed that they did not use ODS process agents but provided no official certification, were visited anyway. As a result of references by the surveyed enterprises, a number of additional enterprises involved in ODS process agent applications were also added to the survey list. After completing the field survey in May

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[1] "Survey on the ODS Applications as Chemical Process Agents in China", Wang Wengchuan and Li Chunxi, Beijing University of Chemical Technology, January 2000.

[2] These included the Catalog of Products of the Chemical Industry in China, the Chlor-Alkali Industry Association, and the Pesticide Association.

2001, a seminar was held in Beijing with representatives of the industry associations and the larger enterprises to discuss the findings and further identify the candidates for continuing survey by follow-up activities. Finally, to ensure the data reliability of the survey, SEPA issued public notices in December 2001 and January 2002 in the China Chemical Industry Daily requiring all PA enterprises to register with SEPA by January 25, 2002, failing which they would lose all rights to be included under the sector plan.

B. ODS PROCESS AGENT APPLICATIONS IN CHINA

2.5 Results from the survey provided evidence of substantial and increasing use of ODS in process agent applications in China.

2.6 ***Number of enterprises in the sector:*** In total, the survey researched 250 enterprises, which were potential ODS users in process agent applications. In the early stages of the survey, 80 enterprises were screened out from the user list because they were identified to be producing lower grade chlorinated paraffin rather than grade 70%, (for example grade 50%, CP-50), where solvent CTC is not used. Subsequently, 170 enterprises were investigated. Annex 6 to this plan provides the detailed references and survey numbers of each enterprise investigated. The 170 enterprises investigated were found to have various characteristics, summarized in Table 2.1 below and described in detail later.

Table 2.1 Summary Profile of investigated enterprises

Total enterprises researched	Enterprises investigated	No	Status		No.	Data statistics			
		ODS users							
250	170	48	X/14 approved application	Enterprises in production	23[1/]	Products	Active Production Lines in 1997-2000	Eligible production lines	ODS Consumption in 1999 (MT/y)
						CR	7	7	3,008
						CSM	1	1	
						PTFE	6	5	
						CP-70	10	9	
						Ketotifen	1	1	
				Enterprises not presently in production	4	CP-70	0	2	
						CSM	0	2	
			Other applications using ODS		21	CPP/CEVA pesticide	21		5,224
								Total	8,232
		Non-ODS users							
		13	The enterprise has adopted substitute technology and converted its production to non-ODS-using processes.						
		57	The enterprise was making products from the approved applications list (X/14), but was set up from the beginning of its						
		52	The enterprise was closed, or not involved in producing ODS PA applications.						
	80	Not using ODS in their production of lower grade CPs							

1/ Two enterprises produce both CR and CP-70; hence 23 enterprises have 25 lines.

2.7 Details on these enterprises are provided in the following sections to present a general picture of ODS process agent applications in China as a whole.

2.8 ***Type of Process Agent Applications*** Of the 44 enterprises currently active in ODS PA processes, 23 enterprises are involved in ODS process agent applications that are included in the Decision X/14 list of 25 approved applications, the remaining 21 enterprises are involved in ODS process agent applications that have not yet been approved for inclusion on the list of applications that are eligible for MLF support. Annexes 6-24 provide, for each process agent application, basic information on the capacity, annual production and ODS consumption of each enterprise that were involved in process agent applications during the period 1997-2000. China has separately raised the issue of coverage of the other applications with the Ozone Secretariat, and this sector plan consequently limits its coverage to only the 25 approved applications; as the other applications have not yet been considered and approved by the Parties, these will be taken up later. However, a description of these other applications is provided both at the end of this chapter and in the Annexes.

2.9 Of the 25 applications contained in Decision X/14, eighteen applications are found in China (See Annex 7 for details). Of those eighteen, only five applications still make use of ODS as process agents. In three of these cases, CSM, PTFE and Ketotifen, all production use CTC as the process agent, whereas in the cases of, CR and CP-70, there are enterprises using both ODS and non-ODS processes.

2.10 The survey team made extensive efforts to locate pharmaceutical producers, since the working hypothesis was that there would be enterprises using ODS for process agent applications in this area, but with the exception of one enterprise producing ketotifen, these extensive efforts discovered that non-ODS-using technologies were the rule in China. As many as thirteen of the products included in the X/14 applications are produced using non-ODS PA technologies from the very beginning.

2.11 ***Consumption of ODS for process agent applications:*** With only one exception, all process agent applications in China make use of CTC; the exception is the use of CFC-113 for the production of polytetrafluoroethylene (PTFE), which occurs in six enterprises as tabulated in Annex 6. According to the survey, consumption of ODS for eligible process agent applications rose from 2,915 tons in 1997 to 3,629 metric tons in 2000, an annual average increase of approximately 10%. The data for 1997, 1998 and 1999 are firm estimates, based in most cases on measured or calculated figures, whereas the figure for 2000 is approximate, since it was calculated for a significant number of enterprises as an extrapolation of actual data for the first three quarters of the year. Details of enterprises which have measured data for the whole of 2000 and enterprises which have extrapolated data can be found in Annexes 6-23.

2.12 ***Chemical prices.*** Recent chemical prices obtained are as follows: CTC is around RMB 5000/MT; CFC 113 is around RMB 23,000/MT (from Jiangsu Changsu 3F); and HCFC 225 is around RMB 160,000/MT.

2.13 Details of ODS consumption for the approved applications in 1997-2000 period, by process agent application, are provided in Table 2.3.

Table 2.3 ODS Consumption in approved Process Agent Applications, 1997-2000

ODS used	Application No.	Product	Annual consumption of ODS, t/a			
			1997	**1998**	**1999**	**2000** [1/]
CTC	C3	CR	1,290	1,154	1,142	1,358
	C7	CSM	710	720	827	1,093
	C12	CP-70	900	819	1,007	1,130
	C17	Ketotifen	8.64	11.75	10.35	11.71
CFC-113	C9	PTFE	5.62	5.85	21.52	36.13
Total ODS tons			**2,915**	**2,713**	**3,008** [2/]	**3,629**
Total ODP tons			**3,204**	**2,980**	**3,302**	**3,981**

1/ Extrapolated estimates for the whole year, based on the 3Q data for Jan-Sep 2000 collected by the field survey.

2/ Includes ineligible consumption of 75 t/a at enterprise # 19 (Annex 6).

C. ISSUE OF SUBSTITUTE TECHNOLOGIES IN THE PROCESS AGENT SECTOR

2.14 The process agent sector is characterized by very specialized application of ODS as a solvent agent in the production process. It is also characterized by a very low number of enterprises globally using the process agents in the same manner. In fact over 50 applications exists using ODS in the process of which the Parties of the Montreal Prtocol presently have listed 25 applications which can apply for funding.

2.15 Due to the low number of enterprises, the technologies applied are application specific and the enterprises within the same sub-sector (i.e. use of the ODS as process agent for the production of a given product) are often competitors. When the developed countries phased out the ODS used in the solvent sector, the impact on the industry was significant. A large number of companies decided it was too costly to convert and some merged with other producers to create significant volume to justify the invetment in non ODS technology. Other companies simply closed down and focused on other products or businesses . Again other companies invested in the development of non ODS technologies.

2.16 It should also be noted that the phase out of ODS in the process sector led to the use of substitute products with similar performance as the ODS based product they replaced, An example is the introduction of non-ODS aqueous technology as a substitute for Chlorinated Rubber. While the substitute products have been able to replace the ODS based products some extent, it should be noted that substitute products does not have the same performance as the ODS based product it substitute.

2.17 The conversion of the process agent in China is facing the problem of access to substitute technology. Many of the companies are fully aware of the Montreal Protocol and its future impact, as well as substitute technologies and ODS emission reducing methods used in developed countries. However, contact to companies in developed countries in order to obtain non ODS has not been successful, neither have a number of companies effort to develop substitute technologies.

2.18 Due to the lack of available liable local non ODS technology, the China PA sector plan must be based on imported technology. The costs of acquiring technology is based on past experience by Chinese companies who have tried to obtain foreign non ODS technology, The use of foreign technology will also have an impact on the conversion costs. Again, based on experiences from companies who have tried to obtain non ODS technology, the conversion costs have been high due to specific requirements for the production line and the material used. In some cases, the technology hol;der has also required that supply of process equipment should be part of the technology transfer to ensure that the product could be produced at the right quality.

2.19 Similar to the situation in developed countries, substitute technologies does not exist for a number of applications. Instead, emission reduction has been applied, reducing the emission of ODS during the process. China will adopt a similar approach for applications where substitute technologies are not available. The emission control costs will depend on the level of ODS reduction. The level of reduction is proposed and the funding needed to achieve the reduction has been requested accordingly. Should the reduction be reduced further now or in the future, additional funding will be needed.

D. ENTERPRISES COVERED IN THE SECTOR PLAN

2.20 Table 2.4 below provides details of the enterprises who will be covered under the Sector Plan. These include 23 enterprises currently in production who are eligible for funding, 3 who are eligible for coverage but are not in production, and 2 who are not eligible.

Table 2.4 Enterprises using ODS for Process Agent Applications

Application # (X/14)	**C3**	**C7**	**C9**	**C12**	**C17**	**Total**
Name of application	**CR**	**CSM**	**PTFE**	**CP-70**	**Ketotifen**	
Eligible Enterprises	7 [1/]	3	5	9 [1/]	1	25

Eligible production lines	7	3	5	11	1	27
- With no production	0	2	0	2	0	4
- With production	7	1	5	9	1	23
Not eligible enterprises	0	0	1	1	0	2

1/ 2 enterprises have one production line each for CR and for CP-70

E. CHLORINATED RUBBER (CR) —PROFILE

2.21 The survey covered eighteen enterprises that are related to the production of chlorinated rubber, a product that is used mainly in the manufacture of corrosion-resistant paints, surface coatings and adhesives for rubber and metal items. Of these eighteen, seven enterprises were still using CTC as the process agent to produce CR during the survey period (table below), while six enterprises were found not manufacturing CR product (e.g. No 9 enterprise was not producing CR but purchasing CR as inputs into paint products), three enterprises had closed, and two enterprises were experimenting with non-ODS aqueous technology and only producing on a pilot scale

2.22 Total capacity for chlorinated rubber in China, all of it ODS-using, is confirmed to have been 4,350 tons in 1999. The survey data for the seven enterprises producing chlorinated rubber using CTC as a process agent are summarized in Annex 8.

Table 2.5 CR enterprises included in the survey

No	Enterprise name	
Enterprises using CTC as the process agent		
1	Shanghai Chlor-Alkali Chem. Co. Ltd	
2	Haotian Chem Co Ltd	
3	Wuxi Chem Group Co. Ltd	
4	Zhejiang Xin-an Chem. Group Co Ltd	
5	Jiangyin Fasten Co Ltd	
6	Henan Puyang oilfield CR Factory	
17	Shangyu Qiming Chemical Co., Ltd	
Enterprises using non-CTC aqueous technology		
7	Fenghua Yulong Chem New Materials Co Ltd	Experimental pilot plant
8	Liaocheng Chem Factory	Experimental pilot plant
Enterprises not manufacturing CR product		
9	Jiangsu Lai-dun Group Co Ltd	Paint producer, not CR producer
13	Jiangsu Desheng New Model Building Material Group	Produces building paint
14	Hangzhou Keli Chemical Co. Ltd,	Paint producer
15	Puyang Municipal Chlorine-Alkali plant	HCPE (producing high

			chlorinated polyethylene)
16	Xuzhou Huaguan Petro-Chemical Co.Ltd		Produce no CR related products
17	Chongqing Changsu Chem general Factory		Produce no CR related products
	Enterprises closed		
10	Nanjing Lishui Fangbian Chem.	Closed 1996	Plant dismantled
11	Jingjiang 2nd Pesticide Factory	Closed 1997	Plant dismantled
12	Yangzhou catalyst general factory	Closed 1997	Plant dismantled

2.23 As indicated above, the survey found that two enterprises have set up experimental production facilities for the production of chlorinated rubber based on non CTC aqueous technology. Neither of them has scaled up the pilot facility for economically viable production. It is reported that the production cost of the aqueous technology is some 15% higher than that of CTC solvent method, while the product quality is inferior.

2.24 So far, both enterprises are experiencing technical problems with the aqueous technology and no commercial scale production has been carried out. In order to use aqueous technology, the operating conditions need further refinement to ensure liable and stable production and that the CR produced with aqueous technology meet the required standards. In conclusion, aqueous technology for commercial production of CR in China is not available at present.

2.25 The survey confirmed that in 1999 seven CR enterprises were still consuming CTC and producing CR products and their total production capacity was 4,350 MT. Two of the enterprises were also producing CP-70 on separate production lines. The survey data for the seven enterprises producing chlorinated rubber using CTC as a process agent is summarized below:

Table 2.6 CR enterprises using CTC as process agents in 1999.

No.	Name of enterprise	Production capacity (MT/a)	Production (MT/a)	CTC consumption (MT/a)	CTC contained in system
1	Shanghai Chlor-Alkali Chem. Co Ltd	450	221	161	10
2	Haotian Chem Co Ltd.	500	181	199	10
3	Wuxi Chem Group Co Ltd	1,000	444	345	15
4	Zhejiang Xin-an Chem. Group Co Ltd	400	412	142	10
5	Jiangyin Fasten Co Ltd	1,000	400	152	15
6	Henan Puyang oilfield CR Factory	500	20	13	10
170	Shangyu Qimin Chemical Co., Ltd	500	402	130	10
	Total	**4,350**	**2,080**	**1,142**	**80**

2.26 Although the first CR plant started production as early as 1968, most of the current production capacities were commissioned in the early 1990s. Over the period of 1997-1999, production of CR has been growing rapidly, at approximately 22% per annum. It is probable that some of this growth has reflected partial import substitution.

2.27 CTC consumption in the seven plants has barely grown in the recent past due to improved performance and reducing of losses during production. Survey results suggest that, despite the growing CR production, CTC consumption fell from 1,290 tons in 1997 (or an 0.96 of CTC unit consumption rate) to 1,142 tons in 1999 (or 0.55), then increasing again to an estimated 1,358 tons (or 0.55) in 2000. In all plants, unit consumption rates have fallen significantly, although it is only from remarkably high rates that were reported in 1997. In that year, four of the plants reported unit consumption rates exceeding 1 ton of CTC per ton of product. Three of these plants managed to bring their unit consumption rates to below 1 in 2000.

Table 2.7 CR enterprises using CTC as process agents, 1997-2000

No	Name of enterprise	1999 production capacity	1997 production	1998 production	1999 production	2000 production
1	Shanghai Chlor-Alkali Chem. Co Ltd	450	134	150	221	225
2	Haotian Chem Co Ltd.	500	191	229	181	129
3	Wuxi Chem Group Co Ltd	1,000	319	341	444	336
4	Zhejiang Xin-an Chem. Group Co Ltd	400	282	389	412	246
5	Jiangyin Fasten Co Ltd	1,000	250	380	400	460
6	Henan Puyang oilfield CR Factory	500	45	19	20	130
170	Shangyu Qimin Chemical Co., Ltd	500	116.7	241,2	402.3	326.3
	Total	**4,350**	**1,338**	1,749	**2,080**	**1,852** [1/]
	Estimated					**2,470** [2/]

[1/] Actual for the first 3 quarters of 2000.

[2/] Estimated for 2000 based on actual production of the first 3 quarters.

F. CHLORINATED PARAFFIN (CP-70) —PROFILE

2.28 Chlorinated paraffin is a product with very diversified applications depending on the degree of chlorination. The initial survey carried out in early 2000 identified a large number of chlorinated paraffin producers in China, most of which were found to produce less heavily chlorinated CP (such as 50% grade, CP-50), which do not involve the use of ODS as a process agent. CTC is used in the production of only chlorinated paraffin 70% solid grade (CP-70), a product which finds uses mainly as a fire retardant in rubber, PE, PVC and ABS resins. CP-70 has a large price advantage over substitute products, such as bromide series products and other inorganic fire retardant.

2.29 After a large number of enterprises had been screened out during the initial survey, the survey carried out as part of sector plan preparations investigated 38 enterprises that were firmly identified as being or having been involved in CP-70 production. In fact, the survey teams found that six of the total were not involved at all in CP-70 production: two of them were producing CP-50 only, two were trading houses whose sales included CP-70 produced by others, and two were found to be involved in other chemical production altogether. (See Table 2.8)

Table 2.8 Surveyed Enterprises not manufacturing CP-70

No.	Name	Production Status
40	Shandong Binhua Group	No CP production
46	Jiangxi Electrochem Plant(Yijiang Branch)	No CP production
47	Kaifeng Dongda Chem. Group Co Ltd.	CP-50 producer
48	Jiangsu Huiyuan Chem Co Ltd	CP-50 producer
49	Shanghai Guotai Grease Chem Factory	Trading company
50	Shanghai DAnhuiu Chem Co Ltd	Trading company

2.30 Of the remaining 32 enterprises, twelve producers were identified as having current capacity for production of CP-70 using CTC as process agent. Of these twelve, ten enterprises were active producers during the survey period (1997-2000), while two enterprises had stopped production but retained facilities that could be brought back into production. Out of the ten active producers, nine are legible for compensation under the sector plan; one enterprise, Luzhou Longmatanqu Chemical Factory (no. 19) is not eligible for compensation because it s facilities were commissioned after January 1, 1999. Therefore, the total number of CP-70 enterprises eligible to receive compensation under the sector plan is eleven. (See Table 2.9)

Table 2.9 Chlorinated Paraffin (70% Solid Grade) Enterprises

Enterprises Using CTC as a Process Agent					
No.	**Name**	**1999 Capacity**	**1999 Production**	**CTC consumption**	**Installed CTC**
171	Huanghua City Jinghua Chem. Co., Ltd	3,000	363	72.6	
4	Zheijiang Xin-an Chem Group Co Ltd.	500	428	85	
5	Jiangyin Fasten Co Ltd	800	600	240	
18	Shenyang Chem. Co Ltd.	1,500	158	31.5	
19	Luzhou Longmatanqu Hongyuan Chem Factory	1,000	250	75	
Enterprises Using CTC as a Process Agent					
No.	**Name**	**1999 Capacity**	**1999 Production**	**CTC consumption**	**Installed CTC**
20	Longchang Shouchang Chem Co Ltd	500	265	67	
21	Longchang Shenghua Chem Factory	1,000	278	83.4	
22	Chongqing Tianyuan Chem General Factory	500	0	0	
23	Longyou Lude Pesticide Chem Co Ltd	300	267	45	
24	Dalian City Jiangxi Chem Ind Head Co.	3,000	1647	287	
25	Harbin Yibin Chem Ind. Co Ltd*	1,000	479	20.1	
45	Shanxi Fenyang Catalyst factory	500	0	0	
	Total	**13,600**	**4,735**	**1,007**	

2.31 Ten enterprises were found by the survey to have either converted from CTC-based production to direct chlorination or aqueous technology at some stage before the survey period, or to have used non-ODS technology from their establishment. However, seven of these producers were found to have stopped production, although their facilities remained capable of re-starting. (See Table 2.10)

Table 2.10 Enterprises using non-CTC substitute technology

No.	**Name**	**Technology**	**Production Status**

25	Harbin Yibin Chem Ind. Co Ltd	Direct chlorinating technology	Producing
26	Yantai Mouping Jingxie Chem Factory	Direct chlorinating technology	Producing
27	Liaohe Oilfield Renlong Chem General Factory	Direct chlorinating technology,	Stopped production
28	Dongtai City Tianteng Chem Co Ltd	Aqueous technology	Stopped production
29	Wuhan Gehua Group Co Ltd	Aqueous technology	Producing
30	Singpu Chemical Industries Co Ltd	Aqueous technology	Stopped production
31	Dongtai phosphorus fertilizer factory	Aqueous technology	Stopped production
32	Shanxi Pesticide Factory	Aqueous technology	Stopped production
44	Jiamushi Helong Chem Ind Co Ltd	Direct chlorinating technology	Stopped production
122	Gansu Guoxiang Chem Ind Co Ltd	Aqueous technology	Stopped production

2.32 A further ten enterprises which had been using CTC for production of CP70 were found to have closed their production and to have dismantled their facilities. In most cases, the survey discovered that the entire company had also closed down. (See Table 2.11)

Table 2.11 Closed Enterprises

No.	Name
33	Nanjing Xingfa dye Chem Factory
34	Jiangyin Xiyuan Chem Factory
35	Jiangning Shangfeng Organic Chem Factory
36	Zhedong 1st Chem Factory
37	Shandong Lunan Chem Factory
38	Laixi City Jinshan Chem Factory
39	Changge Zhongchang Chlorinated Paraffin General Factory
41	Tianjin Chen-guang Chem Factory
42	Daqing Sifang Chem Factory
43	Zhengzhou Auxiliary Chem Factory

2.33 **Industry Capacity.** Total capacity in China for production of CP-70 using ODS as a process agent amounted to 13,600 tons in 1999, (including plant #45; Shanxi and #19 Luzhou). Of this total, 12,600 tons is deemed eligible for compensation under the Process Agent Sector Plan; 1,000 tons of capacity at Luzhou Longmatanqu Hongyuan (enterprise no. 19) is ineligible because it was commissioned after January 1, 1999. The capacity for CTC-based CP-70 is relatively new. The earliest plant was commissioned in 1986, but most sector expansion took place after 1990. (See Annex 9)

2.34 Several enterprises in China have attempted to set up production lines with aqueous technology, but have not had much success. The main problem have been stable operation on commercial scale and the products produced not conforming to the required standards. In addition, the higher production costs, in combination with the operational and product quality problems has created problem for the companies who tried. Again resulting in limited confidence in the local developed technology. Of the operating plants, Wuhan Gehua Group has aqueous technology of 500 tons/a. Two enterprises are using direct chlorination technology derived from patented photo-catalytic chlorination technology, a patent for which is held by Harbin Normal University, information on the capacity of the pilot plant is not available . There is currently no estimate for the capacity of plants which are not producing but retain facilities capable of operating.

2.35 Production Data obtained by the survey for production of CTC-using enterprises is summarized for 1997-2000 in Table 2.12. Over the period covered by the survey, production of CP-70 has been growing, reflecting growth in domestic market demand for CP-70, at an average annual rate of 11%. In addition to the output of these plants, Wehua has been producing approximately 500 tons each year from its aqueous plant, and there is production of several hundred tons from the two direct chlorination plants.

Table 2.12 Production of CTC-using Enterprises, 1997-2000

Enterprises using CTC as a process agent						
No	**Name**	**1999 Capacity**	**1997 Production**	**1998 Production**	**1999 Production**	**2000 Production**
171	Huanghua City Jinghua Chem. Co..	3,000	93	105	363	1,125
4	Zheijiang Xin-an Chem Group Co Ltd.	500	267	317	428	292
5	Jiangyin Fasten Co Ltd	800	560	540	600	0
18	Shenyang Chem. Co Ltd.	1,500	1,031	861	158	343
19	Luzhou Longmatangu	1,000	0	0	250	490
20	Longchang Shouchang Chem Co	500	245	283	265	241
21	Longchang Shenghua Chem Factory	1,000	112	216	278	241
22	Chongqing Tianyuan Chem General	500	0	0	0	160
23	Longyou Lude Pesticide Chem Co	300	289	308	267	214
24	Dalian City Jiangxi Chem Ind Head Co.	3,000	952	992	1,647	953
25	Harbin Yibin Chem Ind. Co Ltd	1,000	448	460	479	230
45	Shanxi Fenyang Catalyst factory	500	0	0	0	0
	Total	**13,600**	**3,997**	**4,082**	**4,735**	**5,596***

Note – Production in 2000 was extrapolated to full year from survey data for the first three quarters of actual production.

G. CHLOROSULPHONATED POLYOLEFIN (CSM)—PROFILE

2.36 The survey identified five enterprises that have been involved in production of CSM, a specialty elastomer known for oil and grease resistance and great durability that is used for coatings, automotive parts, wires and cables, hoses and roofing membranes. Of the five enterprises identified, only one, Jilin Chemical Industrial Company, remains in production, two have stopped production and two have closed. All enterprises were equipped with using CTC as a process agent. Both enterprises that have stopped production, Hongjiang Chemical Company and Jiaohe Organic Chemical Factory, were established in 1996, and have not produced commercially at any time because of technical difficulties. Table 2.13 provides basic data on the plants.

2.37 The domestic market for CSM, which is split between military and civilian purposes, is estimated to be approximately 2,500 tons a year, and has been growing over the survey period at around 6% per annum. Total capacity in China in 1999 was 3,000 tons, all using the same technology. However, only Jilin Chemical Industry Company was an active producer during the survey period.

Table 2.13 Chlorosulphonated Polyolefin (CSM) Enterprises

No.	Enterprise name	Status	1999 Capacity (ton)	1999 Prod. (ton)	1999 ODS unit cons. (ton/ton)	1999 ODS Cons. (ton)
51	Jilin Chemical Industrial Company	In production	3,000	2,330	0.355	827
54	Hongjiang Chemical Company	Stopped prod.	300	0	0	0
55	Jiaohe Organic Chemical Factory	Stopped prod.	1,000	0	0	0
52	Hu-nan Yiyang First Chem. Company	Closed	0			
53	Tianjin Yangguang Construction Paint Plant	Closed	0			

H. FLUOROPOLYMER RESINS (PTFE) —PROFILE

2.38 The survey identified seven enterprises involved in manufacture of fluoropolymer resins. Of the seven, six plants were found to have been using CFC-113 as the process agent in producing polytetrafluoroethylene (PTFE), and one enterprise, Shanghai Shuguang

Chemical Factory, has been producing polytrifluorochloroethylene (PTFCE) with no use of ODS (See Table 2.14).

2.39 However, CFC-113 is used as a process agent in manufacture of PTFE only for recovering tetrafluoroethylene (TFE) monomer from the vent gas. In most cases, especially for the small production scale, this application is not always necessary because the recovery of TFE by CFC-113 absorption is not economical. Therefore, with these six PTFE producers, the CFC-113 absorption towers did not run as routine until very recent years when the production increased and the loss of TFE from the vent gas became pronounced.

2.40 The total capacity for PTFE in China was about 4700 tones for 1997 and 11,000 tons for 2000; it appears to have been growing very rapidly at more than 30% per annum in recent years. Over the same period, the quantity of CFC-113 consumption was increased at approximately 85% per annum, but the amount of consumed ODS was still relatively small. Annex 11 summarizes production and CFC-113 consumption data for the six ODS-using plants during the survey period.

Table 2.14 Polytetrafluoroethylene (PTFE) enterprises

No.	Enterprise name
Enterprises using CFC-113 as the process agent	
56	Shanghai 3F New Materials Share Co Ltd
57	Chenguang Chem Research Institute
166	Shanghai Tianyuan Group Fluor Chemical Plant
167	Jinan 3F Chemical Co., Ltd.
168	Jiangsu Meilan Chemical Co., Ltd.
169	Fuxin Fluor-chemical Co., Ltd.

I. KETOTIFEN—PROFILE

2.41 The survey identified six enterprises in China that have been involved in the production of ketotifen. However, only one enterprise, Zhejiang Huahai Pharmacy Company, was found to be producing ketotifen and to be using ODS for the purpose, while one enterprise had closed. The remaining enterprises were found to be preparing dosages.

2.42 The capacity of ketotifen in China has been kept constant at 3.0 metric ton per year since the producer started production in 1992. Over the survey period, the annual production of ketotifen was fluctuant with the domestic market and some product was also produced for export purpose. It is noted that, in manufacture of ketotifen, the unit consumption of CTC as a process agent was very high and the annual make up of ODS emitted from the process was approximately ranged from 8.0 tons to 12 tons per annum. The production and CTC consumption data for the enterprise is summarized in Annex 12.

I. PROJECTION FOR PROCESS AGENT APPLICATIONS IN CHINA

2.43 As the above sections have indicated, production of process agent applications has been dynamic in China, reflecting both the increasing sophistication of industrial and final consumer demand for globally-available products and also the increasing ability of the Chinese chemical industry to develop and absorb advanced process and product technology. It is expected that these trends will continue into the new century.

2.44 In 1999, SEPA, coordinated with the State Development and Planning Commission, the State Economy and Trade Commission, and the State Industry and Commerce Bureau, had issued a regulation (SEPA [1999] No.147) to ban any expansions and constructions of new facilities using ODS as chemical applications grew at about 10% per annum, reflecting the rapid growth of the end-product production. Details of ODS consumption for the 1997-2000 period, by process agent application, are provided in Table 2.3. However, there still is a large potential in China to increase ODS process agent applications for the next decade due to the following reasons:

a. Rapid developments in both social and economic aspects may increase domestic market needs for ODS-using applications, especially for agrochemical products;

b. Currently, most of the active ODS-using plants are not operated in a full scale;

c. The ODS-using enterprises that stopped production already may resume their production to continue using ODS, if needed by the market;

d. The Ozone Secretariat and the Montreal Protocol Party's Meeting do not yet approve Other applications. Before it comes to true, any capacity expansion of the new application can not be under control.

e. There still is a possibility of finding additional other applications that use ODS as a process agent out of the 25 approved applications.

2.45 Taking these factors into consideration, on the basis of total capacity in 1999 running in a full scale, the maximum consumption of ODS as a process agent in China for the next decade are estimated to be 6,438 MT for the approved applications In preparing this sector phase out plan, this projection provides the basis to set up the cost model for calculating the lost profits that the ODS-using enterprises will incur as a result of closure of their facilities prematurely as a result of China's meeting its Montreal Protocol obligations.

2.46 At present, the domestic market of CR is around 10,000t/a, of which 7,000t/a for anti-corrosion ship paints, 2,500t/a for ship container paints, and 1,000t/a for road mark paints. As the rapid development of seaside cities and ship industry in China, the annual growth rate of CR paints is about 30%, deducting the effect of paints import, the net domestic demand of CR is estimated to increase at 15%.

2.47 The domestic market of CP-70 is about 10,000~20,000t/a, As development in Engineering plastics and chemical building materials sectors, its demand will increase rapidly. According to the domestic production capacity and potential market, the production growth rate is about 15%.

2.48 Based on the information provided by Jilin Chemical Industry Company, the present domestic market for CSM is about 2,5000MT/a. As the import price of CSM is much higher than domestic levels, the domestic market will be occupied by Jilin Chemical Industrial Company and the annual production growth rate is estimated to be 7%.

2.49 As shown above, ODS consumption in PTFE and Ketotifen manufacturing sectors only take a small portion of the total (<10%). In 1996-2001, the domestic market for Ketotifen increased at 28%. It is estimated that the domestic and export market will be 800kg/a and 1500kg/a in 2002, and 2,000kg/a and 6,000kg/a in 2010 respectively. This will lead to a very high production growth rate.

2.50 The overall projections for ODS consumption for China are provided below. The maximum consumption projected refers to full capacity utilization at all enterprises.

Table 2.15 Projection of maximum ODS consumption as a process agent in China

ODS	App. No.	Application	Production capacity, t/a	Maximum ODS consumption, t/a
CTC	C3	CR production	4,350	2,424
	C7	CSM production	3,000	1,065
	C12	CP-70 production	13,600	2,891
	C17	Ketotifen production	3	19.42
CFC-113	C9	PTFE production	8,000	39
Subtotal for 25 applications			28,951	6,438
Subtotal for other applications			26,720	8,138
Total ODS tons				14,576
Total ODP tons				16,022

J. OTHER APPLICATIONS

2.51 As stated above, the survey identified eight other applications, all using CTC as a process agent, and 21 enterprises that are currently using ODS to produce these applications. These applications, numbering 30 in total, cover two general areas: first, the use of CTC to make chlorinated polypropane (CPP) and chlorinated ethylene-vinyl acetate (CEVA), which are both used for paints, inks, adhesives and coatings; and second, the use of CTC to make agrochemicals and their intermediates for a range of pesticides and herbicides. Details of these applications are summarized in Table 2.16, and the names of the enterprises involved in these applications are given in Annex 6. Annex 24 provides detailed description on the process of these applications.

Table 2.16 Other Process Agent Applications in China

No.	ODS used	Application/Product	No of active production lines	Use of the product
N1	CTC	Chlorinated Polypropene (CPP)	3	Painting ink, adhesives, coating materials, etc.
N2	CTC	Chlorinated Ethylene-Vinyl Acetate (CEVA)	3	Painting ink, adhesives, coating materials, etc.
N3	CTC	3-Phenoxy-Benzyldehyde	1	pesticide
N4	CTC	Imidacloprid and its intermediate (2-chloro-5-chloro-methylpyridin)	7	pesticide
N5	CTC	Buprofenzin and its intermediate (chloridized N-methylaniline)	8	pesticide
N6	CTC	Mefenacet and its intermediate (1,3-dichloro-benzothiozole)	2	pesticide
N7	CTC	Oxadiazon	1	herbicide
N8	CTC	Methyl Isocyanate derivative series pesticides (MICSP)	5	pesticide

2.52 The emergence of these applications within the past half decade is indicative of the increasing sophistication of the Chinese chemical industry and its ability to apply domestically-developed process technology to new product development. Since these applications were identified only in the course of the survey and were generally unknown to the authorities of China, it is also a clear indication of the need for government policies to prevent the emergence in future of other ODS-based chemicals and processes.

Table 2.17 ODS Consumption of Other applications, 1997-2000

ODS used	Application No.	Product	Annual consumption of ODS, t/a			
			1997	1998	1999	2000*
	N1, N2	CPP/CEVA	1,925	2,133	1,650	1,765
	N3~N8	Agrochemicals	2,586	3,254	3,574	4,102
Total ODS tons			**4,511**	**5,387**	**5,224**	**5,867**
Total ODP tons						

* Extrapolated estimates for the whole year, based on the 3Q data for Jan-Sep 2000 collected by the field survey.

III. TECHNOLOGICAL OPTIONS

A. INTRODUCTION

3.1 This Chapter examines the feasible potential technological options for phasing out of ODS process agent applications in China.

B. PRINCIPLES FOR SELECTION

3.2 The Government of China has proposed that the selection of alternative technology should be based on the following principles :

a. A candidate substitute technology should be based on non-ODS PA processes, and the production process should be environmentally benign.

b. Safety of production and health of workers should be guaranteed.

c. Application of the substitute technology should not result in any decrease in either production capacity or quality at either the enterprise or the national level.

d. The substitute technology should be commercially viable with proved maturity and good production running records.

e. The scale of substitute technology should be cost-effective.

3.3 The following section examines the available options for substituting or reducing ODS consumption in respect of each process agent application

C. CHLORINATED RUBBER

3.4 There are a number of options for technology substitution in the case of CR..

3.5 **Solvent exchange technology of Bayer Corporation:** CTC is still considered the most suitable solvent for chlorinating process. Bayer's technology continues to use CTC in the chlorinating stage, but then exchanges CTC solvent with a toluene solvent. This greatly reduces the CTC emissions, achieving emissions as low as 0.043kg/t. This technology is a continuous process suitable for large-scale production, but a relatively complicated production process . It also needs highly trained personnel for management and operation. In view of the fact that CR enterprises in China are either small or medium sized, this technology is not considered suitable for China at present. The experience with trying to obtain this technology from Bayer has also not been very positive; one enterprise that entered into negotiations found that the company preferred a merger rather than agreeing to transfer technology.

3.6 **Emission control for CR production:** For CR production, the CTC unit consumption ratio is rather high on average, compared with CP-70. Emission control can be used by using a combination of in-house and imported technology.

3.7 **Aqueous Technology:** Aqueous technology for CR has been developed and used in developed countries, and is now understood to be available in India as well. In this technology, latex is diluted with water or diluted hydrochloride acid in the presence of a dispersing agent, and then chlorine is introduced for chlorination in the water medium. In sum, this technology is feasible for medium-sized enterprises and can be recommended for China. However, the capital and production costs of this technology are higher than that using CTC solvent, because it requires a longer reaction time and more corrosion resistant containers, and has a lower utilization ratio of chlorine as well as a higher cost for the treatment of dilute hydrochloride acid byproduct.

3.8 **Domestic Status of aqueous technology for CR:** two Chinese enterprises are currently experimenting with aqueous technology. Liaocheng Chemical Factory invested in a pilot aqueous technology project through the Anhui Chemical Research Institute in the second half of 2000. Fenghua Yulong New Materials Co Ltd. has also carried out a pilot aqueous technology program. So far, however, no commercial scale production has been carried out, and the operating conditions need further refinement. In conclusion, commercial production technology for CR using aqueous process is not available at present.

3.9 **Recommendation:** Three options regarding technology have been considered. **Option one** is to base the phase out on emission control. This option is not considered to be achievable as it will require significant investment, high level of preventive plant maintenance, and more sophisticated baseline equipment. **Option two** is to develop the aqueous technology presently on an experimental stage at the two companies. This is not considered viable as well because (i) it will take too long and be too costly to develop the aqueous technology; (ii) there are no assurance that the two companies will be successful in developing the aqueous technology for commercial production and the end product will meet required standards; (iii) it may not be supported by the MLF as it is not a mature technology by the MLF; and (iv) obtaining patent may take a long time, thus delaying phase out. **Option three** is to base conversion on imported aqueous technology which is selected as the only option if conversion is to be achieved within the timeframe given in this sector plan.

3.10 Overall, the identified sources of substitute technology (commercial technology holders or research institutes) for CR are given in Table 3.1.

Table 3.1 Substitute technology sources for CR

Technology sources (country)	**Status**
Anhui Chem Research Institute (China)	Aqueous tech, problems in scale-up and drying system.
Fenghua Yulong new materials Co Ltd (China)	Aqueous tech, batch process, pilot scale, no experience in scale-up and commercial production.
Rishiroop (India)	Aqueous tech(in-house technology)
Asahi Denka (Japan)	Aqueous tech, batch process
Japan Paper Co Ltd (Japan)	Aqueous tech
Technology sources (country)	**Status**
ZEON (Japan)	Aqueous tech
Sanyo Guoce Co Ltd (Japan)	Aqueous tech
ICI (UK)	Aqueous tech
Hercules (USA)	Aqueous tech
Bayer Co Ltd (Germany)	Solvent exchange

3.11 So far, Chinese enterprises have not been successful in obtaining quotations or information on costs of technology acquisition.

3.12 One of the consequences of using imported technology will be that the conversion costs will go up. It is expected that the technology provider will require the production equipment to meet standards set by the company and the present existing baseline might not meet such requirements. Furthermore, based on experiences from other projects, the technology supplier might also require that equipment be procured from given suppliers and meeting standards and specifications provided by the company. The consequence is that it is extremely difficult to estimate the conversion costs. Hence a conservative approach is taken based on information available to the sector experts.

3.13 Another issue might also arise, it is commonly seen that the technology provider require JV status as part of the deal and some limitation and conditions might be imposed on the technology transfer. This is reflected in the estimate costs for acquiring the technology.

D. CHLORINATED PARAFFIN (CP-70)

3.14 Available substitute technologies for the production of CP-70 include aqueous technology, direct chlorination technology and non-ODS solvent technology; each of these processes is described below.

3.15 **Aqueous technology:** Aqueous technology utilizes water as a dispersion medium and heat removal agent in the process of chlorinating paraffin with chlorine Aqueous technology has been developed in 1995, and the CTC solvent method has gradually been phased out in developed countries. The main advantage of aqueous technologies over the CTC solvent method is that ODS is completely phased out from the process; the disadvantages include a higher investment per unit of production, poorer production conditions, and more severe equipment corrosion. In addition, because the reaction takes place in inhomogeneous fluid, some surfactant additives are added to keep the reaction in a state of emulsion at high temperature and pressure. This in turn requires high-quality corrosion-resistant and high-pressure reactors, adding further to the production costs.

3.16 **Domestic situation:** Several enterprises in China have attempted to set up production lines with aqueous technology, but have not had much success. Production of CP-70 has been achieved with aqueous technology in Wuhan Gehua Group at production levels of 500t/a with relatively stable operation, but there are still questions regarding product quality.

3.17 **Recommendations:** In the absence of mature aqueous technology in China, it will be necessary to import such technologies under the sector plan.

3.18 **Direct chlorination technology:** Direct chlorination does not use any solvents in the chlorinating process. The merits of this technology lie in its simplicity, as no separation and drying processes are needed, and production cost is therefore 40% lower. However, to enhance the reaction between viscous chlorinated paraffin and chlorine, high reaction temperatures around 160°C have to be maintained, which is close to the decomposing temperature of CP-70. Therefore, some stabilizing additives (which cannot later be removed from the final product) have to be added. This results in the product retaining some undesirable color compared to CP-70 produced with the solvent method. In addition, to improve the fluidity of the reacting liquid, some low molecular weight paraffin is always added, which decreases the softening temperature of CP-70.

3.19 **Domestic situation:** Domestic direct chlorination technology originated from the patented photo-catalytic chlorination technology of Harbin Normal University. Its commercialization was achieved by Harbin Yibin Chemical Co Ltd. Recently, a similar direct chlorination production line has been established in Shandong Muping Jingxie Chemical Factory by using new reactors designed and improved within the enterprise. However, in both cases the product quality is inferior to that achieved by the CTC solvent method, and can not fully meet the quality demanded; this restricts its wide application in China.

3.20 **Recommendations:** While this process is very competitive economically, product quality is a constraint. For this reason, domestic direct chlorinating technology is not recommended.

3.21 **Non-ODS solvent technology:** Dover Corporation of USA patented a new technology for CP-70 production, which uses 4-chloro-trifluorotoluene as a non-ODS process agent. The product quality is comparable with that for the CTC solvent technology but the production cost is reported to be higher than that for the CTC solvent technology. However, availability of the technology is not yet clear, and the prospect for introduction into China will require further examination.

3.22 **Substitute technology sources for CP-70:** Through the field survey and contacts with the producers some technical sources for substitute technologies for CP-70 production have been identified, and are shown in Table 3.2

Table 3.2 Sources of substitute technologies for CP-70 production

Technology sources (country)	Status
Harbin Yibin Chem Co Ltd (China)	Direct chlorination technology, product quality to be improved.
Shandong Muping Jingxie Chem Factory (China)	Direct chlorination technology, product quality to be improved.
Wuhan Gehua Co Ltd (China)	Aqueous tech with fair running record for a 500 t/a production line. Product quality needs improvement.
Anhui Chem Research Institute(China)	Aqueous tech, problems exist in scale-up and drying system.
Wuhan Modern Chem Tech Res. Inst.(China)	Aqueous tech without industrial test
Shanghai Tianpeng Auxialiary Chem. Plant (China)	Aqueous tech. , no experience in scale-up.
Dover Co Ltd (USA)	Non-ODS solvent technology
Asahi Denka (Japan)	Aqueous tech
Sanyo Guoce Co Ltd.(Japan)	Aqueous tech
ICI (UK)	Aqueous tech

E. EMISSION CONTROL FOR CSM AND KETOTIFEN

3.23 **Emission control:** Emission control aims to reduce emissions of ODS to an acceptable level through improvements in production technology and through strict management measures. A typical example is in CSM production: having no mature substitute technology for conversion, an emission level of CTC is achieved by using emission control in the Du Pont Company. As described above for CR, Bayer Corporation has also developed a solvent exchange technology which can reduce the ODS emission ratio. These processes come with high costs, and are not feasible for small and medium enterprises; it should also be pointed out that, as the standard of emission control is elevated, the costs, including facility upgrade and running expenditures, increase dramatically. Therefore, many factors, such as the enterprise size, equipment status, quality of technical personnel, and management level, availability of alternatives, etc., need to be taken into consideration before deciding on emissions controls and for establishing a reasonable emission control standard, which is economically viable, acceptable both for the enterprise and for the purposes of complying with Montreal Protocol requirements.

3.24 **Emission control for CSM production:** There are no substitute technologies currently available for CSM. In the 1970s, the Anhui Chemical Research Institute took up a solvent substitute technology project by using a partially chlorinated paraffin solvent, like chlorobenzene. The Jilin Chemical Corporation also studied the possibility of using non-CTC solvent mixtures to replace CTC in the late 1990s. However, both experiments failed to develop a successful solvent substitute technology for commercial production of CSM

3.25 **Recommendation:** Emission control is therefore the only solution for CSM at present. However, if suitable substitute technologies emerge in the future, such technologies can also be adopted.

3.26 **Emission control for Ketotifen production:** Ketotifen is a very high value pharmaceutical chemical with few producers world-wide; its production in the Chinese enterprise is a complex eighteen-step process, with CTC consumption not being a very significant part of this process. The company has not been able to locate suitable substitute technology, and closure is not a desirable option, given the profitability of the product.

3.27 **Recommendation:** Emission control is therefore the only realistic option for Ketotifen at present. However, if suitable substitute technologies emerge in the future, such technologies can also be adopted.

F. PTFE

3.28 **Non-ODS solvent substitute technology:** CFC-113 is a solvent used for the recovery of trace TEF monomer and some raw materials in the process of TFE monomer production. Consumption of CFC-113 can be phased out by using a new solvent, HCFC-225, under similar operating conditions. This technology has been proposed by Shanghai 3F New Materials Share Co Ltd. Some test runs are still needed for validation of this substitute technology. However, global supply of HCFC-225 is limited, and it is a transitional solvent that will also have to be phased out in the future.

3.29 **Vent gas incineration technology:** An alternative technology for emission control of CFC-113 is to incorporate an incineration system into the original absorption tower system, so that CFC-113 is decomposed to a non-ODS substance via pyrolysis.

3.30 **Recommendation:** Considering the characteristics of these two technologies, either of them can be considered an option by the enterprises.

IV. PHASEOUT STRATEGY

A. INTRODUCTION

4.1 This phase out strategy has been developed based on the current profile of ODS PA consumption in China, as described in Chapter 2. The strategy aims to develop a feasible phase out plan, while protecting domestic market demands for the related products currently being manufactured through these processes, and while ensuring most cost-effective use of MLF funding. This strategy is focused on the five applications of chlorinated paraffin (CP-70), chlorinated rubber (CR), chlorosulphonated polyolefin (CSM), pharmaceutical ketotifen and polytetrafluoroethelyne (PTFE).

B. PHASEOUT STRATEGY

4.2 The strategy for phase out of ODS PA consumption in China is based on the London Amendment to the Montreal Protocol.

a. CTC use in PA applications will be reduced to a reasonable level by 2010. This level is further explained below.

b. **Reasonable levels for CTC phase out**: According to Decision X/14 of the Parties, the emissions of Article 5 countries will be reduced to "levels agreed by the Executive Committee to be reasonably achievable in a cost-effective manner without due abandonment of infrastructure." Accordingly, China has informed the Ozone Secretariat that it will put forward a feasible phase out timetable in this PA sector plan, which will target the above-mentioned level. This sector plan suggests such a time-table.

c. The strategy is developed assuming enterprise eligibility as outlined in Decision X/14 of the Parties. This limits the eligible applications under this sector plan to the 25 applications under Table A of Decision X/14, and establishes an eligibility baseline of 1999. The 1999 eligibility is determined as follows:

   i. The decision requires all parties to report levels of emissions from process agents annually, starting in September 30, 2000; 1999 is therefore the first complete year prior to that date, and should therefore be used as a baseline.

   ii. The decision also requires that Parties should not install or commission new plant capacity using process agents after June 30, 1999; this implies that capacity installed before this date is legitimate/eligible.

iii. The decision requires the Executive Committee to develop funding guidelines and begin to consider proposals during 1999; therefore January 1, 1999 is an appropriate eligibility cut-off date.

iv. In response, the ExCom took Decision 27/78, which indicated that "initial implementation of Decision X/14 could proceed using the parallel approach outlined in document UNEP/OzL.Pro/ExCom/27/40"; this document presumes January 1, 1999 to be the eligible cut-off date.

d. Based on the specific circumstances of China, the phase out of ODS PA consumption will be carried out gradually by using a mix of options including closure of production facilities, application of substitute technologies, and emission abatement. Obviously, rationalization of enterprises is also an efficient method of expediting phase out of ODS PA consumption, because advanced processes and quality management systems can be more successfully and cost-effectively applied to large-scale factories; also, rationalization can be achieved by introducing larger new substitute technology production lines located strategically to replace several small ones.

e. The phase out of ODS PA consumption should not impose any significant impact on the domestic market for the relevant products.

f. Wherever feasible, the preferences and suggestions for phase out approaches proposed by the enterprises involved will be taken into consideration.

g. For emission control options where substitute technologies are not available at present, China also reserves the right to request additional funding later for complete ODS phase out through conversion based on such technologies if they should become available in the future.

C. PHASEOUT TARGETS

4.3 The phase out targets drawn up in this plan are based on the principles enunciated above, using consumption of ODS PA in 1999 by the eligible enterprises as the baseline, as further summarized in Table 4.1.

Table 4.1 Baseline data of ODS consumption for different products in 1999

Product	Number of enterprises	Product output (tons)	ODS PA used	ODS Consumption (ODS tons)
CP-70	11	4,485	CTC	932
CR	7	1,832	CTC	1,142.3

CSM	1	2,330	CTC	827
TFE	5	4,368	CFC-113	21.5
Ketotifen	1	0.533	CTC	10.3
Total	25			2,933

4.4 The phase out target is to reduce the consumption of ODS PA to 5.6 % of the baseline in 1999 between 2003 to January 1, 2010. The remaining residual consumption of 5.6 % of the baseline corresponds to the anticipated consumption of 165.1 t/a CTC, which will be consumed in production of CSM and Ketotifen in 2010, at the levels to be achieved after implementation of emission control projects.

D. PHASEOUT APPROACHES

4.5 Each of the enterprises currently using ODS PA will exercise one of the phase out options available. The criteria for choosing from these options are described as follows.

a. **Closure:** small enterprises with low levels of technical capability, without available or economically applicable substitute technologies or emission control, will opt for closure.

b. **Substitute technology:** Where viable substitute technologies are available, and where the product being manufactured has strong domestic market demand, a non-ODS substitute technology will be introduced.

c. **Emission abatement:** For enterprises using manufacturing processes where no mature substitute technology is available worldwide at present and where closure is not considered a feasible option, emission control will be applied. This is expected to apply to CSM and Ketotifen.

d. **Industrial Rationalization:** In some cases, it may also be possible to introduce rationalization of production lines in an efficient manner for enhancing phase out of ODS PA consumption. This would, however, be expected to be part of a substitute technology approach, suggesting that a new substitute technology with a significantly larger capacity should be introduced to replace production at several smaller enterprises.

E. PHASEOUT SCHEDULE

4.6 Based on the strategy above, the annual national ODS PA consumption targeted is provided in Table 4.2 below. A schedule, also describing the approaches adopted for different products, is provided in Table 4.3, while considering the features of each product that consumes ODS PA as follows.

a. **CP-70:** Because the average production capacity is relatively low (<1000 t/a), and the production invariably uses batch process operating in an open environment, closure and aqueous substitute technology are feasible alternative approaches for these producers. It is expected that three production lines will be converted to aqueous technology, while the others will be closed in phases up to the end of the sector plan.

b. **CR:** Most producers have small production capacity (<1000 t/a) and can phase out ODS use by either of the options of closure or aqueous substitute technology. It should also be possible to carry out some industrial rationalization by establishing two large-scale production lines with aqueous technology. Once the new production lines are in operation, the remaining small CR production lines will be closed without any production capacity loss.

c. **CSM:** Emission abatement is the realistic choice for this process, but no mature emission control technology is available either within China or internationally; the enterprise will endeavor to develop and implement an in-house emission abatement technology. If suitable substitute technologies emerge in the future, they can also be adopted.

d. **Ketotifen:** ODS PA consumption is only a small part of the total process, and a substitute solvent is not available at present. Emission control is proposed. If suitable substitute technologies emerge in the future, they can also be adopted.

e. **PTFE:** This process uses CFC-113 for the recovery of trace TFE monomer and some raw materials. Consumption of CFC-113 can be phased out either by using a new solvent (HCFC-225) or by incineration technology for the vent gas.

Table 4.2 ODS PA annual consumption target for each application (t)

Product	**ODS used**	**Baseline data (ODS PA consumption in 1999)**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
CP-70	CTC	932	932	782.52	640.32	498.12	498.12	355.92	317.72	317.72	0
CR	CTC	1142.3	1142.3	896.3	632	367	235	103.5	103.5	103.5	103.5
CSM	CTC	827	827	827	827	827	827	684	684	163.1	163.1
Ketotifen	CTC	10.35	10.35	10.3	8.3	5.3	2	2	2	2	2
PTFE	CFC-113	21.52	21.52	21.5	21.5	17.5	13.50	10.50	0	0	0
Subtotal		2,933	2,933	2,537*	2,129	1,715	1,576	1,156	1,107	586	269

* CTC consumption of 75 t/a for manufacturing CP-70 in Luzhou Longmatanqu Hongyuan Chemical Factory is excluded from eligible capacity. It is to be phased out by administrative measure.

Table 4.3 ODS PA phase out schedule and approaches for each application

<table>
<tr><th>Product</th><th>Approach</th><th>2003</th><th>2004</th><th>2005</th><th>2006</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th></tr>
<tr><td rowspan="2">CP-70</td><td>Closure</td><td colspan="3"></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Substitute Technology</td><td colspan="5"></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">CR</td><td>Closure</td><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Substitute Technology</td><td colspan="4"></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CSM</td><td>Emissions Control</td><td></td><td colspan="4">1st phase</td><td colspan="2">2nd phase</td><td></td></tr>
<tr><td>Ketotifen</td><td>Emissions Control</td><td></td><td colspan="2"></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>PTFE</td><td>Substitute Technology</td><td colspan="5"></td><td></td><td></td><td></td></tr>
</table>

F. EXISTING PROBLEMS IN OBTAINING SUBSTITUTE TECHNOLOGY

4.7 Producers in China have made their best efforts to acquire state-of-the-art substitute technology, and find that there are many limitations in regard to the sources and availability of technology, and the high associated costs, and there are questions as to whether these technologies are mature. Also, as indicated above, emission control is not a final option as it does not result in complete phase out. If substitute technologies enabling complete ODS phase out through conversion become available in the future for CSM and Ketotifen, China will face the challenge of completing the phase-out of ODS in these sectors by adopting these technologies. Following the provisions of the London Amendment to the MP, China therefore expects that all parties in the ExCom would cooperate to help it obtain the best available technologies, in order to ensure success of the sector plan.

V. PHASEOUT POLICIES

A. INTRODUCTION

5.1 As explained earlier, policies specifically designed for effecting phase out of ODS in chemical process agents applications in China are and will be based on Decision X/14. A number of ODS-related policies have already been introduced, and others are planned for the future. This Chapter presents both existing policies relevant to the process agent application sector and proposed new policies.

B. POLICIES ALEADY IN PLACE

5.2 Several policies relevant to phase out of ODS in the PA Sector have already been adopted by China in the context of its MP obligations or other sector plans. These are summarized as follows:

a. **Circular on Bans for new production facilities of ODS production and consumption:** In 1997, SEPA, State Development Planning Commission, State Economic and Trade Commission, and the State Administration for Industry and Commerce jointly issued this document. It prohibits the construction of new expansion, and installation of halon and CFC production facilities (production lines) after November 1997.

b. **Supplement to Circular on Bans for new production facilities of ODS production and consumption:** SEPA issued a Supplement to the Circular described above, extending the ban to any new construction, re-construction or expansion of plants and, production lines concerning the 25 applications of ODS PA from July 1, 1999 (except for projects that had already been approved by local authorities before that date).

c. **Licensing system for ODS export and import:** the Government issued a set of regulations and policies for controlling export and import of ODS, which came into effect in April 2000; under this regulation, the import of CTC was banned.

C. PROPOSED NEW POLICIES

5.3 **A quota for controlling of ODS PA consumption:** For enterprises currently using ODS PA, quotas will be assigned annually, starting three months after approval of the sector plan based on the present consumption levels and the progress of phase out. Annual reporting from the participating enterprises will be required, and verification will be conducted for consumption. No consumption will be allowed in this sector without issue of quotas.

5.4 **Annual verification of ODS PA consumption:** To ensure the above, a national regulation and monitoring system for this sector plan will have to be put in place, and will be developed.

5.5 **New production specifications and standards:** After the approval of the Sector Plan, an Environment-friendly Labeling System will be put in place to promote products that no longer use any ODS PA. These Environment-friendly labels will be awarded through a transparent and fair process based on published standards determined by experts and approved by Government. It is expected that the Labeling System will help the products produced by substitute technologies to capture market share. In selection of substitute technologies, environment-friendly technologies will be given preference.

5.6 **Selection of enterprises:** As the number of participants is limited and all participants must in any case be covered, selection of enterprises for closure and substitute technology in annual programs will be carried out through administrative measures.

5.7 **Safety standards for the substances used for substitute technologies:** such new health and safety standards will be established as necessary.

VI. INCREMENTAL COST ANALYSIS

A. INTRODUCTION

6.1 The Process Agent Sector plan phase out strategy was developed on the basis of the cost-effective phase out measures and ODS emission abatement measures specified by the Parties (Decision X/14). These measures include process conversions, plant closures, emissions control technologies and industrial rationalization, under which more than one of the closure, conversion and emissions control options might be combined. The practicality of each of these options has been examined in the context of the current state of technology development and availability and the existing capacity for absorbing new technology in China. This chapter examines the costs of these options, and presents the outline of the economic model that was developed to calculate the phase out costs of the proposed sector plan and various options considered. On the basis of the cost calculations for the options, this chapter lays out the overall costs and annual costs of the proposed phase out schedule.

B. CLOSURE OPTION

6.2 The first option considered is to close all enterprises. To calculate the level of compensation for this option, an economic model similar to that used in the Halon and CFC Phase out Plans was used. This model calculates the profit streams foregone due to early closure, comparing with the profits that would have been earned in the absence of Montreal Protocol limits.

6.3 The following principles were followed in setting up a computer model for incremental cost calculations to meet the specific phase out targets:

a. Incremental costs only apply to the 25 applications of ODS PA approved by Decision X/14. The cost model is specific to China;

b. Capacities commissioned/in production on or before January 1, 1999 are eligible for compensation; and

c. Actual eligible production and ODS PA consumption in 1999 provide the baseline for incremental cost calculations.

6.4 Basic data for ODS PA-related enterprises required for incremental cost calculations are summarized in Table 6.1.

Table 6.1 Basic data of eligible enterprises for incremental cost calculation

For enterprises in production	
Number of eligible enterprises in production	**Number**
CR	**7**
CP-70	**9**
CSM	**1**
Ketotifen	**1**
PTFE	**5**
Eligible production capacity, t/a	
CR	**4,350**
CP-70	**12,600**
CSM	**3,000**
Ketotifen	**3**
PTFE	**8,000**
Eligible production in 1999, t/a	
CR	**2,081**
CP-70	**4,485**
CSM	**2,330**
Ketotifen	**0.533**
PTFE	**4,367**
Eligible ODS PA consumption in 1999, ODS t/a	
CR (CTC)	**1,142. 3**
CP-70 (CTC)	**932**
CSM (CTC)	**827**
Ketotifen (CTC)	**10. 35**
PTFE (CFC-113)	**21. 52**
For enterprises not in production	
Number of eligible enterprises not in production	
CR	**0**
CP-70	**2**
CSM	**2**
Ketotifen	**0**
PTFE	**0**

Total number of eligible enterprises		
CR		**7**
CP-70		**11**
CSM		**3**
Ketotifen		**1**
PTFE		**5**
Eligible enterprises		
No.	**Enterprise name**	**Product**
1	Shanghai Chlor-Alkali Chem. Co Ltd	**CR**
2	Haotian Chem Co Ltd.	**CR**
3	Wuxi Chem Group Co Ltd	**CR**
4	Zhejiang Xin-an Chem. Group Co Ltd	**CR, CP-70**
5	Jiangyin Fasten Co Ltd	**CR, CP-70**
6	He-nan Puyang oilfield CR Factory	**CR**
170	Shangyu Qimin Chemical Co., Ltd	**CR**
171	Huanghua City Jinghua Chem. Co., Ltd.	**CP-70**
18	Shenyang Chem. Co Ltd.	**CP-70**
20	Longchang Shouchang Chem Co Ltd	**CP-70**
21	Longchang Shenghua Chem Factory	**CP-70**
22	Chongqing Tianyuan Chemical General Factory	**CP-70**
23	Longyou Lude Pesticide Chem Co Ltd	**CP-70**
24	Dalian city Jiangxi Chem Ind Head Co.	**CP-70**
25	Harbin Yibin Chem Ind. Co Ltd	**CP-70**
45	Shanxi Fenyang Catalyst Factory	**CP-70**
51	Jilin Chem. Ind. Co Ltd	**CSM**
54	Hongjiang Chemical Company	**CSM**
55	Jiaohe Organic Chemical Factory	**CSM**
56	Shanghai 3F New Materials Share Co Ltd	**PTFE**
57	Chenguang Chem Research Institute	**PTFE**
167	Jinan 3F Chemical Co Ltd	**PTFE**
168	Jiangsu Meilan Chemical Co Ltd	**PTFE**
169	Fuxin Fluor-chemical Co Ltd	**PTFE**
59	Zhejiang Huahai Pharm Group Co Ltd	**Ketotifen**

6.5 Incremental costs of closing enterprises in production include: lost profits from premature closure of production lines, labor compensation caused by closure, and dismantling costs of ODS PA related facilities. Incremental costs for enterprises not in production include worker's compensation and dismantling costs of production facilities.

6.6 A computation model was established for estimating the incremental costs by closure. The basic assumptions for the cost model for enterprises in production are:

a. Actual eligible production in 1999 is the production baseline;

b. Compensation excludes capacities commissioned after January 1, 1999;

c. Sale price used is the domestic ex-factory price, net of tax, in 1999;

d. Total life of production facilities for all applications is 25 years starting from the year of last major expansion;

e. Remaining life of production facilities is calculated from January 1, 2003;

f. 10% of unconstrained production annual growth rate for each application up to the eligible capacity limit defined in 1999;

g. Average annual inflation rate of US$ for future compensation after 2003 is 2.5%;

h. Discount rate for future profit loss of each year's closure is 5.58 % [3];

i. Labor compensation is estimated to be two years' salary per worker;

j. Net dismantling cost per production line is US$20,000.

6.7 Basic assumptions of the cost model for enterprises not in production are:

a. 10,000 RMB per capita year for labor compensation on a two year basis;

b. US$ 20,000 of net dismantling cost for each enterprise;

c. All compensations are to be paid in 2003.

[3] This is the current long term (more than 5 years) lending interest rate of the Bank of China (March 27, 2002).

Table 6.2 Basic assumption and key parameters

No.	Basic assumption and key parameters	Values
1	ODS PA phase out starts from January 1, 2003	
2	ODS PA is reduced to agreed levels by the end of 2010 at a constant reduction rate covering the period.	
3	Total life of production facilities for all applications	25 years
4	Average remaining life of the production facilities*	
	CR	16 years
	CP-70	18 years
	CSM	12 years
	Ketotifen	14 years
	PTFE	19 years
5	Sale price of the product in 1999	Varies with enterprise
6	Unconstrained production growth rate	10% p.a.
7	Discount rate of future profit loss	5.58% p.a.
8	Annual inflation rate on and after 2003	2.5% p.a.
9	US$ exchange rate	8.27 RMB/ US$

$$ARL_j = [\sum_i RL_i \frac{CAPACITY_i}{\sum_i CAPACITY_i}]_j$$

Notes: * Determined for each of the applications by

where
ARL average remaining life by application, year;
RL remaining life of each production line, year;
i enterprise (i = 1, 2, 3, …);
j application (j = CR, CP-70, CSM, Ketotifen, PTFE).

6.8 Profit compensations are calculated by following steps:

a. Determining production cost, sales revenue, and profit margin for each of the enterprises based on the eligible 1999 database;

b. Determining the average profit margin and average remaining life on application basis by applying statistical methods;

c. Determining annual unconstrained production, constrained production, lost production, and annual profit loss on application basis; and

d. Determining profit compensation for each of the applications.

6.9 Following these steps, the computed profit compensation to phase out all ODS process agent by production closure is presented in Table 6.2. Basic assumptions and key parameters for this proposal are summarized in Table 6.3. If China were to close all enterprises, the computed costs of closure would have a present value of US$ 345 million.

Table 6.3 Profit compensation for ODS phase out by closure

ODS PA	Application	Phase out (tODS)	Profit (US$'000)	Labor (US$'000)	Dismantling (US$'000)	Total Compensation (US$'000)
CTC	CR	1,142	48,760	1,161	161	50,082
CTC	CP-70	932	48,697	634	220	49,552
CTC	CSM	827	18,722	576	60	19,358
CTC	Ketotifen	10.35	3,906	90	20	4,016
CFC-113	PTFE	21.52	220,131	2,250	100	222,481
	Total	**2,933**	**340,216**	**4,711**	**561**	**345,490**

C. SUBSTITUTE TECHNOLOGY

6.10 The second option considered was to convert all enterprises, where substitute technology is known to be available. As discussed in Chapter 4, technologies are available for CR, CP-70 and PTFE, but not currently for CSM and ketotifen.

6.11 The incremental cost required for substitute technologies includes the following elements in general:

a. Incremental capital cost for replacing the original production line with the same capacity or commercially rational size; this part includes the technology transfer costs, and the necessary equipment and facilities, such as specially designed reactors, dryers, separation and waste stream treatment units, and the necessary civil works, etc;

b. training and trial costs;

c. Incremental operating costs; and

d. Contingencies.

6.12 It is necessary to state that alternative technologies are only now emerging. Due to lack of widespread experience with these technologies, especially in developing country circumstances, it is difficult to estimate the actual cost of conversion at each enterprise. Moreover, the actual cost of conversion is likely to vary significantly depending on the conditions of the baseline equipment in the factory, and the extent to which existing equipment can be modified and adapted. Finally, access to these new technologies is a serious issue, which will affect the size of technology transfer costs and the conditions under which this transfer can take place. The figures for substitute technology used in the evaluation below and in the funding request within the sector plan can only be regarded as approximate.

6.13 **Incremental costs for CP-70:** Incremental costs and cost effectiveness for constructing a 2,000t/a CP-70 production line of aqueous technology are estimated based on the information provided by Shenyang Chemical Co. Ltd through contacts with a foreign technical agency. The incremental costs and cost effectiveness are US$ 7,326,400 and US$ 45/kgCTC, respectively, as shown in Table 6.4.

Table 6.4 Conversion costs for a 2,000t/a CP-70 aqueous technology production line

Items	Cost (in US Dollars)
A. Incremental capital cost	4,524,000
B. Contingency (10%A)	452,400
C. Trials and training	250,000
D. Technology transfer fee	1,500,000
E. Incremental operational costs for 2 years	600,000
Total Cost	7,326,400
CTC consumption 1999	179 ODP Tons
Cost effectiveness (CE) (US$/kg)	45

6.14 The cost of converting 12,600 tons of eligible capacity of CP-70 production facilities, on the basis of the above costs, would be some $46 million.

6.15 **Incremental cost for CR:** Incremental costs for a (1,000t/a) CR production line of aqueous technology are estimated based on the information provided by Guangzhou Haotian Chem Co Ltd through contacts with a foreign agency. To convert all 4,350 tons of eligible capacity would, on the basis of these costs, amount to $47 million.

6.16 The detailed costs are shown in Table 6.5.

Table 6.5 Incremental cost and cost effectiveness for a 1,000t/a CR aqueous technology production line

Items	Cost (in US Dollars)
A. Incremental capital cost	6,591,000
B. Contingency (10%A)	659,000
C. Trials and Training	300,000
D. Technology transfer fee	2,250,000
E. Incremental operation cost for 2 years	1,000,000
Total Cost	10,800,000
CTC Consumed in 1999	251.6 ODP MT
Cost effectiveness(US$/kg)	30.6

6.17 **Incremental cost for PTFE**: CFC-113 substitute technology for TFE monomer recovery is available in China. Shanghai 3F New Materials Share Co Ltd, the leading unit of the Fluoro-resin Association of China, claims that CFC-113 can be substituted by HCFC-225. With this technology, existing equipment for vent gas treatment would need to be improved, and while the consumption ratio of HCFC-225 is nearly the same as CFC-113, increased operating costs would be incurred, because there is a large price difference between CFC-113 and HCFC-225. The incremental costs and cost effectiveness for substituting of CFC-113 with HCFC-225 are estimated at $1,230,000 and US$68.3 per kg CFC-113, respectively.

6.18 There is another technological solution, which would involve emissions control through incineration. The incremental cost and cost effectiveness for substituting of CFC-113 with incineration technology are estimated at $2,170,000, and $120.5 per kg CFC-113, respectively. Details for the costs are listed in Table 6.6.

Table 6.6 Incremental cost for CFC-113 reduction for each line

Items	Costs (US Dollars)	
	Incineration tech.	**HCFC-225 Solvent substitute Tech.**
A. Incremental capital cost	1,700,000	900,000
B. Contingency (10%A)	170,000	90,000
C. Pre-productive cost	50,000	100,000
D. Technology transfer fee	100,000	100,000
E. Incremental operation cost for 2 year	150,000	40,000
Total Cost	2,170,000	1,230,000
CFC-113 consumption in 1999	3.4 ODP MT	2.4 ODP MT

D. EMISSIONS ABATEMENT

6.19 An emission abatement system in principle consists of devices for collection, treatment, recovery, and disposal of materials. Such systems are characterized by strict control of all plant operations, and require a high level of operator and managerial capabilities. Because of variations in baseline equipment and the type of processes employed in the process agent applications, the design and cost of emissions control systems could vary significantly. During the preparation of the China Process Agent Phase out plan, various options in this area were investigated.

Emission abatement for CSM production.

6.20 Based on the survey for Jilin Chem. Ind. Co. Ltd., its production and consumption level in 1999 is shown in Table 6.7.

Table 6.7 CSM Production and CTC consumption for Jilin Chem. Ind. Co Ltd. in 1999

Product	Total production (t)	Total consumption of CTC (t)	Average consumption ratio t CTC /t CSM
CSM	2,330	827	0.355

6.21 Emissions to air and in waste water are the main losses of CTC in the production of CSM. Because Jilin Chem. Ind. Co. Ltd. is a unique producer in China using the technology independently developed in-house, it is the model enterprise for further analysis hereafter. As is shown in Table 6.7, the average consumption ratio is 0.355t CTC /t CSM. This high ratio indicates that emission abatement is a significant and difficult task. Through detailed discussion with the producer, a reasonable and feasible goal has been set for the enterprise for a reduced consumption ratio of 0.07t CTC /t CSM.

6.22 Based on the survey data, emission to air constitutes about 96 % of the losses of CTC. On the other hand, about 4 % of CTC is emitted from liquid effluents. To abate the emissions, the following measures are proposed.

a. **Synthesis unit.** Two existing production lines, which are located separately, are to be merged into one. New synthesis reactors with capacities of 20 m3 are to be installed. In addition to the tail gas treatment equipment, cooled CTC at –10° C will be used as an absorbent for a liquid film absorber to remove CTC in the tail gas. Non-condensed gas will be sent to the central pipe for further treatment. The feeding system will change from pressurization by nitrogen to pumping.

b. **Storage tank system.** By collecting all the venting gases from the storage tanks, metering tanks and other equipment in a central pipe, the tail gas will be sent to a new condenser with brine cooling agent for recovering condensed CTC.

c. All of the off-gases will be charged to an activated carbon adsorption system to minimize the loss of CTC.

d. **CTC in scrubbing liquid.** New storage tank and separator for recycling scrubbing liquid wil be installed to provide sufficient residence time for separating CTC from the scrubbing liquid.

e. **Coagulation.** Vacuum coagulation system will be used to replace the existing system at ambient pressure. Off gas from the coagulation system will be sent to the condensor for the recovery of CTC.

f. **Drying and Extruders.** Twin propeller extruder with a vacuum system will be introduced to remove moisture and solvent in drying. As a result, CTC is recovered, and the quality of CSM product will be improved.

g. Automation and monitoring system will be established to guarantee smooth operation.

h. **Utilities.** A refrigeration system of the capacity of 440,000 kcal/h will be added.

6.23 **Incremental capital and operating cost**s: Table 6.8 presents detailed incremental costs for CSM as estimated by the producer.

Table 6.8 Detailed incremental costs for emission abatement for CSM

Item	**Cost (US Dollars)**
A. Process Facilities	2,847,350
B. Civil, Automation , instrument and Installation Expenses	2,801,551
C. Contingency @ 10% of (A+B)	564,890
D. Incremental Operating Cost (Total for 1 year)	180,000
Total	6,393,791
Cost-effectiveness (US$/kg)	9.6

6.24 Based on the case study, in which CSM production is 2,330 t/a, at the consumption ratio of 0.355t CTC/t CSM in 1999, the target is to reduce the ratio to 0.07 ton CTC/t CSM by 2009. The annual consumption at the target consumption ratio of 0.07 is expected to be 163.1 t/a.

6.25 The above reduction represents a phase out of 664.05 MT, at a cost-effectiveness of US$9.6 per kg. It will amount to a reduced emission equivalent to 19.7% of the 1999 level. If additional emission reductions are required, there would be additional estimated costs, as provided below:

Table 6.9 Estimated costs of Emissions control for a range of percentages

	Emission control level (percentage of consumption)	**Funding required (US$)**
Baseline (this proposal)	19.7	6,393,791

Stage II	10	18,000,000
Stage III	1	125,000,000

6.26 Stages II and III assume substantial reconstruction at the site, use of more costly materials, and very high (presently unknown) technology transfer costs. These estimates are not final, and could be further investigated if necessary.

Emission abatement for Ketotifen production.

6.27 Ketotifen production consumes CTC at an extremely high ratio of 19.42 t CTC/ t ketotifen, although the total consumption of CTC at the enterprise is not very high (10.35 t/a) in absolute terms. Emission control is the only desirable and available option for this application. The producer has proposed a flowsheet for emission abatement and has set a goal to reduce the consumption ratio from 19.42 to 0.68 t CTC/ t ketotifen.

6.28 To achieve the target, the following measures are proposed by Zhejiang Huahai Pharm Group Co. Ltd.

a. A device for CTC removal from filtered crystal will be established.

b. A vacuum drying system for recovering CTC will be installed.

c. A water stripping system for recovering CTC from waste effluents will be established.

d. An activated carbon adsorption system will be introduced in the process.

e. A refrigeration system will be installed for recovering CTC in off gases.

6.29 Table 6.10 presents detailed incremental costs for emission abatement for ketotifen, proposed by Zhejiang Huahai Pharm Group Co. Ltd.

Table 6.10 Detailed incremental costs for emission abatement for ketotifen proposed by Zhejiang Huahai Pharm Group Co. Ltd.

Item	**Subtotal (US Dollars)**
A. Process Facilities	767,957
B. Civil, Automation, instrument and Installation Expenses	143,544
C. Contingency @ 10% of (A+B)	91,151

D. Incremental Operating Cost (Total for 1 year)	17,000
Total	1,019,662
TotalCost-effectiveness (US$/kg)	12.21

6.30 The above reduction represents a phase out of 8.35 MT, at a cost-effectiveness of US$12.21 per kg. It will amount to a reduced emission equivalent to 19.3 % of the 1999 level. If additional emissions reductions are required, there would be additional estimated costs, as provided below:

Table 6.11 Estimated costs of Emissions control for a range of percentages

	Emission control level (percentage of 1999 consumption)	Funding required (US$)
Baseline (this proposal)	19.3%	1,019,662
Stage II	10%	2,039,324
Stage III	5%	4,078,648

6.31 Stages II and III assume substantial reconstruction at the site, use of more costly materials, and very high (presently unknown) technology transfer costs. These estimates are not final, and could be further investigated if necessary.

E. INDUSTRIAL RATIONALIZATION

6.32 As the above sections demonstrate, it is not possible to find a single solution that fits all enterprises. Option 1, which would require closure of all ODS-based process agent applications, is neither feasible nor economic, because it would create considerable disruption for economic development in China. Closure of ketotifen and PTFE enterprises would be extremely expensive, and is not a reasonable option. Option 2, under which all enterprises would convert their production to non-ODS-based technology, is also not feasible, because alternative technology does not exist in some cases, such as CSM and ketotifen, or because alternative technologies may be too highly priced for smaller producers. Option 3, under which all enterprises would apply emission control technologies, is also not viable because of the extremely high associated costs for achieving required levels. As also described in Chapter 4, a combination of approaches is therefore the only viable strategy for China, including elements of industrial rationalization where applicable.

F. INCREMENTAL COSTS OF PHASEOUT PLAN

6.33 Based on the above assumptions and parameters, eligible incremental costs for ODS PA phase out in China are summarized in Table 6.18. In the total costs technical assistance (TA) cost is included; TA activities cover will cover a range of activities, including technical seminars, substitute technology investigations abroad, training programs for the personnel involved in ODS PA phase out, and publicity for ODS PA measures, etc. A summary of the total requested funding is provided in table 6.12 below. There is no deduction for exports, which are reported to be all to Article 5 countries.

Table 6.12 Summary of Funding request

Application	Option	Funding requested (US$, mil.)	Capacity in 1999 (t/a)	Capacity in 2010 (t/a)
CR	Closure	13.54	1,350	0
	Substitute tech.	32.40	3,000	3000
	Subtotal	***45.94***	***4,350***	***3,000***
CP-70	Closure	25.96	6,600	0
	Substitute tech.	23.76	6,000	6000
	Subtotal	***49.72***	***12,600***	***6,000***
CSM	Emission control	6.4	3,000	3,000
	Subtotal	***6.4***	***3000***	***3000***
Ketotifen	Emission control	1	10.35	10.35
	Subtotal	***1***	***10.35***	***10.35***
PTFE	Substitute tech.	9.7	8000	8000
	Subtotal	***9.7***	***8000***	***8000***
TA		***2***		
	TOTAL	**115.41**		

VII. OPERATING MECHANISMS

A. INTRODUCTION

7.1 This Chapter explains the procedures for establishing funding arrangements and operating mechanisms for project management, coordination, supervision and evaluation as well as the responsibilities of various institutions involved in implementation of the Sector Plan.

B. UMBRELLA GRANT AGREEMENT

7.2 China and the World Bank have signed an Umbrella Grant Agreement in December 1997, which sets forth the terms and conditions under which grant resources approved by the ExCom in sector approaches in China would be carried out. This Agreement includes provisions that allow the Bank to disburse funds to China on performance-based indicators in terms of ODS phase out in sector approaches, and will also be extended to the process agents sector.

C. FUNDING ARRANGEMENTS

7.3 **MLF Approval**: It is anticipated that funds for the Sector Plan would be approved in two steps:

a. The Government, through the World Bank, will request that the ExCom consider this overall sector plan and agree to fund the Phase out with annual advances, provided that China meets agreed annual phase out targets. At the same time, the Government will also apply for approval of the First Annual Program, presently proposed to cover activities in the calendar year 2003, which will be submitted to the ExCom as a separate document.

b. From 2004 onwards, annual programs will be submitted to the last ExCom meeting each year, setting out the annual targets and funding requests. The amount of annual funding request would be consistent with the funding amounts indicated in the overall sector plan. The ExCom would be asked to release funds at the levels agreed to in the sector plan based on achievement of previous phase out targets, so that the next annual program could start in the following January. In general, approval of funds would be based on achievement of agreed ODS phase out targets.

7.4 In case China fails to reach the phase out targets for a given year, i.e., if the amount of ODS emission exceeds the agreed targets or the phase out amount contracted is less than that required to meet the target, the Bank and China would agree on remedial actions before applying for the next year's funding. The remedial actions proposed would be to bring the program back on track in the coming year, and would be further subject to ExCom approval. Other conditions as stated in the Umbrella Grant Agreement would also apply.

7.5 The Annual Program would contain the following sections:

a. sector phase out schedule, including phase out activities, enterprises involved, phase out approaches adopted and the phase out timetable arranged;

b. status of all activities of previous year(s) and any agreed remedial actions if necessary, for the current year;

c. objectives of following year’s Annual Program – phase out targets and funding requirements for activities in the following year;

d. Description of activities in the subsequent year's Annual Program, including phase out activities for the enterprises involved, any new policies to be taken up, and technical assistance activities; and

e. performance indicators of the annual program.

7.6 The World Bank would approve the technical assistance consistent with the Annual Program, based on agreed Terms of reference for each TA (including the funding level of TA) in that year’s Annual Program.

D. DISBURSEMENT MECHANISM

7.7 **MLF disbursement to the World Bank**: MLF disbursement to the World Bank: Upon approval of the Annual Program by the ExCom, the Multilateral Fund will transfer the funding to the World Bank account.

7.8 **World Bank disbursement to China**: There would be four disbursements into the ODS Phase out Account at SEPA for each Annual Program. The Government would be allowed to request these four disbursements at any time during the year, provided that the disbursement conditions have been met. In any particular year, disbursement to China will start only when the Bank receives grants for that annual program from the MLF. Disbursement conditions and amounts to be disbursed are as follows:

a. ***First disbursement*** – funds for technical assistance and DIA’s agency fees. ***Condition:*** Approval of the Annual Program by the ExCom and release of funding to the World Bank.

b. ***Second disbursement –*** 50% of funds allocated for enterprise activities and 50% of SEPA’s management fees; ***Conditions:***

i. 30% of all reduction contracts covering target phase out amount of the current year's Annual Program have been signed by government with enterprises;

ii. Progress report on the sector plan implementation is satisfactory to the Bank; and

iii. Any other conditions as specified in the current Annual P rogram.

c. ***Third disbursement*** **–** 30% of funds allocated to enterprise activities and 30% of SEPA's management fees. ***Conditions***:

i. 100% of all reduction contracts covering target phase out amount and TA contracts of the current year's Annual Program have been si gned;

ii. The government reports the actual consumption does not exceed the consumption target set for the previous year (not applicable to the first implementation program);

iii. A Progress report should be provided to the Bank on the sector plan, which is satisfactory to the Bank;

iv. the Annual Program implementation should be considered satisfactory to the Bank; and

v. Any other conditions as specified in the current Annual Program.

d. **Fourth disbursement –** 20% of funds allocated to enterprise activities and 20% of SEPA's management fees. ***Conditions:***

i. Performance audit of the previous year's annual program is acceptable to the Bank;

ii. Progress report on sector plan implementation satisfactory to the Bank; and

iii. Any other conditions as specified in the current Annual Program.

7.9 In the event that any phase out target is not met, the Bank will suspend further disbursements to China. Disbursements will resume only after China and the Bank agree on and carry out remedial actions.

7.10 **Allocation of funds to ODS consuming enterprises for phase out activities.** The grant funds will be allocated to enterprises through administrative measures. Selection of enterprises for the first annual program will be carried out as soon as possible after the ExCom approval of the sector plan. Selection of enterprises in subsequent years will be carried out in the second half of each year and would be concluded after ExCom approval of the following year's Annual Program and funding level. Selected enterprises would sign ODS reduction contracts with SEPA. The contracts will stipulate, among others; (a) date and amount of ODS phase out in chemical process agent applications; (b) the disposal equipment list and agreed disposal dates.

7.11 **Disbursement from SEPA's ODS phase out account to grant recipients**. For enterprises without ODS PA consumption quota, grant funds will be disbursed directly to the enterprise account for dismantling production facilities only. For enterprises with ODS PA consumption quota, grant funds will be directly allocated to recipient enterprises according to (a) clause of “ODS reduction contract” and (b) clauses for consulting or training services in technical assistance activities.

E. MANAGEMENT AND COORDINATION

7.12 The Government would be responsible for implementing the Sector Plan. PMO will manage and coordinate execution of each year’s Annual Program. In addition, SEPA will select a qualified firm as a Domestic Implementing Agency (DIA) to help manage day-to-day activities at enterprise level. The World Bank will supervise overall implementation of this Sector Plan, replenish the local project account, report implementation progress to the ExCom and submit future funding requests to the ExCom.

7.13 The national execution management and coordination functions are as follows:

a. ***Project Management Office*** **(PMO):** PMO is the administrative office under the State Environmental Protection Administration (SEPA) with overall responsibility for implementation of China's ODS PA Phase out Program. PMO is also responsible for establishing an ODS PA work team comprised of officials from SEPA, PMO and related departments, and domestic specialists from specified industries. With support of the ODS PA work team, PMO will manage and handle the following work related to the Sector Plan:

   i. Establish a monitoring and reporting system, including a management information system (MIS) to track implementation of Annual Programs and all activities related to ODS PA phase out;

   ii. report implementation status of Annual Program and sector plan to the World Bank quarterly and as requested;

   iii. authorize disbursement requests to enterprises as prepared by the DIA;

   iv. monitor and enforce the ODS PA consumption quota system;

   v. supervise consultant firms in all TA activities;

   vi. implement technical assistance activities with relevant Ministries;

   vii. verify completed ODS phase out activities at the enterprise-level, oversee verification process and preparation of financial audit; develop, implement and enforce ODS phase out policies in the sector with all relevant authorities; and

   viii. develop monitoring indicators to verify and report on the sector consumption phase out.

b. **Industrial Organizations**: The industrial administration organizations as well as the concerned industrial associations will, under the coordination of SEPA, provide supervision, monitoring and technical support for the implementation of the sector plan.

c. **Local Environmental Protection Bureaus:** SEPA and PMO will assign local environmental protection bureaus the responsibility of conducting random visits to the beneficiary enterprises to make sure that the ODS PA phase out program is implemented and the phase out policies are executed as planned.

d. **Domestic Implementation Agent**（**DIA**）– A DIA[8] will be selected by SEPA through a competitive bidding process for the ODS sector. Under the guidance of PMO, DIA will supervise all day-to-day enterprise activities, including:

i. supervise implementation of enterprise activities;

ii. take charge of implementation of quota system for ODS PA consumption;

iii. review disbursement requests from beneficiary enterprises, and prepare disbursement requests to PMO for authorization;

iv. maintain the MIS for the entire sector;

v. report regularly all enterprise activities related to the phase out to PMO; and

vi. alert PMO to problems identified during supervision of enterprise activities; and

vii. prepare quarterly progress report and all PCRs on enterprise activities related to closure, substitute technology and emission control approaches.

F. MONITORING AND EVALUATION

7.14 PMO is the core organization for monitoring the implementation of ODS PA phase out annual program with the responsibility for reporting to the World Bank. DIA will oversee the progress of ODS PA phase out program for selected enterprises, and submit written reports to PMO quarterly. PMO will also be responsible for tracking the implementation of policy measures and the technical assistance activities. PMO will submit progress reports to the Bank every quarter. PMO will also report on specific issues if requested. The implementation status of all activities in annual programs will be reported to ExCom once a year during preparation of following year's annual program, and at other times if specifically requested.

7.15 **Verification:** The Bank will conduct an independent verification annually to verify ODS consumption and conversion activities. The Bank will supervise the implementation of Annual Programs and will have access to any ongoing or completed enterprises for spot checks of the records of projects, including random factory visits. The Bank will also carry out such additional verifications as are required by the ExCom.

[8] SEPA will select a DIA from a shortlist of consulting firms agreed with the Bank. All the firms should have experience of financial and project management.

7.16 **Audit:** There will be a) an annual financial audit of the ODS Phase out Account at SEPA, conducted by an independent audit agency acceptable to the Bank, and (b) a performance audit, also by an independent audit agency acceptable to the Bank.

VIII ACTION PLAN

8.1 This Chapter presents the Action Plan and schedule for implementing ODS PA phase out according to the strategy proposed in Chapter 4, including annual phase out targets, that will be implemented to achieve these objectives. This is a rolling plan where the impact of an annual program can be spread over subsequent years. Every annual program will provide detailed progress of all program activities of previous years, including policy implementation, enterprise activities, and technical assistance activities. The proposed Action Plan is summarized as follows.

TABLE 8.1. PHASEOUT ACTIVITIES FROM 2003 TO 2010 IN ACTION PLAN

Line		Baseline (1999)	2003	2004	2005	2006	2007	2008	2009	2010
Phase out targets and project impacts (ODS MT)										
1.	Domestic consumption target	2933 (net eligible consumption)	2,537	2,129	1,715	1,473	1,053	1,004	483	165
2.	Phase out targets for sector plan	2,768	396	408	414	242	420	49	521	318*
3.	Phase out impact of Sector Plan	2,768	396	408	200	214	242	301	169	838
Funding Request (US$ million)										
4.	Enterprise-level activities	113.4	30	30	25	10	7	6	5.4	0
5.	TA	2.0	0.5	0.5	0.35	0.30	0.15	0.10	0.10	0
6.	Total	115.4								

*: These contracts will also be signed in 2009.

8.2 **Explanations**: The following explains lines 1 to 3 in the above table, as well as the composition of each Annual program.

a. Line 1 – the ***domestic consumption target*** in the PA sector reflects the consumption of participating enterprises, and will decline through phase out activities at the enterprise level.

b. Line 2: ***Phase out targets for the sector plan***: to be delivered through contracts with participating enterprises. Except for 2003, all closure contracts will be signed before the end of the previous year.

c. Line 3: ***Phase out impact of sector plan***: impact of implementation contracts (same year for closures or permanent reduction of consumption quotas, and with a lag of up to 2 years for conversion or emissions control contracts). Consumption already carried out in 2003 by enterprises to be closed in this year will have to be adjusted through quota instruments at other enterprises.

8.3 **2003 Annual Program**: the following activities will be covered under this program:

a. Phase out target: new investment projects contracts with enterprises for phasing out 396 MT of ODS PA to be signed by the end of 2003.

b. Line 3 –As these will be closures or permanent reduction of consumption quotas, the full impact will be captured within 2003.

c. Verification of the closure accounting for ODS phase out.

d. In addition, the consumption of CTC at Luzhou Longmatanqu Hongyuan Chemical (Annex 6, No. 19) will be stopped.

e. Preparatory activities for options other than closure will begin. While the impact of closure can be captured during the year, the impact of conversion or emission control projects will not.

8.4 **2004 Annual Program**: This will be submitted to the last ExCom meeting of 2003. It will consist of the following:

a. Phase out target: new projects contracts with enterprises for phasing out 408 MT of ODS PA to be signed in the first half of 2004.

b. Phase out impact: As these will be closures or permanent reduction of consumption quotas, the full impact will be captured within 2004.

c. Verification will include both the closure accounting for ODS phase out in the year, as well as the contracts for options other than closure signed in the preceding year.

d. Preparatory activities for options other than closure will continue.

8.5 **2005 Annual Program**: This will be submitted to the last ExCom meeting of 2004. It will consist of the following:

a. Phase out target: New project contracts with enterprises for phasing out 414 MT of ODS to be signed in the first half of 2005.

b. Phase out impact: This will be the first year when the annual phase out impact will result from both closures and other options; Accordingly, the phase out impact from this year onwards need not be identical to the phase out target.

c. Verification will include both the closure accounting for ODS phase out in the year, phase out resulting from projects other than closure, as well as the contracts for options other than closure signed in the preceding year.

d. Preparatory activities for options other than closure will continue.

8.6 **2006-2008 Annual Programs**: These annual programs will be similar in all respects to the 2005 Annual Program, except for the variations in the phase out targets and impacts indicated in Table 8.1.

8.7 **2009 Annual Program.** This will be submitted to the last ExCom meeting of 2008. It will consist of the following:

a. Phase out target: As this will be the penultimate year of the Sector Plan, it will target all remaining ODS consumption (except residual amounts of consumption arising from agreed emission control applications). All remaining projects contracts with enterprises for phasing out ODS PA under the sector plan are to be signed within 2009.

b. Phase out impact: Verification will include all closures in 2009, and all other contracts prior to 2009.

8.8 **2010 Annual Program.** This will be submitted to the last ExCom meeting of 2009. It will consist of the following:

a. Final verification of all phase out targets under the sector plan,

b. A Project Completion Report covering all sector plan activities will be prepared and submitted during the year.

ANNEX 1 CHLORINATED RUBBER (CR) [4]

Industry Profile

1. The survey covered eighteen enterprises that are related to the production of chlorinated rubber, a product that is used mainly in the manufacture of corrosion -resistant paints, surface coatings and adhesives for rubber and metal items. Of these eighteen , seven enterprises were still using CTC as the process agent to produce CR during the survey period (table below), while six enterprises were found not manufacturing CR product (e.g. No 9 enterprise was not producing CR but purchasing CR as inputs into paint products), three enterprises had closed, and two enterprises were experimenting with non-ODS aqueous technology and only producing on a pilot scale .

Table 1. CR enterprises included in the survey

No.	Enterprise name	
Enterprises using CTC as the process agent		
1	Shanghai Chlor-Alkali Chem. Co. Ltd	
2	Haotian Chem Co Ltd	
3	Wuxi Chem Group Co. Ltd	
4	Zhejiang Xin-an Chem. Group Co Ltd	
5	Jiangyin Fasten Co Ltd	
6	He-nan Puyang oilfield CR Factory	
170	Shangyu Qiming Chemical Co., Ltd	
Enterprises using non-CTC aqueous technology		
7	Fenghua Yulong Chem New Materials Co	Experimental pilot plant
8	Liaocheng Chem Factory	Experimental pilot plant
Enterprises not manufacturing CR product		
9	Jiangsu Lai-dun Group Co Ltd	Paint producer, not CR producer
13	Jiangsu Desheng New Model Building	Produces building paint
14	Hangzhou Keli Chemical Co. Ltd,	Paint producer
15	Puyang Municipal Chlorine-Alkali plant	HCPE (producing high chchchlorinated polyethylene)
16	Xuzhou Huaguan Petro-Chemical Co.Ltd	Produce no CR related products
17	Chongqing Changsu Chem general Factory	Produce no CR related products

[4] Annexes 1-5 are extracts from chapters 2 to 6 of the section plan. These annexes provide a complete picture of each of the five major subsectors.

Enterprises closed			
10	Nanjing Lishui Fangbian Chem. Factory	Closed 1996	Plant dismantled
11	Jingjiang 2nd Pesticide	Closed 1997	Plant dismantled
12	Yangzhou catalyst	Closed 1997	Plant dismantled

2. As indicated above, the survey found that two enterprises have set up experimental production facilities for the production of chlorinated rubber based on non CTC aqueous technology. Neither of them has scaled up the pilot facility for economically viable production. It is reported that the production cost of the aqueous technology is some 15% higher than that of CTC solvent method, while the product quality is inferior.

3. So far, both enterprises are experiencing technical problems with the aqueous technology and no commercial scale production has been carried out. In order to use aqueous technology, the operating conditions need further refinement to ensure liable and stable production and that the CR produced with aqueous technology meet the required standards. In conclusion, aqueous technology for commercial production of CR in China is not available at present.

4. The survey confirmed that in 1999 seven CR enterprises were still consuming CTC and producing CR products and their total production capacity was 4,350 MT. Two of the enterprises were also producing CP-70 on separate production lines. The survey data for the seven enterprises producing chlorinated rubber using CTC as a process agent is summarized below:

Table 2. CR enterprises using CTC as process agents in 1999.

No.	**Name of enterprise**	**Production capacity (MT/a)**	**Production (MT/a)**	**CTC consumption (MT/a)**	**CTC contained in system**
1	Shanghai Chlor-Alkali Chem. Co Ltd	450	221	161	10
2	Haotian Chem Co Ltd.	500	181	199	10
3	Wuxi Chem Group Co Ltd	1,000	444	345	15
4	Zhejiang Xin-an Chem. Group Co Ltd	400	412	142	10
5	Jiangyin Fasten Co Ltd	1,000	400	152	15
6	He-nan Puyang oilfield CR Factory	500	20	13	10
170	Shangyu Qimin Chemical Co., Ltd	500	402	130	10
	Total	4,350	2,080	1,142	80

5. Although the first CR plant started production as early as 1968, most of the current production capacities were commissioned in the early 1990s. Over the period of 1997-1999, production of CR has been growing rapidly, at approximately 22% per annum. It is probable that some of this growth has reflected partial import substitution.

6. CTC consumption in the seven plants has barely grown in the recent past due to improved performance and reducing of losses during production. Survey results suggest that, despite the growing CR production, CTC consumption fell from 1,290 tons in 1997 (or an 0.96 of CTC unit consumption rate) to 1,142 tons in 1999 (or 0.55), then increasing again to an estimated 1,358 tons (or 0.55) in 2000. In all plants, unit consumption rates have fallen significantly, although it is only from remarkably high rates that were reported in 1997. In that year, four of the plants reported unit consumption rates exceeding 1 ton of CTC per ton of product. Three of these plants managed to bring their unit consumption rates to below 1 in 2000.

Table 3. CR enterprises using CTC as process agents, 1997-2000

No	Name of enterprise	1999 production capacity	1997 production	1998 production	1999 production	2000 production
1	Shanghai Chlor-Alkali Chem. Co Ltd	450	134	150	221	225
2	Haotian Chem Co Ltd.	500	191	229	181	129
3	Wuxi Chem Group Co Ltd	1,000	319	341	444	336
4	Zhejiang Xin-an Chem. Group Co Ltd	400	282	389	412	246
5	Jiangyin Fasten Co Ltd	1,000	250	380	400	460
6	He-nan Puyang oilfield CR Factory	500	45	19	20	130
170	Shangyu Qimin Chemical Co., Ltd	500	116.7	241.2	402	326.3
	Total	**4,350**	**1,338**	**1,749**	**2,080**	**1,852** [1/]
	Estimates for 2000					**2,470** [2/]

1/ Actual for the first 3 quarters of 2000.

2/ Estimated for the year based on the actual production of the first 3 quarters of 2000.

Market Demand

7. At present, the domestic market of CR is around 10,000t/a, of which 7,000t/a for anti-corrosion ship paints, 2,500t/a for ship container paints, and 1,000t/a for road mark paints. As the rapid development of seaside cities and ship industry in China, the annual growth rate of CR paints is about 30%, deducting the effect of paints import, the net domestic demand of CR is estimated to increase at 15%. Assuming 30% growth until 2005

and 15% growth thereafter, the estimated CR market in China is as shown in the table below. Assuming that China will maintain its market share, the existing capacity will be fully utilized in 2005 and the capacity would have to be double to meet the demand for CR in 2010.

Table 4. Estimated demand and CTC consumption from 2002-2010

	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total demand	10,000	13,000	16,900	21,970	25,266	29,055	33,414	38,426	44,190
Domestic share	1,832	2,382	3,096	4,025	4,629	5,323	6,121	7,040	8,096
Estimated CTC consumption [1/]	**1,357**	**1,765**	**2,294**	**2,982**	**3,430**	**3,944**	**4,536**	**5,216**	**5,998**

[1/] Based on 2000 ratio and production figures.

Technology options

8. There are a number of options for technology substitution in the case of CR.

9. **Solvent exchange technology of Bayer Corporation.** CTC is still considered the most suitable solvent for chlorinating process with chlorine. Bayer's technology continues to use CTC in the chlorinating stage, but then exchanges CTC solvent with a toluene solvent. This greatly reduces the CTC emission, achieving emissions as low as 0.043kg/t. This technology is a continuous process suitable for large-scale production, but a relatively complicated production process . It also needs highly trained personnel for management and operation. In view of the fact that that CR enterprises in China are eith er small or medium sized, this technology is not considered suitable for China at present. The experience with trying to obtain this technology from Bayer has also not been very positive; one enterprise that entered into negotiations found that the company preferred a merger rather than agreeing to transfer technology.

10. **Emission control for CR production.** For CR production, the CTC unit consumption ratio is rather high on average, compared with CP-70. Emission control can be used by using a combination of in-house and imported technology.

11. **Aqueous Technology.** Aqueous technology for CR has been developed and used in developed countries, and is now understood to be available in India as well. In this technology, latex is diluted with water or diluted hydrochloride acid in the presence of a dispersing agent, and then chlorine is introduced for chlorination in the water medium. In sum , this technology is feasible for medium sized enterprises and can be recommended for China. However, the capital and production costs of this technology are higher than that using CTC solvent, because it requires a longer reaction time and more corrosion resistant containers, and has a lower utilization ratio of chlorine as well as a higher cost for the treatment of dilute hydrochloride acid byproduct.

12. **Domestic Status of aqueous technology for CR.** Two Chinese enterprises are currently experimenting with aqueous technology. Liaocheng Chemical Factory invested in a pilot aqueous technology project through the Anhui Chemical Research Institute in the second half of the year of 2000. Fenghua Yulong New Materials Co Ltd. has also carried out a pilot aqueous technology program. So far, however, no commercial scale production has been carried out, and the operating conditions need further refinement. In conclusion, the commercial production technology for producing CR using aqueous process is not available at present.

13. **Recommendation.** Three options regarding technology have been considered. **Option one** is to base the phase out on emission control. This option is not considered to be achievable as it will require significant investment, high level of preventive plant maintenance, and more sophisticated baseline equipment. **Option two** is to develop the aqueous technology presently on an experimental stage at the two companies. This is not considered viable as well because (i) it will take too long and be too costly to develop the aqueous technology; (ii) there are no assurance that the two companies will be successful in developing the aqueous technology for commercial production and the end product will meet required standards; (iii) it may not be supported by the MLF as it is not a mature technology by the MLF; and (iv) obtaining patent may take a long time, thus delaying phase out. **Option three** is to base conversion on imported aqueous technology which is selected as the only option if conversion is to be achieved within the timeframe given in this sector plan.

14. Overall, the identified sources of substitute technology (commercial technology holders or research institutes) for CR are given in the following table.

Table 5. Substitute technology sources for CR

Technology sources (country)	Status
Anhui Chem Research Institute (China)	Aqueous tech, problems in scale-up and drying system.
Fenghua Yulong new materials Co Ltd (China)	Aqueous tech, batch process, pilot scale, no experience in scale up and commercial production.
Rishiroop (India)	Aqueous tech(in-house technology)
Asahi Denka (Japan)	Aqueous tech, batch process
Japan Paper Co Ltd (Japan)	Aqueous tech
ZEON (Japan)	Aqueous tech
Sanyo Guoce Co Ltd (Japan)	Aqueous tech
ICI (UK)	Aqueous tech
Hercules (USA)	Aqueous tech
Bayer Co Ltd (Germany)	Solvent exchange

15. So far, Chinese enterprises have not been successful in obtaining quotations or information on costs of technology acquisition.

16. One of the consequences of using imported technology will be that the conversion costs will go up. It is expected that the technology provider will require the production equipment to meet standards set by the company and the present existing baseline might not meet such requirements. Furthermore, based on experiences from other projects, the technology supplier might also require that equipment be procured from given suppliers and meeting standards and specifications provided by the company. The consequence is that it is extremely difficult to estimate the conversion costs. Hence a conservative approach is taken based on information available to the sector experts.

17. Another issue might also arise, it is commonly seen that the technology provider require JV status as part of the deal and some limitation and conditions might be imposed on the technology transfer. This is reflected in the estimate costs for acquiring the technology.

Phase out schedule.

18. Most CR producers have small production capacity (<1000 t/a) and can phase out ODS use by closure or by conversion to aqueous substitute technology. It should also be possible to carry out some industrial rationalization by establishing two large-scale production lines with aqueous technology.

Incremental cost calculation.

Table 6. Basic data of CR eligible enterprises in 1999 for incremental cost calculation

Total number of CR enterprises		7
Number of eligible CR enterprises in production		7
Number of eligible enterprises not in production		0
Number of non-eligible enterprises not in production		0
Eligible production capacity, MT/a		4,350
Eligible CR production, MT/a		2,081
Eligible CTC consumption for CR, ODS MT/a		1,142. 3
Eligible enterprises		
No.	**Enterprise name**	**Product**
1	Shanghai Chlor-Alkali Chem. Co Ltd	CR
2	Haotian Chem Co Ltd.	CR
3	Wuxi Chem Group Co Ltd	CR
4	Zhejiang Xin-an Chem. Group Co Ltd	CR, CP-70
5	Jiangyin Fasten Co Ltd	CR, CP-70
6	He-nan Puyang oilfield CR Factory	CR
170	Shangyu Qimin Chemical Co., Ltd	CR
Average remaining life of the production facilities*		
CR		16 years

19. CR Closure costs (figures in the table below are in US$1,000). In case all seven

CR producers were to be closed, the total compensation required due to lost profit over remaining lifetime of the plant, labor compensation in accordance with Chinese laws and dismantling and disposal of the CR facilities.

Table 7. Profit compensation for ODS phase out by closures

(In US$'000)

ODS PA	Application	Production	Lost profit	Labor	Dismantling	Total
CTC	CR	1,142	48,760	1,161	161	50,082

20. **Incremental cost for CR.** Incremental cost for a (1,000t/a) CR production line of aqueous technology is estimated based on the information provided by Guangzhou Haotian Chem Co Ltd through contacts with a foreign agency. To convert all 4,350 tons of eligible capacity would, on the basis of these costs, amount to $47 million **(4.35*US$ 10.800,000).**

21. The detailed costs are shown in Table 6.5.

Table 8 Incremental cost and cost effectiveness for a 1,000t/a CR aqueous technology production line

Items	Cost (in US Dollars)
A. Incremental capital cost	6,591,000
B. Contingency (10%A)	659,000
C. Trials and Training	300,000
D. Technology transfer fee	2,250,000
E. Incremental operation cost for 2	1,000,000
Total Cost	10,800,000
CTC Consumed in 1999	251.6 ODP MT
Cost effectiveness(US$/kg)	30.6

ANNEX 2 CHLORINATED PARAFFIN (CP-70)

Industry profile

1. Chlorinated paraffin is a product with very diversified applications depending on the degree of chlorination. The initial survey carried out in early 2000 identified a large number of chlorinated paraffin producers in China, most of which were found to produce less heavily chlorinated CP (such as 50% grade, CP-50), which do not involve the use of ODS as a process agent. CTC is used in the production of only chlorinated paraffin 70% solid grade (CP-70), a product which finds uses mainly as a fire retardant in rubber, PE, PVC and ABS resins. CP-70 has a large price advantage over substitute products, such as bromide series products and other inorganic fire retardant.

2. After a large number of enterprises had been screened out during the initial survey, the survey carried out as part of sector plan preparations investigated 38 enterprises that were firmly identified as being or having been involved in CP-70 production. In fact, the survey teams found that six of the total were not involved at all in CP-70 production: two of them were producing CP-50 only, two were trading houses whose sales included CP-70 produced by others, and two were found to be involved in other chemical production altogether. (See Table 1)

Table 1. Surveyed Enterprises not manufacturing CP-70

No.	Name	Production Status
40	Shandong Binhua Group	No CP production
46	Jiangxi Electrochem Plant(Yijiang Branch)	No CP production
47	Kaifeng Dongda Chem. Group Co Ltd.	CP-50 producer
48	Jiangsu Huiyuan Chem Co Ltd	CP-50 producer
49	Shanghai Guotai Grease Chem Factory	Trading company
50	Shanghai DAnhuiu Chem Co Ltd	Trading company

3. Of the remaining 32 enterprises, twelve producers were identified as having current capacity for production of CP-70 using CTC as process agent. Of these twelve, ten enterprises were active producers during the survey period (1997-2000), while two enterprises had stopped production but retained facilities that could be brought back into production. Out of the ten active producers, nine are legible for compensation under the sector plan; one enterprise, Luzhou Longmatanqu Chemical Factory (no. 19) is not eligible for compensation because it s facilities were commissioned after January 1, 1999. Therefore, the total number of CP-70 enterprises eligible to receive compensation under the sector plan is eleven. (See Table 2)

Table 2. Chlorinated Paraffin (70% Solid Grade) Enterprises

No.	Name	1999 Capacity	1999 Production	CTC consumption
171	Huanghua City Jinghua Chem. Co., Ltd	3,000	363	72.6
4	Zheijiang Xin-an Chem Group Co Ltd.	500	428	85
5	Jiangyin Fasten Co Ltd	800	600	240
18	Shenyang Chem. Co Ltd.	1,500	158	31.5
19	Luzhou Longmatanqu Hongyuan Chem Factory	1,000	250	75
20	Longchang Shouchang Chem Co Ltd	500	265	67
21	Longchang Shenghua Chem Factory	1,000	278	83.4
22	Chongqing Tianyuan Chem General Factory	500	0	0
23	Longyou Lude Pesticide Chem Co Ltd	300	267	45
24	Dalian City Jiangxi Chem Ind Head Co.	3,000	1647	287
25	Harbin Yibin Chem Ind. Co Ltd*	1,000	479	20.1
45	Shanxi Fenyang Catalyst factory	500	0	0
	Total	**13,600**	**4,735**	**1,007**

4. Ten enterprises were found by the survey to have either converted from CTC-based production to direct chlorination or aqueous technology at some stage before the survey period, or to have used non-ODS technology from their establishment. However, seven of these producers were found to have stopped production, although their facilities remained capable of re-starting. (See Table 3)

Table 3. Enterprises using non-CTC substitute technology

No.	Name	Technology	Production Status
25	Harbin Yibin Chem Ind. Co Ltd	Direct chlorinating technology	Producing
26	Yantai Mouping Jingxie Chem Factory	Direct chlorinating technology	Producing
27	Liaohe Oilfield Renlong Chem General Factory	Direct chlorinating technology,	Stopped production
28	Dongtai City Tianteng Chem Co Ltd	Aqueous technology	Stopped production
29	Wuhan Gehua Group Co Ltd	Aqueous technology	Producing
30	Singpu Chemical Industries Co Ltd	Aqueous technology	Stopped production
31	Dongtai phosphorus fertilizer factory	Aqueous technology	Stopped production
32	Shanxi Pesticide Factory	Aqueous technology	Stopped production
44	Jiamushi Helong Chem Ind Co Ltd	Direct chlorinating technology	Stopped production
122	Gansu Guoxiang Chem Ind Co Ltd	Aqueous technology	Stopped production

5. A further ten enterprises which had been using CTC for production of CP70 were found to have closed their production and to have dismantled their facilities. In most cases, the survey discovered that the entire company had also closed down. (See Table 4)

Table 4. Closed Enterprises

No.	Name
33	Nanjing Xingfa dye Chem Factory
34	Jiangyin Xiyuan Chem Factory
35	Jiangning Shangfeng Organic Chem Factory
36	Zhedong 1st Chem Factory
37	Shandong Lu-nan Chem Factory
38	Laixi City Jinshan Chem Factory
39	Changge Zhongchang Chlorinated Paraffin General Factory
41	Tianjin Chen-guang Chem Factory
42	Daqing Sifang Chem Factory
43	Zhengzhou Auxiliary Chem Factory

6. **Industry Capacity**. Total capacity in China for production of CP-70 using ODS as a process agent amounted to 13,600 tons in 1999, (including plant #45; Shanxi and #19 Luzhou). Of this total, 12,600 tons is deemed eligible for compensation under the Process Agent Sector Plan; 1,000 tons of capacity at Luzhou Longmatanqu Hongyuan (enterprise no. 19) is ineligible because it was commissioned after January 1, 1999. The capacity for CTC-based CP-70 is relatively new. The earliest plant was commissioned in 1986, but most sector expansion took place after 1990. (See Annex 9)

7. Several enterprises in China have attempted to set up production lines with aqueous technology, but have not had much success. The main problem have been stable operation on commercial scale and the products produced not conforming to the required standards. In addition, the higher production costs, in combination with the operational and product quality problems has created problem for the companies who tried. Again resulting in limited confidence in the local developed technology. Of the operating plants, Wuhan Gehua Group has aqueous technology of 500 tons/a. Two enterprises are using direct chlorination technology derived from patented photo-catalytic chlorination technology, a patent for which is held by Harbin Normal University, information on the capacity of the pilot plant is not available . There is currently no estimate for the capacity of plants which are not producing but retain facilities capable of operating.

8. Production Data obtained by the survey for production of CTC-using enterprises is summarized for 1997-2000 in Table 5. Over the period covered by the survey, production of CP-70 has been growing, reflecting growth in domestic market demand for CP-70, at an average annual rate of 11%. In addition to the output of these plants, Wehua has been producing approximately 500 tons each year from its aqueous plant, and there is production of several hundred tons from the two direct chlorination plants.

Table 6. Production of CTC-using Enterprises, 1997-2000

Enterprises using CTC as a process agent						
No	**Name**	**1999 Capacity**	**1997 Production**	**1998 Production**	**1999 Production**	**2000 Production**
171	Huanghua City Jinghua Chem. Co..	3,000	93	105	363	1,125
4	Zheijiang Xin-an Chem Group Co Ltd.	500	267	317	428	292
5	Jiangyin Fasten Co Ltd	800	560	540	600	0
18	Shenyang Chem. Co Ltd.	1,500	1,031	861	158	343
19	Luzhou Longmatanqu	1,000	0	0	250	490
20	Longchang Shouchang Chem Co	500	245	283	265	241

Enterprises using CTC as a process agent						
No	**Name**	**1999 Capacity**	**1997 Production**	**1998 Production**	**1999 Production**	**2000 Production**
21	Longchang Shenghua Chem Factory	1,000	112	216	278	241
22	Chongqing Tianyuan Chem General	500	0	0	0	160
23	Longyou Lude Pesticide Chem Co	300	289	308	267	214
24	Dalian City Jiangxi Chem Ind Head Co.	3,000	952	992	1,647	953
25	Harbin Yibin Chem Ind. Co Ltd	1,000	448	460	479	230
45	Shanxi Fenyang Catalyst factory	500	0	0	0	0
	Total	**13,600**	**3,997**	**4,082**	**4,735**	**5,596** [1/]

[1/] Production in 2000 was extrapolated to full year from survey data for the first three quarters of actual production.

Market Demand

9. Demand for CP-70 seems to have been growing by 11% annually, based on production records for CTC-using enterprises over the last four years and upon the assumption that Chinese companies have maintained their market shares during the period. It is possible that part of this production growth rate consists of import substitution, and therefore inflates the underlying market growth, but this can not be confirmed because import statistics can not be disaggregated to obtain product data. Future growth is ex pected to be at least as high as the growth rate of GDP, and it is also possible that the demand for CP-70 might increase, if the use of bromine is phased out as a fire retardant in paint and other products where CP70 might be used as a substitute. Table 5 below shows expected market size and annual growth, and the resulting consumption of CTC that would arise if the structure of the industry was not affected by Montreal Protocol obligations.

Table 5. Market Demand for CP-70, 2000-2010

Year	**2000**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Estimated market	5,596	6,212	6,895	7,653	8,495	9,430	10,467	11,618	12,896	14,315
CTC consumption [1/]	2,015	2,236	2,482	2,755	3,058	3,395	3,768	4,183	4,643	5,153

[1/] using the 1999 ratio which is 0.36 kg CTC per kg CP70 produced.

Technology Options.

10. Available substitute technologies for the production of CP-70 include aqueous technology, direct chlorination technology and non-ODS solvent technology. Each of these processes is described below.

11. **Aqueous technology**. Aqueous technology utilizes water as a dispersion medium and heat removal agent in the process of chlorinating paraffin with chlorine. Aqueous technology has been under development since in 1995, and the CTC solvent method has gradually been phased out in developed countries. The main advantage of aqueous technologies over the CTC solvent method is that ODS is completely phased out from the process; the disadvantages include a higher investment per unit of production, poorer production conditions, and more severe equipment corrosion. In addition, because the reaction takes place in inhomogeneous fluid, some surfactant additives are added to keep the reaction in a state of emulsion at high temperature and pressure. This, in turn, requires high-quality corrosion-resistant and high-pressure reactors, adding further to the production costs.

12. Several enterprises in China have attempted to set up production lines with aqueous technology, but have not had much success. All but one of the plants that have adopted aqueous technology have stopped production; production of CP-70 has been achieved with aqueous technology only in Wuhan Gehua Group, which has attained production levels of 500t/a with relatively stable operation, but there are still questions regarding product quality, e.g. softening temperature, color etc.. In the absence of mature aqueous technology in China, the sector plan can not utilize the domestic technology due to the problems encountered by the companies and the lack of progress in solving the problems. As a result, it is necessary to import non-ODS technology for the production of CP70 under the sector plan.

13. **Direct chlorination technology**. Direct chlorination does not use any solvents in the chlorinating process. The merits of this technology lie in its simplicity, as no separation and drying processes are needed, and production cost is correspondingly 40% lower than CTC-based costs. However, to enhance the reaction between viscous chlorinated paraffin and chlorine, high reaction temperatures around 160°C have to be maintained, which is close to the decomposing temperature of CP-70. Therefore, some stabilizing additives (which cannot later be removed from the final product) have to be added. This results in the product retaining some undesirable color compared to CP-70 produced with the solvent method. In addition, to improve the fluidity of the reacting liquid, some low molecular weight paraffin is always added, which decreases the softening temperature of CP-70.

14. Domestic direct chlorination technology originated from the patented photo-catalytic chlorination technology of Harbin Normal University. Its commercialization was achieved by Harbin Yibin Chemical Co Ltd, and recently, a similar direct chlorination production line has been established in Shandong Muping Jingxie Chemical Factory by using new reactors designed and improved within the enterprise. However, in both cases it has been reported that the product quality can not generally meet market standards and that the product is regarded as inferior to that achieved by the CTC solvent method. This

restricts its application in China, and it can, therefore, not be regarded as a suitable substitute technology for the sector plan.

15. **Non-ODS solvent technology.** Dover Corporation of USA has patented a new technology for CP-70 production, which uses 4-chloro-trifluorotoluene as a non-ODS process agent. The product quality is comparable with that for the CTC solvent technology, but the production cost is reported to be higher than that of the CTC solvent technology. However, availability of the technology is not yet clear, and the prospects for introduction into China will require further examination.

16. **Substitute technology sources for CP-70**. Through the field survey and contacts with the producers, some technical sources for substitute technologies for CP-70 production have been identified, and are shown in Table 7.

Table 7. Sources of substitute technologies for CP-70 production

Technology sources (country)	Status
Harbin Yibin Chem Co Ltd (China)	Direct chlorination technology, product quality not fully acceptable and needs to be improved.
Shandong Muping Jingxie Chem Factory (China)	Direct chlorination technology, product quality not fully acceptable and needs to be improved.
Wuhan Gehua Co Ltd (China)	NA
Anhui Chem Research Institute(China)	Aqueous tech, problems exist in scale-up and drying system.
Wuhan Modern Chem Tech Res. Inst.(China)	Aqueous tech, without industrial test
Shanghai Tianpeng Auxiliary Chem. Plant (China)	NA.
Dover Co Ltd (USA)	Non-ODS solvent technology
Asahi Denka (Japan)	Aqueous tech
Sanyo Guoce Co Ltd.(Japan)	Aqueous tech
ICI (UK)	Aqueous tech

Phase out schedule

17. Because the average production capacity is relatively low (<1000 t/a), and the production invariably uses batch process operating in an open environment, closure and aqueous substitute technology are feasible alternative approaches for these producers. It is expected that three production lines will be converted to aqueous technology, while the others will be closed in phases up to the end of the sector plan.

Incremental cost calculation

18. This section contains information concerning phase out costs, upon the basis of which the incremental costs presented in the sector plan have been calculated.

Table 8. Basic data of eligible CP-70 enterprises in 1999 for incremental cost calculation

Total number of CP-70 enterprises	12
Number of eligible CP-70 enterprises in production	9
Number of eligible enterprises not in production	2
Number of non-eligible enterprises (#19)	1
Eligible production capacity, MT/a	12,600
Eligible production in 1999, MT/a	4,485
Eligible ODS consumption in 1999, ODS MT/a	932

Eligible enterprises		
No.	**Enterprise name**	**Product**
4	Zhejiang Xin-an Chem. Group Co Ltd	**CR, CP-70**
5	Jiangyin Fasten Co Ltd	**CR, CP-70**
171	Huanghua City Jinghua Chem. Co., Ltd.	**CP-70**
18	Shenyang Chem. Co Ltd.	**CP-70**
20	Longchang Shouchang Chem Co Ltd	**CP-70**
21	Longchang Shenghua Chem Factory	**CP-70**
22	Chongqing Tianyuan Chemical General Factory	**CP-70**
23	Longyou Lude Pesticide Chem Co Ltd	**CP-70**
24	Dalian city Jiangxi Chem Ind Head Co.	**CP-70**
25	Harbin Yibin Chem Ind. Co Ltd	**CP-70**
45	Shanxi Fenyang Catalyst Factory	**CP-70**

19. **Conversion costs.** Incremental costs and cost effectiveness for constructing a 2,000t/a CP-70 production line of aqueous technology have been estimated on the basis of information provided by Shenyang Chemical Co. Ltd, obtained through contacts with a foreign technical agency. The incremental costs and cost effectiveness are US$ 7,326,400 and US$ 45/kgCTC, respectively, as shown in Table 9

Table 9. Conversion costs for a 2,000t/a CP-70 aqueous technology production line

Items	**Cost (in US Dollars)**
A. Incremental capital cost	4,524,000
B. Contingency (10%A)	452,400
C. Trials and training	250,000
D. Technology transfer fee	1,500,000
E. Incremental operational costs for 2 years	600,000 IOC of ~US$150/tons
Total Cost	7,326,400
CTC consumption 1999	179 ODP Tons
Cost effectiveness (CE) (US$/kg)	45

20. The cost of converting 12,600 tons of eligible capacity of CP-70 production facilities, on the basis of the above costs, would be some $49.82 million. (39.9 million + IOC based on conversion costs for each individual company)

21. **Closure costs.** Using the assumptions given in chapter 4, the computed profit compensation, labor compensation and dismantling costs to phase out all ODS process agent by production closure are presented in Table 10.

Table 10. Profit compensation for ODS phase out by closure

ODS PA	Application	Lost profit	Labor	Dismantling	Total
CTC	CP-70	48,697	634	220	49,552

22. **Sector Plan Phase out Costs:** Table 10 below summarizes the costs of phase out under different assumptions.

Table 10. Comparison of different scenarios

Scenario	Closure costs	Conversion costs	
Conversion of all enterprises	0	US$ 49.82 million	US$ 49.82 million
Closure of enterprises	US$ 49.552 million	0	US$ 49.552 million
Proposed approach - Combination of closure and conversion	US$ 25.96 million	US$ 23.76 million	US$ 49.72 million

ANNEX 3 CHLOROSULPHONATED POLYOLEFIN (CSM)

Industry Profile

1. The survey identified five enterprises that have been involved in the production of CSM, a specialty elastomer known for oil and grease resistance and great durability that is used for coatings, automotive parts, wires and cables, hoses and roofing membranes. Of the five enterprises identified through the survey, only one, Jilin Chemical Industrial Company, remains in production; two have stopped production and two have closed. All enterprises were equipped to use CTC as a process agent. Both enterprises that have stopped production, Hongjiang Chemical Company and Jiaohe Organic Chemical Factory, were established in 1996, and have not produced commercially at any time because of technical difficulties. Table 1 and 2 provides basic data on the plants.

Table 1. Basic Data on CSM Enterprises in 1999

No	Enterprise name	Status	Capacity (ton)	Prod. (ton)	ODS unit cons. (ton/ton)	ODS Cons. (ton)
51	Jilin Chemical Industrial Company	In production	3,000	2,330	0.355	827
54	Hongjiang Chemical Company	Commercial production not started.	300	0	0	0
55	Jiaohe Organic Chemical Factory	Commercial production not started.	1,000	0	0	0
52	Hunan Yiyang First Chem. Company	Closed	0	0	0	0
53	Tianjin Yangguang Construction Paint Plant	Closed	0	0	0	0

Table 2. Production in CSM Enterprises 1997-2000 (in MT)

No.	Enterprise name	1999 Capacity	1997 Production	1998 Production	1999 Production	2000 Production
51	Jilin Chemical Industrial Company	3,000	2,028	2,010	2,330	2,473
54	Hongjiang Chemical Company	300	0	0	0	0
55	Jiaohe Organic Chemical Factory	1,000	0	0	0	0
52	Hu-nan Yiyang First Chem.	0	0	0	0	0
53	Tianjin Yangguang Construction Paint	0	0	0	0	0

Market Demand

2. The domestic market for CSM, which is split between military and civilian purposes, is currently estimated to be approximately 2,500 tons a year, and has been growing over the survey period at around 6% per annum. Total capacity in China in 1999 was 3,000 tons. Jilin Chemical Industrial Company was the only active producer during the survey period. As the import price of CSM is much higher than domestic levels, the domestic market will be occupied by Jilin Chemical Industrial Company, and the annual production growth rate is estimated to be 7%.

Technology Options

3. **Emission control.** Emission control aims to reduce emissions of ODS to an acceptable level through improvements in production technology and through strict management.

4. Since the CSM production process has no mature substitute technology available for conversion, emission control has been adapted in the DuPont Company, where a very low emission level has been achieved. As described above for CR, Bayer Corporation has also developed a solvent exchange technology which can reduce the ODS emission ratio. These processes, however, come with high costs, and are not feasible for small and medium enterprises; as the standard of emission control is elevated, the costs, including facility upgrade and running expenditures, increase dramatically. Many factors such as the enterprise size, equipment status, quality of technical personnel, and management level, availability of alternatives, etc., need to be taken into consideration before deciding on emissions controls and for establishing a reasonable emission control standard, which is economically viable and acceptable both for the enterprise and for the purposes of complying with Montreal Protocol requirements.

5. There are no substitute technologies currently available for CSM. In the 1970s,

Anhui Chemical Research Institute took up a solvent substitute technology project by using a partially chlorinated paraffin solvent, like chlorobenzene. The Jilin Chemical Industry Comapny has also studied the possibility of using non-CTC solvent mixtures to replace CTC in the late 1990s. However, all experiments have failed to develop a successful solvent substitute technology for commercial production of CSM

6. **Recommendation regarding technology to be applied:** Emission control is therefore, the only solution for CSM at present. However, the reduction which can be achieved in China might not reach the level achieved in developed countries. China and Jilin Chemical Industrial Company are prepared to meet the emission level specified in the sector plan in return for the funding requested, and would be ready to reduce the emissions to a lower level if technology and funding is provided which make it possible to achieve those goals.

Phase out schedule

7. Emission abatement is the realistic choice for this process, but no mature emission control technology is available either within China or internationally; the enterprise will endeavor to develop and implement an in-house emission abatement technology. If suitable substitute technologies emerge in the future, such technologies could also be adopted .

Incremental Cost Calculation

8. The following table provides basic data on CSM.

Table 3. Basic data of eligible CSM enterprises in 1999 for incremental cost calculation

Total number of CSM		5
Number of eligible enterprises in production		1
Number of eligible enterprises not in production		2
Number of enterprises already closed		2
Eligible production capacity, MT/a		3,000
Eligible production MT/a		2,330
Eligible ODS consumption, MT/a		827
Eligible enterprises		
No.	**Enterprise name**	**Product**
51	Jilin Chem. Ind. Co Ltd	CSM
54	Hongjiang Chemical Company	CSM
55	Jiaohe Organic Chemical Factory	CSM

9. In order to identify the lowest cost option, the following options have been considered; (1) closure of all CSM enterprises, (2) emission control measures to reduce

CTC consumption and (3) a combination of closure of some enterprises and conversion of other.

10. Based on the assumptions provided in chapter 6, the closure costs for all three remaining CSM producing enterprises have been calculated as shown in the table 4 below.

Table 4. Closure costs for ODS phase-out in the CSM sub-sector

ODS PA	Application	ODS Phase-out	Lost profit (US$)	Labor (US$)	Dismantling (US$)	Total (US$)
CTC	CSM	827 MT	18,722,000	576,000	60,000	19,358,000

11. **Emission abatement for CSM production.** Because Jilin Chem. Ind. Co. Ltd. is the only active producer in China, emissions reduction could be obtain only at Jilin. Based on the survey for Jilin Chem. Ind. Co. Ltd., its production and consumption level in 1999 is shown in Table 7.

Table 5. CSM Production and CTC consumption for Jilin Chem. Ind. Co Ltd. in 1999

Product	Total production (MT)	Total consumption of CTC (MTt)	Average consumption ratio MT CTC /MT CSM
CSM	2,330	827	0.355

12. Emissions to air and in waste water are the main losses of CTC in the production of CSM. Based on the survey data, emission to the air constitutes about 96% of the losses of CTC, while 4% of CTC is emitted from liquid effluents. As shown in Table 7, the average consumption ratio is 0.355 tons CTC /ton CSM. Through detailed discussion with the producer, a reasonable and feasible goal has been set for the enterprise for a reduced consumption ratio of 0.07tons CTC /ton CSM, which translates to 163.1 tons of CTC per annum.

13. To abate the emissions, the following measures are proposed:

a. Synthesis unit**.** Two existing production lines, which are located separately, are to be merged into one. New synthesis reactors with capacity of 20 m3 are to be installed. In addition to the tail gas treatment equipment, cooled CTC at –10° C will be used as an absorbent for a liquid film absorber to remove CTC in the tail gas. Non-condensed gas will be sent to the central pipe for further treatment. The feeding system will change from pressurization by nitrogen to pumping.

b. Storage tank system. All the venting gases from the storage tanks, metering tanks and other equipment will be collected in a central pipe, and the tail gas will be sent to a new condenser with brine cooling agent for recovering condensed CTC.

c. All of the off-gases will be charged to an activated carbon adsorption system to minimize the loss of CTC.

d. CTC in scrubbing liquid. New storage tank and separator for recycling scrubbing liquid will be installed to provide sufficient residence time for separating CTC from the scrubbing liquid.

e. Coagulation. Vacuum coagulation system will be used to replace the existing system at ambient pressure. Off gas from the coagulation system will be sent to the condensor for the recovery of CTC.

f. Drying and Extruders. Twin propeller extruder with a vacuum system will be introduced to remove moisture and solvent in drying. As a result, CTC will be recovered, and the quality of CSM product will be improved.

g. Automation and monitoring systems will be established to guarantee smooth operation.

h. Utilities. A refrigeration system of the capacity of 440,000 kcal/h will be added.

14. Table 6 below shows the detailed incremental costs involved in emission abatement measures as estimated by the producer.

Table 6. Detailed incremental costs for emission abatement for CSM

Item	**Cost (US Dollar)**
A. Process Facilities	2,847,350
B. Civil, Automation , instrument and Installation Expenses	2,801,551
C. Contingency @ 10% of (A+B)	564,890
D. Incremental Operating Cost (Total for 1 year)	180,000
Total	**6,393,791**
Cost-effectiveness (US$/kg)	**9.6**

15. Based on the case study, in which CSM production is 2,330 t/a, at the consumption ratio of 0.355t CTC/t CSM in 1999, the target is to reduce the ratio to 0.07 ton CTC/t CSM by 2009. The annual consumption at the target consumption ratio of 0.07 is expected to be 163.1 t/a.

16. The above reduction represents a phase out of 664.05 MT, at a cost-effectiveness of US$9.6 per kg. It will amount to a reduced emission equivalent to 19.7% of the 1999 level. If additional emission reductions are required, there would be additional estimated costs, as provided below:

Table 7. Estimated costs of Emissions control for a range of percentages (Estimates)

Emission reduction options	Emission control level (percentage of current consumption)	Funding required (US$)
This proposal (base case)	19.7	6,393,791
Stage II	10	18,000,000
Stage III	1	125,000,000

Table 8. Funding request for the CSM subsector

Application	Option	Funding requested (US$, mil.)	Capacity in 1999 (t/a)	Capacity in 2010 (t/a)
CSM	Emission control	6.4	3,000	3,000
	Subtotal	***6.4***	***3,000***	***3,000***

Table 9. Comparison of cost of closure versus emission control

	Closure	Emission control	Total
Closure	19,000,000		19,000,000
Emission control		6,400,000	6,400,000
Proposed action		6,400,000	6,400,000

ANNEX 4 FLUOROPOLYMER RESINS (PTFE)

Industry Profile

1. The survey identified seven enterprises involved in manufacture of fluoropolymer resins. Of the seven, six plants were found to use CFC-113 as the process agent in the production of PTFE (Table 1).

Table 1. Polytetrafluoroethylene (PTFE) enterprises

No.	Enterprise name
Enterprises using CFC-113 as the process agent	
56	Shanghai 3F New Materials Share Co Ltd
57	Chenguang Chem Research Institute
166	Shanghai Tianyuan Group Fluor Chemical Plant
167	Jinan 3F Chemical Co., Ltd.
168	Jiangsu Meilan Chemical Co., Ltd.
169	Fuxin Fluor-chemical Co., Ltd.

2. However, CFC-113 is used as a process agent in manufacture of PTFE only for recovering tetrafluoroethylene (TFE) monomer from the vent gas. In most cases, especially for the small production scale, this application is not always necessary because the recovery of TFE by CFC-113 absorption is not economical. Therefore, with these six PTFE producers, the CFC-113 absorption towers did not run as routine until very recent years when the production increased and the loss of TFE from the vent gas became pronounced.

3. The total capacity for PTFE in China was about 4,700 tones for 1997 and 11,000 tons for 2000; it appears to have been growing very rapidly at more than 30% per annum in recent years. Over the same period, the quantity of CFC-113 consumption was increased at approximately 85% per annum, but the amount of consumed ODS was still relatively small. Table 2 summarizes production and CFC-113 consumption data in yhr six ODS-using plants in 1999. Table 3 provides production data for the survey year, 1997-2000.

Table 2. ODS Production and Consumption in PTFE producing enterprises in 1999

No.	Name of enterprise	Production capacity (MT/a)	Production (MT/a)	CTC unit consumption (MT/a)
56	Shanghai 3F New Materials Share Co Ltd	1,000	664	0.005

No.	Name of enterprise	Production capacity (MT/a)	Production (MT/a)	CTC unit consumption (MT/a)
57	Chenguang Chem Research Institute	1,500	1,024	0.0077
166	Shanghai Tianyuan Group Fluor-chem. Plant	0	0	0
167	Jinan 3F Chemical Co Ltd	1,500	830.8	0.0049
168	Jiangsu Meilan Chemical Co Ltd	3,000	1055	0.005
169	Fuxin Fluor-chemical Co Ltd	1,000	793.8	0.0013
	Total	**8,000**	**4,368**	**0.0049**

Table 3. CSM enterprises using CFC 113 as process agents, 1997-2000

No	Name of enterprise	1999 production capacity	1997 production	1998 production	1999 production	2000 production
56	Shanghai 3F New Materials Share Co Ltd	1,000	642	597	664	920
57	Chenguang Chem Research Institute	1,500	0	0	1,024	960
166	Shanghai Tianyuan Group Fluor-chem. Plant	0	0	0	0	426.09
167	Jinan 3F Chemical Co Ltd	1,500	1,006	664.25	830.8	1,040.5
168	Jiangsu Meilan Chemical Co Ltd	3,000	690	999	1055	595
169	Fuxin Fluor-chemical Co Ltd	1,000	922	700	793.8	715
	Subtotal	**8,000**	**3,260**	**2,960**	**4,368**	**4,657** [1/]
						6,209 [2/]

[1/] Actuals for Jan. –Dec. 2000.

[2/] **Estimate for the entire year of 2000, based on the actuals of the first 9 months.**

Technology Options

4. **Non-ODS solvent substitute technology:** CFC-113 is a solvent used for the recovery of trace TEF monomer and some raw materials in the process of TFE monomer production. Consumption of CFC-113 can be phased out by using a new solvent, HCFC-225, under similar operating conditions. This technology has been proposed by Shanghai 3F New Materials Share Co Ltd. Some test runs are still needed for validation of this substitute technology. However, global supply of HCFC-225 is limited, and it is a

transitional solvent that will also have to be phased out in the future.

5. **Vent gas incineration technology:** An alternative technology for emission control of CFC-113 is to incorporate an incineration system into the original absorption tower system, so that CFC-113 is decomposed to a non-ODS substance via pyrolysis.

Consumption per tons produced 0**.**0056/tons PTFE

6. **Recommendation regarding technology to be applied:** Technology for conversion to a non CFC technology is available. Considering the characteristics of these two technologies, either of them can be considered an option by the enterprise.

Phase out Schedule

7. This process uses CFC-113 for the recovery of trace TFE monomer and some raw materials. Consumption of CFC-113 can be phased out either by using a new solvent (HCFC-225) or by incineration technology for the vent gas.

Incremental Cost Calculation

Table 4. Basic data of eligible PTFE enterprises for incremental cost calculation in 1999

Total number of enterprises		**6**
Number of eligible enterprises		**5**
Number of eligible enterprises not in production		**0**
Number of non eligible enterprises		**1**
Eligible production capacity, MT/a		**8,000**
Eligible production in 1999, MT/a		**4,367**
Eligible CFC-113 consumption		**21. 52**
Eligible enterprises		
No.	**Enterprise name**	**Product**
56	Shanghai 3F New Materials Share Co Ltd	**PTFE**
57	Chenguang Chem Research Institute	**PTFE**
167	Jinan 3F Chemical Co Ltd	**PTFE**
168	Jiangsu Meilan Chemical Co Ltd	**PTFE**
169	Fuxin Fluor-chemical Co Ltd	**PTFE**

8. In order to determine the least cost option for phasing out CFC-113 for the production of PTFE, both closure and conversion as well as combination here off have been

consider. The following provide an overview of cost associated with closure and conversion.

9. Following these steps for calculating closure as provided in chapter 6, the computed closure phase out costs for all ODS process agent by production is presented in Table 5. Basic assumptions and key parameters for this proposal are summarized in chapter 6, Table 6.3. If China were to close all PTFE enterprises, the closure costs would be US$ 222,481,000 million

Table 5. Profit compensation for ODS phase out by closure (in $'000)

ODS PA	Application	Phase out	Profit	Labor	Dismantling	Total Compensation
CFC-113	PTFE	21.52 MT	$220,131	$2,250	$100	$222,481

10. **Conversion of PTFE production to non CFC technology:** CFC-113 substitute technology for TFE monomer recovery is available in China. Shanghai 3F New Materials Share Co Ltd, the leading unit of the Fluoro-resin Association of China, claims that CFC-113 can be substituted by HCFC-225. With this technology, existing equipment for vent gas treatment would need to be improved, and while the consumption ratio of HCFC-225 is nearly the same as CFC-113, increased operating costs would be incurred, because there is a large price difference between CFC-113 and HCFC-225. The incremental costs and cost effectiveness for substituting of CFC-113 with HCFC-225 are estimated at $1,230,000 and US$68.3 per kg CFC-113 respectively.

11. **CFC-113 phase out through incineration:** There is another technological solution, which would involve emissions control through incineration. The incremental cost and cost effectiveness for substituting of CFC-113 with incineration technology are estimated at $2,170,000, and $120.5 per kg CFC-113, respectively. Details for the costs are listed in Table 6.

Table 6. Incremental cost for CFC-113 reduction for each line

Items	Technologies for substituting CFC-113 for the production of PFTE	
	Incineration Techology	**HCFC-225 Solvent substitute Tech.**
A. Incremental capital cost	1,700,000	900,000
B. Contingency (10%A)	170,000	90,000
C. Pre-productive cost	50,000	100,000
D. Technology transfer fee	**100,000**	**100,000**
E. Incremental operation cost for 2 year	150,000	40,000
Total Cost	2,170,000	1,230,000
CFC-113 consumption in 1999	3.4 ODP MT	2.4 ODP MT

12. Based on the above three option, conversion of all enterprises is the lowest costs option and is proposed. The phase out costs is shown in the table below.

Table 7. Summary of Funding request

Application	Option	Funding requested (US$, mil.)	Capacity in 1999 (t/a)	Capacity in 2010 (t/a)
	Subtotal	***1***	***10.35***	***10.35***
PTFE	Substitute tech.	9.7	8,000	8,000
	Subtotal	***9.7***	***8,000***	***8,000***

Table 8. Closure and conversion phase out costs for the PTFE process agent sub-sector.

Scenarios	Closure	Conversion	Total
Closure of all enterprises	222,481,000	0	
Conversion of all 6 enterprises		9,700,000	
Proposed action		9,700,000	9.700,000

ANNEX 5 KETOTIFEN

Industry Profile

1. Ketotifen is an oral medication treatment for asthma; originally a patented product of Sandoz GmbH (Swiss), it is now in the generic regime. It is a very high value pharmaceutical with few producers world-wide; China is one of only four countries that has production facilities for this drug. Within the Chinese enterprise, the production process involves eighteen steps, with CTC being used in only of the stages.

2. The survey identified on a provisional basis six enterprises that were connected with ketotifen production. Subsequent investigations revealed that only one enterprise was producing ketotifen intermediate, using CTC as the process agent, during the survey period. One enterprise was found to have closed, and the remaining four enterprises were found to be producing the final product, without producing their own ketotifen intermediate and therefore without using CTC (See Table 1).

Table 1. Status of Surveyed Ketotifen Enterprises

No.	Name	Location	Ownership	Product	Status
59	Zhejiang Huahai Pharm Group Co Ltd	Zhejiang	Private	Ketotifen intermediate	ODS user (CTC)
60	Zhejiang Yuhuan Pharm Factory	Zhejiang		Ketotifen dosage	Closed
61	Xi-an Yangshen Pharm Co Ltd	Shan-xi		Ketotifen dosage	No production of intermediate
62	Nantong 3rd Pharm Factory	Jiangsu		Ketotifen dosage	No production of intermediate
63	Shanghai Shenxing Pharm Factory	Shanghai		Ketotifen dosage	No production of intermediate
64	Shanghai Med Univ. Hongqi Pharm Factory	Shanghai	State-owned	Ketotifen dosage	No production of intermediate

3. The survey found no examples of enterprises producing ketotifen intermediate with non-ODS-using technology.

4. The total capacity for production of ketotifen intermediate at Zhejiang Huahai is estimated at 3 MT, all of which is eligible for compensation under the Process Agent Sector

Plan. The existing plant, which was scaled up from a small pilot plant, was commissioned in 1992.

5. Data obtained by the survey on production are summarized for 1997-2000 in Table 2. Between 1997 and 2000, annual production more than doubled, reflecting growth in both domestic and international demand and the enterprise's strong competitive position.

Table 2. Production of Ketotifen, 1997-2000 (in kg)

Enterprises using CTC as a process agent						
No	**Name**	**1999 Capacity**	**1997 Production**	**1998 Production**	**1999 Production**	**2000 Production** [1/]
59	Zhejiang Huahai Pharm Group Co Ltd	3,000	410	880	533	870

[1/] extrapolated from survey data for the first three quarters.

6. Production of these small volumes generate substantial sales revenues, since the sales price is about US$1.5 million per ton. Production is also associated with large unit consumption of CTC per ton of ketotifen output, as shown in Table 3 below. Essentially, the enterprise uses between 13 and 21 tons of CTC per ton of ketotifen produced, partly as a result of the process but largely because few efforts to control emissions have been made in the past. Even at such large unit consumptions, the emissions of CTC from ketotifen production are small in relation to national consumption of CTC.

Table 3. CTC Consumption for Ketotifen Production, 1997-2000

	1997	**1998**	**1999**	**2000**
Unit Consumption of CTC (tons per ton of product)	21.06	13.35	19.42	13.4
Annual Consumption of CTC (tons)	8.64	11.75	10.35	11.71 [1/]

[1/] extrapolated from survey data for first three quarters

Market Demand

7. Demand for ketotifen has been expanding steadily and rapidly, in both China and globally. Between 1996 and 2001, the domestic market for Ketotifen intermediate increased at more than 25% per annum, and the company also was able to sell a substantial and growing percentage of its output to the international market. Based on interviews with the company, it has been estimated that the domestic market will be 800kg in 2002, growing to 2,000 kg by 2010, while the international market will amount to 6,000kg in 2010.

Technology Options

8. There are no substitute technologies for ketotifen production. Short of closure, the only option is emissions control. Each of the factories in Spain, Switzerland and Italy has developed its own emissions control approach, and it is not expected that any of them would be willing to sell their technology to an active competitor. Therefore, the Zhejiang Huahai company has started work on designing its own approach to emissions control. The producer has proposed a flowsheet for emission abatement and has set a goal to reduce the consumption ratio from 19.42 to 0.68 t CTC/ t ketotifen. The above reduction represents a phase out of 8.35 MT, at a cost-effectiveness of US$12.21 per kg, and amounts to emissions equivalent to 19.3% of the 1999 level.

9. To achieve the target, the following measures are proposed by Zhejiang Huahai Pharmaceutical Group Co. Ltd.:

a. A device for CTC removal from filtered crystal will be established.

b. A vacuum drying system for recovering CTC will be installed.

c. A water stripping system for recovering CTC from waste effluents will be established.

d. An activated carbon adsorption system will be introduced in the process.

e. A refrigeration system will be installed for recovering CTC in off gases.

Phase out schedule

10. This process uses CFC-113 for the recovery of trace TFE monomer and some raw materials. Consumption of CFC-113 can be phased out either by using a new solvent (HCFC-225) or by incineration technology for the vent gas

Incremental costs calculation

Table 4. Basic data of eligible Ketorifen enterprise for incremental cost calculation in 11999

Number of eligible enterprises in production		1
Number of eligible enterprises not in production		0
Eligible production capacity, MT/a		3
Eligible production in 1999, MT/a		0.533
Eligible ODS PA consumption in 1999, ODS t/a		10. 35
No.	**Name of eligible enterprise**	**Product**
59	Zhejiang Huahai Pharm Group Co Ltd	Ketotifen

11. The following section contains information concerning phase out costs, upon the basis of which the incremental costs presented in the sector plan have been calculated.

12. **Closure costs**. Using the assumptions given in Chapter 4, the computed profit compensation, labor compensation and dismantling costs to close down the enterprise are presented in Table 5.

Table 5. Profit Compensation for Closure of Ketotifen

ODS PA	Application	Phase out (tODS)	Profit (US$'000)	Labor (US$'000)	Dismantling (US$'000)	Total Compensation (US$'000)
CTC	Ketotifen	10.35	3,906	90	20	4,016

13. Incremental costs and cost effectiveness for the proposed emissions control program have been estimated on the basis of information provided by the enterprise, and are summarized in Table 6 below.

Table 6. Incremental costs for emission abatement for ketotifen proposed by Zhejiang Huahai Pharm. Group Co. Ltd.

Item	Subtotal (US$)
A. Process Facilities	767,957
B. Civil, Automation, instrument and Installation Expenses	143,544
C. Contingency @ 10% of (A+B)	91,151
D. Incremental Operating Cost (Total for 1 year)	17,000
Total	**1,019,662**
Total Cost-effectiveness (US$/kg)	12.21

14. If additional emissions reductions are required, there would be additional estimated costs, as estimated below:

Table 7. Estimated costs of Emissions control for a range of percentages (National Estimates)

	Emission control level (percentage of 1999 consumption)	Funding required (US$)
Baseline (this proposal)	19.3%	1,019,662
Stage II	10%	2,039,324
Stage III	5%	4,078,648

15. Sector Plan Phase out Costs Table 8 below summarizes the costs of phase out under different scenarios.

Table 8. Comparison of Different Scenarios for Ketotifen Phase out

Scenario	Closure costs (US$)	Emission Control costs (US$)
Closure of enterprise	4,016,000	0
Emissions Control	0	1,019,662

16. Based on the continuing need for ketotifen and its profitability, and taking into account the guidance given by the Parties to the Montreal Protocol, the following phase out is proposed for ketotifen.

Table 9. Phase out of CTC Consumption in the Production of Ketotifen

	1999	2002	2003	2004	2005	2006	2007	2008	2009	2010
CTC Consumption	10.35	10.35	10.35	8.3	5.3	2.0	2.0	2.0	2.0	2.0
US$			331,530	339,818	348,314					

ANNEX 6 TABULATION OF THE 170 INVESTIGATED ENTERPRISES CONCERNED WITH ODS PROCESS AGENT APPLICATIONS

No.	Enterprise Name	Location	Ownership	Product	Status*
1	Shanghai Chlor-Alkali Chem. Co Ltd	Shanghai	Shares Co.	CR	ODS user (CTC)
2	Haotian Chem Co Ltd	Guangdong	State owned	CR	ODS user (CTC)
3	Wuxi Chem Group Co Ltd	Jiangsu	Shares Co.	CR	ODS user (CTC)
4	Zhejiang Xin-an Chem. Group Co Ltd	Zhejiang	Shares Co.	CR, CP-70	ODS user (CTC)
5	Jiangyin Fasten Co Ltd	Jiangsu		CR, CP-70	ODS user (CTC)
6	He-nan Puyang oilfield CR Factory	Henan		CR	ODS user (CTC)
7	Fenghua Yulong Chemical New Materials Co Ltd	Zhejiang	Corp. Ltd.	CR	Aqueous tech.
8	Liaocheng Chem Factory	Shandong	State-owned	CR	Aqueous tech.
9	Jiangsu Lai-dun Group Co Ltd	Jiangsu	Shares Co.	CR	No production
10	Nanjing Lishui Fangbian Chemical Factory	Jiangsu		CR	Closed
11	Jingjiang 2nd Pesticide Factory	Jiangsu		CR	Closed
12	Yangzhou catalyst general factory	Jiangsu		CR	Closed
13	Jiangsu Desheng New Model Building Material Group Company	Jiangsu		CR	No production
14	Hangzhou Keli Chemical Co Ltd.	Zhejiang		CR	No production
15	Puyang Municipal Chlor-Alkali plant	Henan		CR	No production
16	Xuzhou Huaguan Petro-Chem Co Ltd	Jiangsu		CR	No production
17	Chongqing Changsu Chemical general Factory	Chongqing		CR	No production
18	Shenyang Chem. Co Ltd.	Liaoning	Shares Co.	CP-70	ODS user (CTC)
19	Luzhou Longmatanqu Hongyuan Chemical Factory	Sichuan		CP-70	ODS user (CTC)
20	Longchang Shouchang Chem Co Ltd	Sichuan		CP-70	ODS user (CTC)
21	Longchang Shenghua Chem Factory	Sichuan		CP-70	ODS user (CTC)
22	Chongqing Tianyuan Chemical General Factory	Chongqing		CP-70	ODS user (CTC)
23	Longyou Lude Pesticide Chem Co Ltd	Zhejiang	Private	CP-70	ODS user (CTC)
24	Dalian city Jiangxi Chem Ind Head Co.	Liaoning	Shares Co.	CP-70	ODS user (CTC)
25	Harbin Yibin Chem Ind. Co Ltd	Helongjiang	Joint-venture	CP-70	ODS user (CTC) Direct chlor tech.

No.	Enterprise Name	Location	Ownership	Product	Status*
26	Yantai Mouping Jingxie Chem Factory	Shandong	Collective	CP-70	Direct chlor tech.
27	Liaohe Oilfield Renlong Chem General Factory	Liaoning	Collective	CP-70	Direct chlor tech. (prod. stopped)
28	Dongtai City Tianteng Chem Co Ltd	Jiangsu	Corp. Ltd.	CP-70	Aqueous tech. (prod. stopped)
29	Wuhan Gehua Group Co Ltd	Hubei	State-owned	CP-70	Aqueous tech.
30	Singpu Chemical Industries Co Ltd	Jiangsu		CP-70	Aqueous tech. (prod. stopped)
31	Dongtai phosphorus fertilizer factory	Jiangsu	Shares Co.	CP-70	Aqueous tech. (prod. stopped)
32	Shanxi Pesticide Factory	Shanxi	State-owned	CP-70	Aqueous tech. (prod. stopped)
33	Nanjing Xingfa dye Chem Factory	Jiangsu	Collective	CP-70	Closed
34	Jiangyin Xiyuan Chem Factory	Jiangsu	Collective	CP-70	Closed
35	Jiangning Shangfeng Organic Chem Factory	Jiangsu		CP-70	Closed
36	Zhedong 1st Chem Factory	Zhejiang	State-owned	CP-70	Closed
37	Shandong Lu-nan Chem Factory	Shandong	State-owned	CP-70	Closed
38	Laixi City Jinshan Chem Factory	Shandong	State-owned	CP-70	Closed
39	Changge Zhongchang Chlorinated Paraffin General Factory	Henan		CP-70	Closed
40	Shandong Binhua Group	Shandong		CP-70	No production
41	Tianjin Chen-guang Chem Factory	Tianjin	Collective	CP-70	Closed
42	Daqing Sifang Chem Factory	Helongjiang		CP-70	Closed
43	Zhengzhou Auxiliary Chem Factory	Henan		CP-70	Closed
44	Jiamushi Helong Chem Ind Co Ltd	Helongjiang		CP-70	Direct chlor tech. (prod. stopped)
45	Shanxi Fenyang Catalyst Factory	Shanxi		CP-70	Stopped prod.
46	Jiangxi Electrochemical Plant (Yijiang Branch)	Jiangxi		CP-70	No production
47	Kaifeng Dongda Chem Group Co Ltd	Henan	State-owned	CP-50	Never used ODS
48	Jiangsu Huiyuan Chem Co Ltd	Jiangsu		CP-50	Never used ODS
49	Shanghai Guotai Grease Chem Factory	Shanghai		CP-70	Trading company

No.	Enterprise Name	Location	Ownership	Product	Status*
50	Shanghai Danhuiu Chem Co Ltd	Shanghai		CP-70	Trading company
51	Jilin Chem. Ind. Co Ltd	Jilin	Shares Co.	CSM	ODS user (CTC)
52	Hu-nan Yiyang 1st Chem. Factory	Hunan	State-owned	CSM	Closed
53	Tianjin Yangguang Construction Paint Plant	Tianjin		CSM	Closed
54	Hongjiang Chem Co Ltd	Hunan		CSM	Stopped prod.
55	Jiaohe Organic Chem Factory	Jilin		CSM	Stopped prod.
56	Shanghai 3F New Materials Share Co Ltd	Shanghai	Shares Co.	PTFE	ODS user (CFC113)
57	Chenguang Chem Research Institute	Sichuan	State-owned	PTFE	ODS user (CFC113)
58	Shanghai Shuguang Chem Factory	Shanghai	State-owned	PTFCE	Never used ODS
59	Zhejiang Huahai Pharm Group Co Ltd	Zhejiang		Ketotifen	ODS user (CTC)
60	Zhejiang Yuhuan Pharm Factory	Zhejiang		Ketotifen	Closed
61	Xi-an Yangshen Pharm Co Ltd	Shan-xi		Ketotifen	No production
62	Nantong 3rd Pharm Factory	Jiangsu		Ketotifen	No production
63	Shanghai Shenxing Pharm Factory	Shanghai		Ketotifen	No production
64	Shanghai Med Univ. Hongqi Pharm Factory	Shanghai	State-owned	Ketotifen IsoMono	No production No production
65	Shanghai Xinya Pharm Co Ltd	Shanghai	Corp. Ltd.	IsoMono	No production
66	Shandong Boshan Pharm Co Ltd	Shandong	Shares Co.	IsoMono	Never used ODS
67	Suzhou Leader Chem Co Ltd	Jiangsu	Corp. Ltd.	DicloSodium	Never used ODS
68	Shangyu City Hensheng Chem Co Ltd	Zhejiang	Corp. Ltd.	DicloSodium	Never used ODS
69	Jiangxi Liming Pharm Factory	Jiangxi	State-owned	DicloSodium	Never used ODS
70	Jiangxi Dongming Pharm Co Ltd	Jiangxi		DicloSodium	Never used ODS
71	Jiangxi Kangli Pharm Co Ltd	Jiangxi		DicloSodium	Never used ODS
72	Anyang Jiuzhou Pharm Co Ltd	Henan	Corp. Ltd.	DicloSodium	Never used ODS
73	Guangzhou Mingxing Pharm Factory	Guangdong	State-owned	DicloSodium	Never used ODS
74	Tsingtao Pharm Share Co Ltd	Shandong	Shares Co.	DicloSodium	Never used ODS
75	Ji-nan Dongfeng Pharm Factory	Shandong	Shares Co.	DicloSodium	Never used ODS
76	Shanghai Medical Co Ltd, 15th Pharm Branch	Shanghai	State-owned	DicloSodium	Never used ODS
77	Yicheng Wulian Medical Chem Co Ltd	Hubei	Corp. Ltd.	DicloSodium	Never used ODS

No.	Enterprise Name	Location	Ownership	Product	Status*
78	Beijing Beihua Fine Chem. Co Ltd	Beijing	State-owned	DicloSodium PPTA	Never used ODS Never used ODS
79	Henan Topfond Pharm Group Company	Henan		DicloSodium	Never used ODS
80	Zhe-Chem Pharm-Chem Co Ltd	Zhejiang		DicloSodium	Trading company
81	Taizhou Dazhong Chem & Pharm.Co	Zhejiang		DicloSodium	Never used ODS
82	Anyang Guanhua Pharmacy Factory	Henan		DicloSodium	Never used ODS
83	Xixiang Lianyi Pharm Factory	Henan		DicloSodium	Never used ODS
84	Changzhou 4th pharm. Factory	Jiangsu	Joint-venture	Omeprazol	Never used ODS
85	Zhejiang Kang-En-Bei Group, Jinhua Pharm Factory	Zhejiang	Shares Co.	Omeprazol	Never used ODS
86	Zhejiang yiwu Fine Chem Co Ltd	Zhejiang	Shares Co.	Omeprazol	Never used ODS
87	Zhejiang Taizhou Jiangbei Chem Factory	Zhejiang	Shares Co.	Omeprazol	Never used ODS
88	Jingdezhen city Pharm Chem Factory	Jiangxi	State-owned	PhenGly	Never used ODS
89	Hengdian Group Organic Chem Co Ltd	Zhejiang	Collective	PhenGly	Never used ODS
90	Dongyang Kangfeng Organic Fluoro-Chem. Factory	Zhejiang	Private	PhenGly	Never used ODS
91	Xinji Zhongqin Chem Co Ltd	Hebei	Joint-venture	PhenGly	Never used ODS
92	Shanghai 3rd Chem Agent Factory	Shanghai		PhenGly	No production
93	Shanghai Lizhhu Dongfeng Tech Company	Shanghai		PhenGly	Closed
94	Shandong Xinhua pharm Factory	Shandong	State-owned	Ibuprofen	Never used ODS
95	Wuhan 6th Pharm Factory	Hubei		Ibuprofen	Never used ODS
96	Hubei Zhongtian Pharm Co Ltd	Hubei	Joint-venture	Ibuprofen	Never used ODS
97	Xi-an Bohua Pharm Co Ltd.	Shan-xi	State-owned	Ibuprofen	Never used ODS
98	Northwest 2nd Pharm Factory	Shan-xi		Ibuprofen	Never used ODS
99	Nantong Qinfen Pharm Factory	Jiangsu		Ibuprofen	Never used ODS
100	Zhangjiakou Dongfeng Pharm Factory	Hebei		Ibuprofen	Never used ODS
101	Changshu city Pharm Factory	Jiangsu		BromoHydro	Never used ODS
102	Zhejiang Wenling Pharm Factory	Zhejiang		BromoHydro	Never used ODS
103	Taiyuan Pharm Factory	Shanxi		Cloxacilin	Never used ODS
104	Shanghai 4th Pharm Factory	Shanghai		Cloxacilin	Never used ODS
105	Shanghai 17th Pharm Factory	Shanghai		BromoHydro	Never used ODS
106	Kunshan Ruize Pesticide Factory	Jiangsu	Collective	Endosulphan	No production

No.	Enterprise Name	Location	Ownership	Product	Status*
107	Jiangsu Rudong Pesticide Factory	Jiangsu	State-owned	Endosulphan Dicofol	Never used ODS Never used ODS
108	Fujian Jian-ou Chem General Factory	Fujian	State-owned	Dicofol	Never used ODS
109	Zhangjiakou Changcheng Agrochemical Co Ltd	Hebei	Corp. Ltd.	Dicofol	Never used ODS
110	Wuhan Han-nan Chem General Factory	Hubei	State-owned	Dicofol	Never used ODS
111	Xiaxian Yaofeng Pesticide Factory	Shanxi	Collective	Dicofol	Never used ODS
112	Shandong Pesticide Share Co Ltd	Shandong	Shares Co.	Dicofol	Never used ODS
113	Tianjin People's Pharm Factory	Tianjin	Collective	Dicofol	Never used ODS
114	Jiangxi Dongxiang Pesticide Chem Factory	Jiangxi	State-owned	Dicofol	Never used ODS
115	Shanghai Celluloid Factory	Shanghai		PPTA	Never used ODS
116	Jiangxi Nanchang Pesticide Factory	Jiangxi		PPTA	Never used ODS
117	Shanghai Qunli Chem Co Ltd	Shanghai		PPTA	Never used ODS
118	Guangdong Yangchun Gangli Chem Co Ltd	Guangdong	Joint-venture	CPP, CEVA	ODS user (CTC)
119	Guangzhou Jinzhujiang Chem CoLtd	Guangdong	State-owned	CPP, CEVA	ODS user (CTC)
120	Suzhou Xianke Chem Co Ltd.	Anhui		CPP, CEVA	ODS user (CTC)
121	Xinzhou city Chem Factory	Shanxi		CPP	Closed
122	Gansu Guoxiang Chem Ind Co Ltd	Gansu		CEVA CP-70	Closed Aqueous tech. (prod. stopped)
123	Jiangsu Agro-chemical Co Ltd	Jiangsu	State-owned	Imidacloprid 3Phenox 2CH5	ODS user (CTC) ODS user (CTC) ODS user (CTC)
124	Ji-nan Donghe Chem Co Ltd	Shandong		3Phenox	Stopped prod.
125	Shanghai Dongfeng Pesticide Factory	Shanghai		Buprofenzin	ODS user (CTC)
126	Jiangyin 2nd Pesticide Co Ltd	Jiangsu		Buprofenzin	ODS user (CTC)
127	Hai-an Pesticide Factory	Jiangsu	State-owned	Buprofenzin	ODS user (CTC)
128	Jiangsu Anbang Electrochem Co Ltd	Jiangsu		Buprofenzin	ODS user (CTC)
129	Jiangsu Dongtai Agro-chemical Factory	Jiangsu		Buprofenzin	ODS user (CTC)
130	Jiangsu Taizhou Shanda Chem Co Ltd	Jiangsu		Buprofenzin	No production
131	Hangzhou Dadi Pesticide Co Ltd	Zhejiang		Buprofenzin	No production

No.	Enterprise Name	Location	Ownership	Product	Status*
132	Zhejiang Jiahua Co Ltd	Zhejiang		Buprofenzin	No production
133	Taizhou Biological Agrochem. Factory	Zhejiang		Buprofenzin	No production
134	Hu-nan Dongkou County Pesticide Factory	Hunan		Buprofenzin	No production
135	Hu-nan Dongyong Pesticide Factory	Hunan		Buprofenzin	No production
136	Chongqing Jialing Pesticide Factory	Chongqing		Buprofenzin	No production
137	Jiangsu Suzhong Agrochem Factory	Jiangsu		Buprofenzin	No production
138	Jiangsu Suqian city pesticide Factory	Jiangsu		Buprofenzin	No production
139	Zhenjiang Pesticide Factory	Jiangsu		Buprofenzin	No production
140	Jiangsu Xinghua city Pesticide Factory	Jiangsu		Buprofenzin	No production
141	Chongqing Changfeng Chem Factory	Chongqing		ChloroN-Methy 13Dichloro-Ben	ODS user (CTC) ODS user (CTC)
142	Jiangsu Changzhou Pesticide Factory	Jiangsu	State-owned	Buprofenzin Imidacloprid MIC SP	ODS user (CTC) ODS user (CTC) ODS user (CTC)
143	Jiangsu Wuxian Pesticide Factory	Jiangsu		Imidacloprid	ODS user (CTC)
144	Kesheng Group Jianhu Pesticide Factory	Jiangsu		Imidacloprid	Aqueous tech.
145	Nanjing 1st Pesticide Factory (Red Sun Group Co Ltd)	Jiangsu	Shares Co.	Imidacloprid	ODS user (CTC)
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	Jiangsu	State-owned	Imidacloprid Buprofenzin Mefenacet	ODS user (CTC) ODS user (CTC) ODS user (CTC)
147	Lianyungang city Donghai Chem Factory	Jiangsu		Imidacloprid	No production
148	Jiangsu Yangnong Chem Group Co Ltd	Jiangsu	State-owned	Imidacloprid Dicofol	ODS user (CTC) Never used ODS
149	Chanzhou Xinhua Industry General Company	Jiangsu	Collective	Imidacloprid Diclosodium	ODS user (CTC) Never used ODS
150	Sharonda (Jingzhou) Chem Co Ltd	Hubei		MIC SP	ODS user (CTC)
151	Hu-nan Linxiang Amino-chem factory	Hunan		MIC SP	ODS user (CTC)

No.	Enterprise Name	Location	Ownership	Product	Status*
152	Shandong Huayang Agrochem Group Co Ltd	Shangdong		MIC SP	ODS user (CTC)
153	Hu-na Haili Chem Co Ltd	Hunan		MIC SP	ODS user (CTC)
154	Taichang Baolige Chem Co Ltd	Jiangsu		MIC SP	Non-ODS tech.
155	Jiangsu Tongshan Pesticide Factory	Jiangsu		MIC SP	Non-ODS tech.
156	Maanshan city Hua-nuo Chem Co Ltd	Anhui		MIC SP	No production
157	Nanchang Weidi Chem Medicament Factory	Jiangxi		MIC SP	No production
158	He-nan Yuxi Pengcheng Chem. Metallurgy General Company	Henan		MIC SP	No production
159	Lishui regional Pesticide Factory	Zhejiang		MIC SP	No production
160	Qiqihare synthesis Agent Factory	Helongjiang		MIC SP	No production
161	Binyang County Psticide Factory	Guizhou		MIC SP	No production
162	Jingjiang Pesticide Factory	Jiangsu		Oxadiazon	ODS user (CTC)
163	Lanzhou oil refinary Factory, Sanxing Company	Gansu		Cinnamon	CTC used as feedstock
164	Dalian 2nd Organic Chem Factory	Liaoning		Dibenzyl-keton	CTC used as feedstock
165	Sichuan Yibin Tianyuan Chemical General Factory	Sichuan	State-owned	Chlorinated PVC	Never used ODS
166	Shanghai Tianyuan Group Fluor-Chemical Plant	Shanghai	State-owned	PTFE	ODS user (CFC-113)
167	Jinan 3F Chemical Co Ltd	Shandong	State-owned	PTFE	ODS user (CFC-113)
168	Jiangsu Meilan Chemical Co Ltd	Jiangsu	State-owned	PTFE	ODS user (CFC-113)
169	Fuxin Fluor-chemical Co Ltd	Liaoning	State-owned	PTFE	ODS user (CFC-113)
170	Shangyu Qiming Chemical Co Lt	Zhejiang	Share Co.	CR	ODS user (CTC)
171	Huanghua City Jinghua Chem. Co Ltd	Hebei	Share Co.	CP-70	ODS user (CTC)

* Status description

Status	Description
ODS user	The enterprise still uses ODS as a process agent during the manufacturing process.
Stopped prod.	The enterprise stopped ODS PA-related production, but facilities still exist and are capable of resuming production.
Substitute tech.	The enterprise has adopted substitute technology and converted the production to non-ODS-using processes.
Substitute tech. (prod. stopped)	The enterprise has adopted substitute technology and converted to non-ODS-using process, but the production was stopped due to technical or other reasons.
Never used ODS	The enterprise sets up from the beginning of its production with non-ODS PA technology.
Closed	The enterprise was closed, and the physical facilities for process agent application production no longer exist.
No production	The enterprise does not produce the ODS PA application products.
Trading company	The enterprise is a trading company only involved in selling the ODS PA application products, but has no production facilities.

ANNEX 7 STATUS OF THE 25 APPROVED APPLICATIONS OF ODS AS A PROCESS AGENT IN CHINA

Case No.	ODS PA	Applications approved by Decision X/14	China Status
C1	CTC	Elimination of NCl_3 in production of chlorine and caustic	No ODS PA used
C2	CTC	Recovery of chlorine in tail gas from chlorine production	No ODS PA used
C3	CTC	Manufacture of chlorinated rubber	Major use
C4	CTC	Manufacture of endosulphan (insecticide)	No production
C5	CTC	Manufacture of isobutyl acetophenone (Ibuprofen)	No ODS PA used
C6	CTC	Manufacture of dicofol (Insecticide)	No ODS PA used
C7	CTC	Manufacture of chlorosulphonated polyolefin (CSM)	Major use
C8	CTC	Manufacture of poly-phenylene-terephtal-amide	No ODS PA used
C9	CFC-113	Manufacture of fluoropolymer resins	Little use for PTFE
C10	CFC-11	Manufacture of fine synthetic polyolefin fibre sheet	No production
C11	CTC	Manufacture of styrene butadiene rubber (SBR)	No ODS PA used
C12	CTC	Manufacture of chlorinated paraffin 70% solid grade (CP-70)	Major use
C13	CFC-113	Manufacture of vinorelbine (pharmaceutical product)	No production
C14	CFC-12	Photochemical synthesis of perfluoropolyetherpolyperoxide precursors of Z-perfluoropolyethers and difunctional derivatives	No production
C15	CFC-113	Reduction of perfluoropolyetherpolyperoxide intermediate for production of perfluoropolyether diesters	No production
C16	CFC-113	Preparation of perfluoropolyether diols with high functionality	No production
C17	CTC	Production of pharmaceuticals (ketotifen, anticol and disulfiram)	Little use for ketotifen
C18	CTC	Production of tralomethrine (insecticide)	No production
C19	CTC	Bromohexine hydrochloride	No ODS PA used
C20	CTC	Diclofenac sodium	No ODS PA used
C21	CTC	Cloxacilin	No ODS PA used
C22	CTC	Phenyl glycine	No ODS PA used
C23	CTC	Isosorbid mononitrate	No ODS PA used
C24	CTC	Omeprazol	No ODS PA used

C25	CFC-12	Manufacture of vaccine bottles	No ODS PA used

ANNEX 8 BASIC DATA ON CHLORINATED RUBBER (CR) FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
1	Shanghai Chlor-Alkali Chem. Co Ltd	CTC	M	150	134	0.89	1.08	144
2	Haotian Chem Co Ltd.	CTC	M	500	191	0.38	1.47	281
3	Wuxi Chem Group Co Ltd	CTC	M	1,000	319	0.32	1.16	370
4	Zhejiang Xin-an Chem. Group Co Ltd	CTC	M	400	282	0.71	0.43	121
5	Jiangyin Fasten Co Ltd	CTC	M	1,000	250	0.25	1.2	300
6	He-nan Puyang oilfield CR Factory	CTC	M	500	45	0.09	0.65	29.2
170	Shangyu Qimin Chemical Co., Ltd	CTC	M	500	1,16.7	0.23	0.39	45.05
	Sub-Total 1997			**4,050**	**1,338**	**0.33**	**0.96**	**1,290**
				1998				
1	Shanghai Chlor-Alkali Chem. Co Ltd	CTC	M	150	150	1.00	0.77	115
2	Haotian Chem Co Ltd.	CTC	M	500	229	0.46	1.1	252
3	Wuxi Chem Group Co Ltd	CTC	M	1,000	341	0.34	0.83	284
4	Zhejiang Xin-an Chem. Group Co Ltd	CTC	M	400	389	0.97	0.417	162
5	Jiangyin Fasten Co Ltd	CTC	M	1,000	380	0.38	0.65	247
6	He-nan Puyang oilfield CR Factory	CTC	M	500	19	0.04	0.65	12
170	Shangyu Qimin Chemical Co., Ltd	CTC	M	500	241.2	0.48	0.34	81.77
	Sub-Total 1998			**4,050**	**1,749**	**0.43**	**0.66**	**1,154**

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1999				
1	Shanghai Chlor-Alkali Chem. Co Ltd	CTC	M	450	221	0.49	0.77	161
2	Haotian Chem Co Ltd.	CTC	M	500	181	0.36	1.1	199
3	Wuxi Chem Group Co Ltd	CTC	M	1000	444	0.44	0.78	345
4	Zhejiang Xin-an Chem. Group Co Ltd	CTC	M	400	412	1.03	0.345	142
5	Jiangyin Fasten Co Ltd	CTC	M	1000	400	0.40	0.38	152
6	He-nan Puyang oilfield CR Factory	CTC	M	500	20	0.04	0.65	13
170	Shangyu Qimin Chemical Co., Ltd	CTC	M	500	402.3	0.80	0.32	130.35
	Sub-Total 1999			**4,350**	**2,080**	**0.48**	**0.55**	**1142**
				2000*				
1	Shanghai Chlor-Alkali Chem. Co Ltd	CTC	M(3Q)	450	225	0.67	0.71	160
2	Haotian Chem Co Ltd.	CTC	M(3Q)	500	129	0.34	1.18	152
3	Wuxi Chem Group Co Ltd	CTC	M(3Q)	1000	336	0.45	0.8	268
4	Zhejiang Xin-an Chem. Group Co Ltd	CTC	M(3Q)	400	246	0.82	0.336	88.8
5	Jiangyin Fasten Co Ltd	CTC	M(3Q)	1000	460	0.61	0.35	161.2
6	He-nan Puyang oilfield CR Factory	CTC	M(3Q)	500	130	0.35	0.65	84.5
170	Shangyu Qimin Chemical Co., Ltd	CTC	M(3Q)	500	326.3	0.87	0.32	104.1
	Sub-Total			**4,350**	**1,852**	**0.57**	**0.55**	**1,019**
	Estimate 2000			**4,350**	**2,470**	**0.57**	**0.55**	**1,358**

* The survey collected data on CR production and ODS consumption only for the first three quarters of 2000. The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 9 BASIC DATA ON CHLORINATED PARAFFIN 70% SOLID GRADE (CP-70) FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
171	Huanghua City Jinghua Chem. Co., Ltd.	CTC	M	500	93	0.19	0.23	21.4
4	Zhejiang Xin-an Chem. Group Co Ltd	CTC	M	300	267	0.89	0.23	61
5	Jiangyin Fasten Co Ltd	CTC	M	800	560	0.70	0.5	280
18	Shenyang Chem. Co Ltd.	CTC	M	1,500	1,031	0.69	0.155	159.7
19	Luzhou Longmatanqu Hongyuan Chem Factory	CTC	M	0	0	0.00	0	0
20	Longchang Shouchang Chem Co Ltd	CTC	M	500	245	0.49	0.265	78
21	Longchang Shenghua Chem Factory	CTC	M	1,000	112	0.11	0.3	33.6
22	Chongqing Tianyuan Chemical General Factory	CTC	M	500	0	0.00	0	0
23	Longyou Lude Pesticide Chem Co Ltd	CTC	M	300	289	0.96	0.171	49
24	Dalian city Jiangxi Chem Ind Head Co.	CTC	M	3,000	952	0.32	0.208	198.4
25	Harbin Yibin Chem Ind. Co Ltd	CTC	M	1,000	448	0.45	0.042	18.8
45	Shanxi Fenyang Catalyst Factory	CTC	M	500	0	0	0	0
	Sub-Total 1997			**9,900**	**3,997**	**0.43**	**0.225**	**900**
				1998				
171	Huanghua City Jinghua Chem. Co., Ltd.	CTC	M	3,000	105	0.04	0.22	23.1
4	Zhejiang Xin-an Chem. Group Co Ltd	CTC	M	500	317	0.63	0.23	73
5	Jiangyin Fasten Co Ltd	CTC	M	800	540	0.68	0.45	243
18	Shenyang Chem. Co Ltd.	CTC	M	1,500	861	0.57	0.104	89.13
19	Luzhou Longmatanqu Hongyuan Chem Factory	CTC	M	0	0	0.00	0	0

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
20	Longchang Shouchang Chem Co Ltd	CTC	M	500	283	0.57	0.265	67
21	Longchang Shenghua Chem Factory	CTC	M	1,000	216	0.22	0.3	65
22	Chongqing Tianyuan Chemical General Factory	CTC	M	500	0	0.00	0	0
23	Longyou Lude Pesticide Chem Co Ltd	CTC	M	300	308	1.03	0.165	51
24	Dalian city Jiangxi Chem Ind Head Co.	CTC	M	3,000	992	0.33	0.19	188.3
25	Harbin Yibin Chem Ind. Co Ltd	CTC	M	1,000	460	0.46	0.042	19.3
45	Shanxi Fenyang Catalyst Factory	CTC	M	500	0	0	0	0
	Sub-Total 1998			**12,600**	**4,082**	**0.34**	**0.201**	**819**
				1999				
171	Huanghua City Jinghua Chem. Co., Ltd.	CTC	M	3,000	363	0.12	0.2	72.6
4	Zhejiang Xin-an Chem. Group Co Ltd	CTC	M	500	428	0.86	0.2	85
5	Jiangyin Fasten Co Ltd	CTC	M	800	600	0.75	0.4	240
18	Shenyang Chem. Co Ltd.	CTC	M	1,500	158	0.11	0.2	31.5
19	Luzhou Longmatanqu Hongyuan Chem Factory	CTC	M	1,000	250	0.25	0.25	75
20	Longchang Shouchang Chem Co Ltd	CTC	M	500	265	0.53	0.265	67
21	Longchang Shenghua Chem Factory	CTC	M	1,000	278	0.28	0.3	83.4
22	Chongqing Tianyuan Chemical General Factory	CTC	M	500	0	0.00	0	0
23	Longyou Lude Pesticide Chem Co Ltd	CTC	M	300	267	0.89	0.168	45
24	Dalian city Jiangxi Chem Ind Head Co.	CTC	M	3,000	1,647	0.55	0.174	287
25	Harbin Yibin Chem Ind. Co Ltd	CTC	M	1,000	479	0.48	0.042	20.1
45	Shanxi Fenyang Catalyst Factory	CTC	M	500	0	0	0	0
	Sub-Total 1999			**13,600**	**4735**	**0.36**	**0.213**	**1007**

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				2000*				
171	Huanghua City Jinghua Chem. Co., Ltd.	CTC	M(3Q)	3,000	1,125	0.50	0.2	219.4
4	Zhejiang Xin-an Chem. Group Co Ltd	CTC	M(3Q)	500	292	0.78	0.2	56
5	Jiangyin Fasten Co Ltd	CTC	M(3Q)	800	0	0.00	0	0
18	Shenyang Chem. Co Ltd.	CTC	M(3Q)	1,500	343	0.30	0.095	32.5
19	Luzhou Longmatanqu Hongyuan Chem Factory	CTC	M(4Q)	1,000	490	0.49	0.31	150
20	Longchang Shouchang Chem Co Ltd	CTC	M(3Q)	500	241	0.64	0.265	61
21	Longchang Shenghua Chem Factory	CTC	M(3Q)	1,000	241	0.32	0.3	72.3
22	Chongqing Tianyuan Chemical General Factory	CTC	M(3Q)	500	160	0.43	0.4	64
23	Longyou Lude Pesticide Chem Co Ltd	CTC	M(3Q)	300	214	0.95	0.152	32.5
24	Dalian city Jiangxi Chem Ind Head Co.	CTC	M(3Q)	3,000	953	0.42	0.187	178.5
25	Harbin Yibin Chem Ind. CoLtd	CTC	M(3Q)	1,000	230	0.31	0.042	9.7
45	Shanxi Fenyang Catalyst Factory	CTC	M	500	0	0	0	0
	Sub-Total			**13,600**	**4,289**	**0.43**	**0.20**	**876**
	Estimate 2000			**13,600**	**5,596**	**0.43**	**0.20**	**1130**

* The survey collected data on CP-70 production and ODS consumption only for the first three quarters of 2000. The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 10 BASIC DATA ON CHLOROSULPHONATED POLYOLEFIN (CSM) FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
51	Jilin Chem. Ind. Co Ltd	CTC	M	3,000	2,028	0.68	0.355	710
				1998				
51	Jilin Chem. Ind. Co Ltd	CTC	M	3,000	2,010	0.67	0.358	720
				1999				
51	Jilin Chem. Ind. Co Ltd	CTC	M	3,000	2,330	0.78	0.355	827
				2000*				
51	Jilin Chem. Ind. Co Ltd	CTC	M(3Q)	3,000	1,855	0.82	0.44	820
	Estimate 2000			**3,000**	**2,473**	**0.82**	**0.44**	**1,093**

* The survey collected data on CSM production and ODS consumption only for the first three quarters of 2000. The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 11 BASIC DATA ON POLYTETRAFLUOROETHYLENE (PTFE) FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
56	Shanghai 3F New Materials Share Co Ltd	CFC-113	M	1,000	642	0.64	0.0004	0.25
57	Chenguang Chem Research Institute	CFC-113	M	0	0	0.00	0	0
166	Shanghai Tianyuan Group Fluor-chem. Plant	CFC-113	M	0	0	0.00	0	0
167	Jinan 3F Chemical Co Ltd	CFC-113	M	1,200	1,006	0.84	0.0043	4.37
168	Jiangsu Meilan Chemical Co Ltd	CFC-113	M	1,500	690	0.46	0	0
169	Fuxin Fluor-chemical Co Ltd	CFC-113	M	1,000	922	0.92	0.0011	1
	Sub-Total 1997			**4,700**	**3,260**	**0.69**	**0.0017**	**5.62**
				1998				
56	Shanghai 3F New Materials Share Co Ltd	CFC-113	M	1,000	597	0.6	0.003	1.75
57	Chenguang Chem Research Institute	CFC-113	M	1,500	0	0	0	0
166	Shanghai Tianyuan Group Fluor-chem. Plant	CFC-113	M	0	0	0	0	0
167	Jinan 3F Chemical Co Ltd	CFC-113	M	1,500	664.25	0.44	0.0047	3.1
168	Jiangsu Meilan Chemical Co Ltd	CFC-113	M	3,000	999	0.33	0	0
169	Fuxin Fluor-chemical Co Ltd	CFC-113	M	1,000	700	0.7	0.0014	1
	Sub-Total 1998			**8,000**	**2,960**	**0.37**	**0.0020**	**5.85**
				1999				
56	Shanghai 3F New Materials Share Co Ltd	CFC-113	M	1,000	664	0.664	0.005	3.5
57	Chenguang Chem Research Institute	CFC-113	M	1,500	1,024	0.68	0.0077	7.92
166	Shanghai Tianyuan Group Fluor-chem. Plant	CFC-113	M	0	0	0	0	0

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
167	Jinan 3F Chemical Co Ltd	CFC-113	M	1,500	830.8	0.55	0.0049	4.1
168	Jiangsu Meilan Chemical Co Ltd	CFC-113	M	3,000	1055	0.35	0.005	5
169	Fuxin Fluor-chemical Co Ltd	CFC-113	M	1,000	793.8	0.79	0.0013	1
	Sub-Total 1999			**8,000**	**4,368**	**0.55**	**0.0049**	**21.52**
				2000*				
56	Shanghai 3F New Materials Share Co Ltd	CFC-113	M(3Q)	1,000	920	1.23	0.004	4
57	Chenguang Chem Research Institute	CFC-113	M(3Q)	3,000	960	0.43	0.0077	7.4
166	Shanghai Tianyuan Group Fluor-chem. Plant	CFC-113	M(3Q)	1,500	426.09	0.28	0.021	9
167	Jinan 3F Chemical Co Ltd	CFC-113	M(4Q)	1,500	1,040.5	0.69	0.004	4.2
168	Jiangsu Meilan Chemical Co Ltd	CFC-113	M(3Q)	3,000	595	0.26	0.0025	1.5
169	Fuxin Fluor-chemical Co Ltd	CFC-113	M(3Q)	1,000	715	0.95	0.0014	1
	Sub-Total			**11,000**	**4,657**	**0.42**	**0.0058**	**27.1**
	Estimate 2000			**11,000**	**6,209**	**0.56**	**0.01**	**36.13**

* The survey collected data on PTFE production and ODS consumption only for the first three quarters of 2000. The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 12 BASIC DATA ON KETOTIFEN FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
59	Zhejiang Huahai Pharm Group Co Ltd	CTC	M	3.00	0.41	0.14	21.06	8.635
				1998				
59	Zhejiang Huahai Pharm Group Co Ltd	CTC	M	3.00	0.88	0.29	13.35	11.75
				1999				
59	Zhejiang Huahai Pharm Group Co Ltd	CTC	M	3.00	0.533	0.18	19.42	10.35
				2000*				
59	Zhejiang Huahai Pharm Group Co Ltd	CTC	M(3Q)	3.00	0.655	0.29	13.4	8.78
	Estimate 2000			**3.00**	**0.87**	**0.29**	**13.4**	**11.71**

* The survey collected data on ketotifen production and ODS consumption only for the first three quarters of 2000. The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 13 BASIC DATA ON CPP AND CEVA FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
118	Guangdong Yangchun Gangli Chem Co Ltd	CTC	M	200	169	0.85	1.09	184
119	Guangzhou Jinzhujiang Chem Co Ltd	CTC	M	2,000	1,296	0.65	1.24	1,600
120	Suzhou Xianke Chem Co Ltd	CTC	M	250	86	0.34	1.65	141
	Sub-Total 1997			**2,450**	**1,551**	**0.63**	**1.24**	**1,925**
				1998				
118	Guangdong Yangchun Gangli Chem Co Ltd	CTC	M	400	207	0.52	1.30	269
119	Guangzhou Jinzhujiang Chem Co Ltd	CTC	M	2,000	1,662	0.83	1.06	1,762
120	Suzhou Xianke Chem Co Ltd	CTC	M	250	65	0.26	1.58	102
	Sub-Total 1998			**2,650**	**1,934**	**0.73**	**1.10**	**2,133**
				1999				
118	Guangdong Yangchun Gangli Chem Co Ltd	CTC	M	400	130	0.33	1.92	249
119	Guangzhou Jinzhujiang Chem Co Ltd	CTC	M	2000	1862	0.93	0.69	1,280
120	Suzhou Xianke Chem Co Ltd	CTC	M	250	81	0.32	1.50	121
	Sub-Total 1999			**2,650**	**2,073**	**0.78**	**0.80**	**1,650**

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				2000*				
118	Guangdong Yangchun Gangli Chem Co Ltd	CTC	M(3Q)	400	90	0.30	2.11	190
119	Guangzhou Jinzhujiang Chem Co Ltd	CTC	M(3Q)	2,000	1,615	1.08	0.62	1,001
120	Suzhou Xianke Chem Co Ltd	CTC	M(3Q)	250	108	0.58	1.20	133
	Sub-Total			**2,650**	**1,813**	**0.91**	**0.73**	**1,324**
	Estimate 2000			**2,650**	**2,417**	**0.91**	**0.73**	**1,765**

* The survey collected data on CPP/CEVA production and ODS consumption only for the first three quarters of 2000.The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 14 BASIC DATA ON 2-CHLORO-5-CHLORO-METHYLPYRIDIN FOR 1997-2000*

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
1997								
123	Jiangsu Agro-chemical Co Ltd.	**CTC**	E	100	47	0.47	4.07	191.3
1998								
123	Jiangsu Agro-chemical Co Ltd	**CTC**	E	100	52	0.52	4.07	212
1999								
123	Jiangsu Agro-chemical Co Ltd	**CTC**	E	100	57	0.57	4.07	232
2000**								
123	Jiangsu Agro-chemical Co Ltd	**CTC**	E(3Q)	100	47.3	0.63	4.07	192.3
	Estimate 2000			**100**	**63**	**0.63**	**4.07**	**256**

* All data are estimated on the basis of the field survey.

** Estimate 2000 assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 15 BASIC DATA ON 3-PHENOXY BENZYLDEHYD FOR 1997-2000*

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
123	Jiangsu Agro-chemical Co Ltd	**CTC**	E	**1,500**	**888**	**0.59**	**0.40**	**355.2**
				1998				
123	Jiangsu Agro-chemical Co Ltd	**CTC**	E	**1,500**	**977**	**0.65**	**0.40**	**391**
				1999				
123	Jiangsu Agro-chemical Co Ltd	**CTC**	E	**1,500**	**1075**	**0.72**	**0.40**	**430**
				2000**				
123	Jiangsu Agro-chemical Co Ltd	**CTC**	E(3Q)	**1,500**	**886.5**	**0.79**	**0.40**	**354.6**
	Estimate 2000			**1,500**	**1182**	**0.79**	**0.40**	**473**

* All data are estimated on the basis of the field survey.

** Estimate 2000 assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 16 BASIC DATA ON BUPROFENZIN FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
125	Shanghai Dongfeng Pesticide Factory	CTC		No data offered.				
127	State-owned Hai-an pesticide Factory	CTC		No data offered.				
126	Jiangyin 2nd Pesticide Co Ltd	CTC	M	900	593	0.66	0.408	242
128	Jiangsu Anbang Electrochem Co Ltd	CTC	E	600	0	0.00	0	0
129	Jiansu Dongtai Agro-chemical Factory	CTC	M	450	417.5	0.93	0.91	380.5
142	Jiangsu Chanzhou Pesticide Factory	CTC	E	1,000	800	0.80	0.18	144
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	M	300	115	0.38	1.21	139
	Sub-Total 1997			**2,650**	**1,926**	**0.73**	**0.47**	**906**
				1998				
125	Shanghai Dongfeng Pesticide Factory	CTC		No data offered.				
127	State-owned Hai-an pesticide Factory	CTC		No data offered.				
126	Jiangyin 2nd Pesticide Co Ltd	CTC	M	900	519	0.58	0.324	168
128	Jiangsu Anbang Electrochem Co Ltd	CTC	E	600	550	0.92	0.5	275
129	Jiansu Dongtai Agro-chemical Factory	CTC	M	450	369.8	0.82	0.53	197
142	Jiangsu Chanzhou Pesticide Factory	CTC	E	1,500	1,000	0.67	0.18	180
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	M	300	183	0.61	0.68	123.3
	Sub-Total 1998			**3,750**	**2,622**	**0.70**	**0.36**	**943**

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
1999								
125	Shanghai Dongfeng Pesticide Factory	CTC		No data offered.				
127	State-owned Hai-an pesticide Factory	CTC		No data offered.				
126	Jiangyin 2nd Pesticide Co Ltd	CTC	M	900	385	0.43	0.322	119
128	Jiangsu Anbang Electrochem Co Ltd	CTC	E	600	550	0.92	0.5	275
129	Jiansu Dongtai Agro-chemical Factory	CTC	M	450	260	0.58	0.53	140
142	Jiangsu Chanzhou Pesticide Factory	CTC	E	2,000	1,500	0.75	0.18	270
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	M	300	0	0.00	0	0
	Sub-Total 1999			**4,250**	**2,695**	**0.63**	**0.30**	**804**
2000*								
125	Shanghai Dongfeng Pesticide Factory	CTC		No data offered.				
127	State-owned Hai-an pesticide Factory	CTC		No data offered.				
126	Jiangyin 2nd Pesticide Co Ltd	CTC	M(3Q)	900	423	0.47	0.325	137.5
128	Jiangsu Anbang Electrochem Co Ltd	CTC	E(4Q)	600	500	0.83	0.5	250
129	Jiansu Dongtai Agro-chemical Factory	CTC	M(3Q)	450	360	1.07	0.35	126
142	Jiangsu Chanzhou Pesticide Factory	CTC	E(4Q)	2,000	1,300	0.65	0.18	234
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	M(3Q)	300	0	0.00	0	0
	Sub-Total			**4,250**	**2,583**	**0.61**	**0.29**	**748**
	Estimate 2000			**4,250**	**2,994**	**0.70**	**0.29**	**876**

* Data on Buprofenzin production and ODS consumption are partially for the first three quarters of 2000. The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 17 BASIC DATA ON CHLORIDIZED N-METHYLANILINE FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
141	Chongqing Changfeng Chem Factory	CTC	M	0	0	0.00	0.00	0
				1998				
141	Chongqing Changfeng Chem Factory	CTC	M	1,000	650	0.65	0.440	286
				1999				
141	Chongqing Changfeng Chem Factory	CTC	M	1,000	485	0.49	0.254	123
				2000*				
141	Chongqing Changfeng Chem Factory	CTC	M(3Q)	1,000	386	0.51	0.18	70.2
	Estimate 2000			**1,000**	**515**	**0.51**	**0.18**	**94**

* The survey collected data on Chloridized N-Methylaniline production and ODS consumption only for the first three quarters of 2000. The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 18 BASIC DATA ON 1,3-DICHLORO-BENZOTHIOZOLE, 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
141	Chongqing Changfeng Chem Factory	CTC	M	0	0	0.00	0	0
				1998				
141	Chongqing Changfeng Chem Factory	CTC	M	0	0	0.00	0	0
				1999				
141	Chongqing Changfeng Chem Factory	CTC	M	500	16.6	0.03	0.49	8.2
				2000*				
141	Chongqing Changfeng Chem Factory	CTC	M(3Q)	500	53.2	0.14	0.35	18.6
	Estimate 2000			**500**	**71**	**0.14**	**0.35**	**25**

* The survey collected data on 1,3-dichloro-benzothiozole production and ODS consumption only for the first three quarters of 2000. The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 19 BASIC DATA ON IMIDACLOPRID FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
123	Jiangsu Agro-chemical Co Ltd	CTC	E	100	47	0.47	2.063	97
142	Jiangsu Chanzhou Pesticide Factory	CTC	E	500	30	0.06	1.5	45
143	Jiangsu Wuxian Pesticide Factory	CTC		No data offered.				
145	Nanjing 1st Pesticide Factory (Red Sun Group)	CTC	E	150	23	0.15	4.23	97.4
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	M	200	13	0.07	1.96	25.5
148	Jiangsu Yangnong Chem Group Co Ltd	CTC	M	0	0	0.00	0	0
149	Chanzhou Xinhua Industry General Co.	CTC	E	0	0	0.00	0	0
	Sub-Total 1997			**950**	**113**	**0.12**	**2.344**	**265**
				1998				
123	Jiangsu Agro-chemical Co Ltd	CTC	E	100	52	0.52	2.063	107.3
142	Jiangsu Chanzhou Pesticide Factory	CTC	E	500	50	0.10	1.5	75
143	Jiangsu Wuxian Pesticide Factory	CTC		No data offered.				
145	Nanjing 1st Pesticide Factory (Red Sun Group)	CTC	E	150	83	0.55	1.45	120.3
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	M	200	15.4	0.08	1.96	30.2
148	Jiangsu Yangnong Chem Group Co Ltd	CTC	M	0	0	0.00	0	0
149	Chanzhou Xinhua Industry General Co.	CTC	E	120	80	0.67	1.5	120
	Sub-Total 1998			**1,070**	**280.4**	**0.26**	**1.61**	**453**

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1999				
123	Jiangsu Agro-chemical Co Ltd	CTC	E	100	57	0.57	2.063	117.6
142	Jiangsu Chanzhou Pesticide Factory	CTC	E	500	230	0.46	1.5	345
143	Jiangsu Wuxian Pesticide Factory	CTC		No data offered.				
145	Nanjing 1st Pesticide Factory (Red Sun Group)	CTC	E	150	78	0.52	1.04	81.2
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	M	200	36	0.18	1.96	70.6
148	Jiangsu Yangnong Chem Group Co Ltd	CTC	M	100	5	0.05	2.0	10
149	Chanzhou Xinhua Industry General Co.	CTC	E	120	80	0.67	1.5	120
	Sub-Total 1999			**1,170**	**486**	**0.42**	**1.53**	**744**
				2000*				
123	Jiangsu Agro-chemical Co Ltd	CTC	E(3Q)	100	47.3	0.47	2.063	97.6
142	Jiangsu Chanzhou Pesticide Factory	CTC	E(4Q)	500	400	0.80	1.5	600
143	Jiangsu Wuxian Pesticide Factory	CTC		No data offered.				
145	Nanjing 1st Pesticide Factory (Red Sun Group)	CTC	E(4Q)	150	107	0.71	1.56	167.4
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	M(3Q)	200	42	0.21	1.96	82.3
148	Jiangsu Yangnong Chem Group Co Ltd	CTC	M(3Q)	100	23	0.23	1.52	35
149	Chanzhou Xinhua Industry General Co.	CTC	E(4Q)	120	0	0.00	0	0
	Sub-Total			**1,170**	**619.3**	**0.53**	**1.59**	**982**
	Estimate 2000			**1,368**	**699**	**0.51**	**1.60**	**1,118**

* The survey collected data on Imidacloprid production and ODS consumption partially for the first three quarters of 2000. The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 20 BASIC DATA ON MICSP* FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
142	Jiangsu Chanzhou Pesticide Factory	CTC	M	3,000	2,472	0.82	0.18	434
150	Sharonda (Jingzhou) Chem Co Ltd	CTC	E	1,500	900	0.60	0.10	90
151	Hu-nan Linxiang Amino-chem factory	CTC	E	1,500	900	0.60	0.10	90
152	Shandong Huayang Agro-chem Group Co Ltd	CTC	E	1,500	900	0.60	0.10	90
153	Hu-nan Haili Chem Co Ltd	CTC	M	4,000	1,674	0.42	0.10	165
	Sub-Total 1997			**11,500**	**6,846**	**0.60**	**0.127**	**869**
				1998				
142	Jiangsu Chanzhou Pesticide Factory	CTC	M	5,000	2,778	0.56	0.17	465
150	Sharonda (Jingzhou) Chem Co Ltd	CTC	E	1,500	900	0.60	0.10	90
151	Hu-nan Linxiang Amino-chem factory	CTC	E	1,500	900	0.60	0.10	90
152	Shandong Huayang Agro-chem Group Co Ltd	CTC	E	1,500	900	0.60	0.10	90
153	Hu-nan Haili Chem Co Ltd	CTC	M	4,500	2,640	0.59	0.09	231
	Sub-Total 1998			**14,000**	**8,118**	**0.58**	**0.119**	**966**
				1999				
142	Jiangsu Chanzhou Pesticide Factory	CTC	M	6,000	3,692	0.62	0.18	669
150	Sharonda (Jingzhou) Chem Co Ltd	CTC	E	1,500	900	0.60	0.10	90
151	Hu-nan Linxiang Amino-chem factory	CTC	E	1,500	900	0.60	0.10	90
152	Shandong Huayang Agro-chem Group Co Ltd	CTC	E	1,500	900	0.60	0.10	90
153	Hu-nan Haili Chem Co Ltd	CTC	M	5,000	3,181	0.64	0.09	280
	Sub-Total 1999			**15,500**	**9,573**	**0.62**	**0.127**	**1,219**

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
2000**								
142	Jiangsu Chanzhou Pesticide Factory	CTC	M(4Q)	6,000	4,270	0.71	0.17	735
150	Sharonda (Jingzhou) Chem Co Ltd	CTC	E(4Q)	1,500	900	0.60	0.10	90
151	Hu-nan Linxiang Amino-chem factory	CTC	E(4Q)	1,500	900	0.60	0.10	90
152	Shandong Huayang Agro-chem Group Co Ltd	CTC	E(4Q)	1,500	900	0.60	0.10	90
153	Hu-nan Haili Chem Co Ltd	CTC	M(3Q)	6,000	3,032	0.67	0.08	243
	Sub-Total			**16,500**	**10,002**	**0.61**	**0.125**	**1,248**
	Estimate 2000			**16,500**	**10,760**	**0.65**	**0.12**	**1,309**

* MICSP = methyl isocyanate derivative series pesticides, such as furandan, etc.

** The survey collected data on MICSP production and ODS consumption partially for the first three quarters of 2000. The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 21 BASIC DATA ON MEFENACET FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	E	0	0	0.00	0	0
				1998				
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	E	0	0	0.00	0	0
				1999				
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	E	0	0	0.00	0	0
				2000				
146	Jiangsu Pesticide Research Institute, Nanjing Pesticide Factory	CTC	E(4Q)	300	30	0.10	0.70	21
	Estimate 2000	CTC		**300**	**30**	**0.10**	**0.70**	**21**

* The data on Mefenacet production and ODS consumption are estimated on the basis of field survey.

ANNEX 22 BASIC DATA ON OXADIAZON FOR 1997-2000

No.	Enterprise name	ODS used	Estimate or Measured Data	Capacity (t/a)	Production (t/a)	Capacity utilization	ODS unit consumption (t/t)	ODS consumption (t/a)
				1997				
162	Jingjiang Pesticide Factory	**Oxadiazon**	M	**0**	**0**	**0**	**0**	**0**
				1998				
162	Jingjiang Pesticide Factory	**Oxadiazon**	M	**50**	**10**	**0.20**	**0.25**	**2.5**
				1999				
162	Jingjiang Pesticide Factory	**Oxadiazon**	M	**50**	**30**	**0.60**	**0.45**	**13.5**
				2000*				
162	Jingjiang Pesticide Factory	**Oxadiazon**	M(3Q)	**50**	**40**	**1.07**	**0.29**	**11.38**
	Estimate 2000	**Oxadiazon**		**50**	**53**	**1.07**	**0.28**	**15**

* The survey collected data on Oxadiazon production and ODS consumption only for the first three quarters of 2000. The estimate 2000 for the full year assumes that production in the fourth quarter was one-third of production in the first three quarters.

ANNEX 23 OTHER APPLICATIONS

N1-N2: CPP and CEVA

1. Chlorinated Polypropylene (CPP) and Chlorinated Ethyl Vinyl Acetate (CEVA) are both thermal elastic resins, and good adhesive for metals and plastics as well as an excellent additive for printing inks. Their production lines and processes are nearly identical. In fact, they are produced with the same production facilities and under similar operating conditions. Meanwhile, their CTC consumption ratios are basically the same.

2. The domestic principal producers are Guangzhou Jinzhujiang Chemical Co. Limited and Guangdong Yangchun Gangli Chemical Co. Ltd. The CTC consumption ratio for Guangzhou Jinzhujiang is about 0.7t/t after using water scrubbing and brine condenser treatment for tail gas. In order to reduce the CTC consumption ratios further, the tail gas is treated with the active carbon adsorption system in Guangzhou Jinzhujiang Chemical Co Ltd. However, the CTC consumption ratio has been lowered only from 0.68t/t to 0.62t/t, which is less effective than expected. Meanwhile, the development of solvent substitutes has been undertaken in this corporation.

3. Aqueous technologies for CPP and CEVA have been developed by Da-you-mo Corporation Limited and Sanyoo-guoce Corporation of Japan as well as Eastman Corporation of US. In China, a pilot scale aqueous technology has been developed by Anhui Chemical Research Institute. However, no successful production is reported. Consequently, further test and improvement on the scale up and real production run are required. In addition to Anhui Chemical Research Institute, Fenghua Yulong and Harbin Yibin Co Ltd also are interested in the development of aqueous technologies for these products. It is concluded that no mature substitute technologies have been put into production currently, and the technologies in either pilot plant or laboratories need to be improved further.

N3: 3-PhenoxyBenzyldehyde

4. 3-PhenoxyBenzyldehyde is an important pesticide intermediate. Although its production is limited to Jiangsu Chemical Pesticide Corporation Limited (capacity 1000t/a), its users are plentiful, such as Changzhou Pesticide Factory, Shanghai Pesticide Factory, Shandong Pesticide Factory and Kaifeng Pesticide Factory etc. Details of the production process for this intermediate and the function of CTC here are not available, because the producers have not been cooperative. However, the CTC consumption ratio is reported to be 0.4t/t. While a case study for this intermediate production is required in further investigation, if possible, enterprise cooperation would be crucial for success.

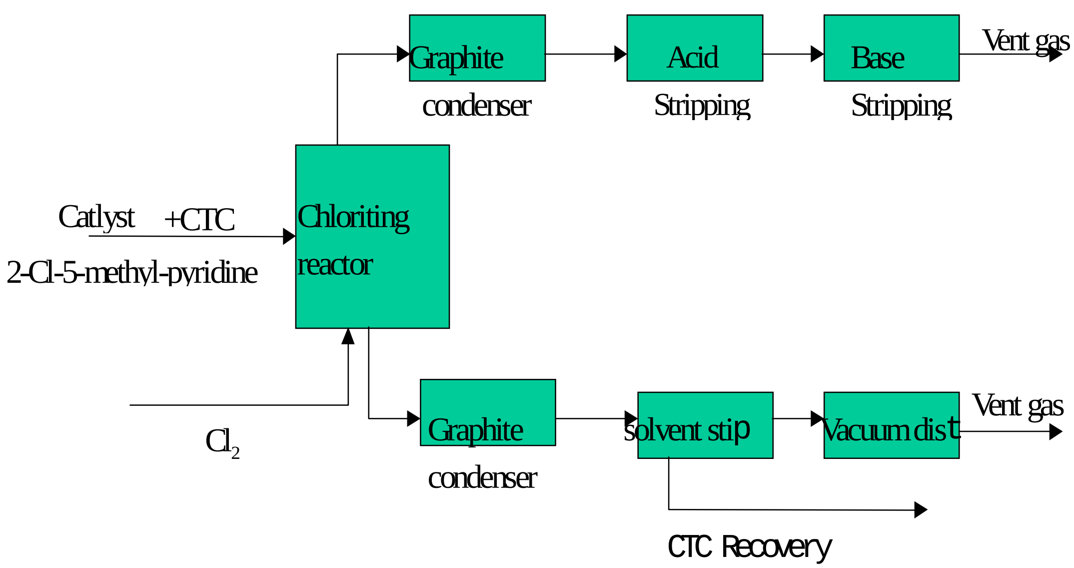
N4: Imidacloprid and its intermediate

5. Imidacloprid, chemically named as 1-(6-chloro-3-pyridyl methyl)-N-nitroimidazolene amine-2, is a highly effective, long lasting and low toxicity pesticide for insects affecting paddy, cotton and vegetables. Its usage is only 3 grams per 1000 square meter field, and its preparation is nontoxic for human beings. As a good substitute for pesticide buprofenzin, its market is rising now and is expected to increase rapidly in the future. This pesticide is originally developed by Bayer Corporation and Japanese Special Pesticide Association. In China, Pesticide Research Institutes of Shanghai and Jiangsu

also possess the production technology for imidacloprid. However, China Pesticide Association has ceased to provide licenses for new constructions of this pesticide to avoid excess competition. Therefore, a limit of annual production of the pesticide is imposed. The CTC consumption ratio for imidacloprid production varies from 1.0 to 2.0t/t for different enterprises, and CTC consumption is in the synthesis stage for 2-chloro-5-chloromethyl-pyridine intermediate. CTC emission control measures used at present are designed to capture ODS from the tail gas with the brine graphite condensers.

6. 2-chloro-5-chloromethyl-pyridine is the intermediate for pesticide imidacloprid; it is obtained by chlorinating 2-chloro-5-methyl-pyridine with chlorine in CTC solvent. A flow sheet for this intermediate production is shown as follows. No study on solvent substitute technologies for producing this intermediate has been found in China to date. However, for it is relatively stable and non-explosive, the reduction of CTC consumption can be implemented through production rationalization. It means that massive production with delicate measures, efficient equipment, strict management for emission control can be centralized in a reasonable size factory, which is located in an appropriate place and of economical and technical background.

7. As a substitute technology, this intermediate can be produced with a new ring-forming technique by using POCl or CH3COCl as the chlorinating agent, instead of CTC solvents. However this technology has not been commercialized in China. It is noted that the aqueous technology for imidacloprid production developed by Shenyang Chemical Research Institute has been successfully realized in Kesheng Group Corporation Ltd with somewhat higher cost.

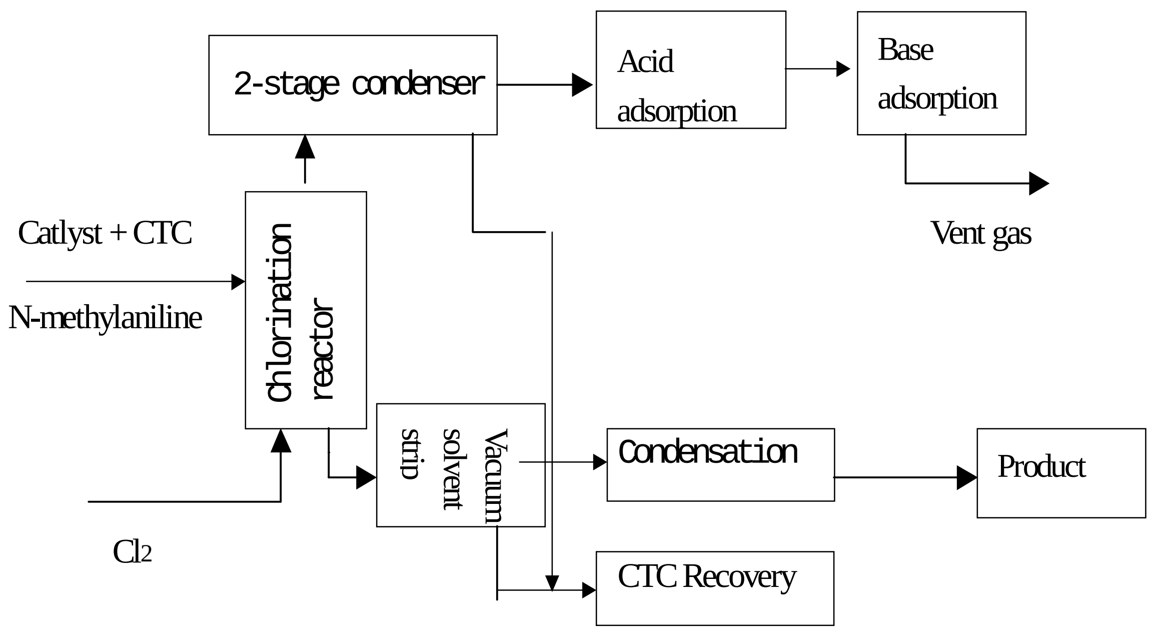


N5: Buprofenzin and its intermediate

8. Buprofenzin, chemically named as 2-tert-Butylimino-3-isopropyl-5-phenylperhydro-1,3,5-thiodiazin-4-one, is an insecticide for paddy cootie. CTC process agent is used in producing the intermediate of this insecticide i.e. chlorinated N-

methylaniline, by chlorinating N-methylaniline with chlorine in CTC reaction medium. In this process, the CTC consumption ratio has been found to vary from 0.20t/t to 0.60t/t (CTC/intermediate), and 75% of the CTC consumed is emitted from the tail gas to atmosphere due to inefficient cooling capacity.

9. At present, substitute technology and successful emission control technology are not available, and production rationalization may be a practical measure for reducing the CTC consumption ratio. In fact, some enterprises, such as Jiangyin 2nd pesticide Factory, purchase this intermediate for producing buprofenzin. The production flow sheet for the intermediate Chlorinated N-mrthylaniline is as follows. It is noted that the production output is stable and even shows a little decline, since its substitute product imidacloprid has a better performance/ price ratio.



N6: Mefenacet and its intermediate

10. Mefenacet, chemically named as D-(1,3-benzothiozole-2-oxy)-N-methylacetanilide, is a newly developed herbicide for paddy field. The production of its intermediate 1,3-dichloro-benzothiozole needs CTC as process agent. However, full details of production process and substitute technology are not available. The producers for this herbicide include Jiangyin 2nd Pesticide factory and Chongqing Changfeng Chemical Factory.

11. At present the intermediate is produced by Changfeng Chemical Factory with CTC consumption ratio of 0.4~0.7t/t. CTC is used here as an inert chlorinating medium. Although the production process is not available currently, CTC is known to be recycled with two-stage brine condensers. Changfeng Chemical Factory is planning to substitute CTC with chloroform, which was tested in its original patent technology.

N7: Oxadiazon

12. Oxadiazon, chemically named as 2-tert-Butyl-4-(2,4-dichloro-5-isoproxyphenyl)-1,3,4-oxadiazolin-5-one, is a herbicide used in paddy field and in glebe plants such as cotton, peanut and sugar cane. Two enterprises, Jingjiang Pesticide Factory and Jiangsu Chemical and Pesticide Corporation Ltd, are currently producing this pesticide, and their CTC consumption ratios are about 0.3t/t. Sixty percent of the CTC consumption results from tail gas emissions, and 30% more is contained in wastewater. Details of the production process are not available. However, CTC is known to be used as a diluent agent and inert solvent for the chlorination reaction.

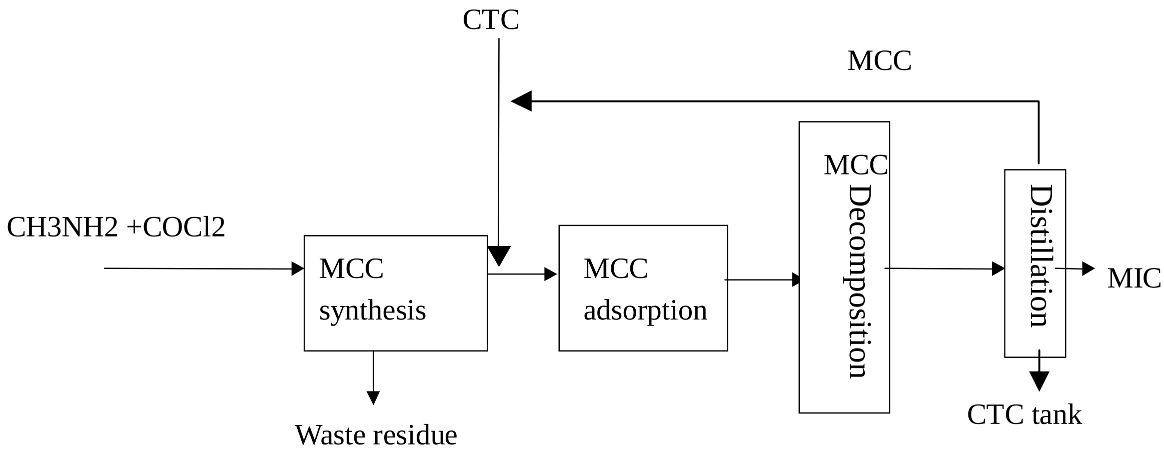
N8: Methyl Isocyanate Series Pesticides

13. Methyl Isocyanate(MIC) series pesticides consist of more than 100 varieties, a dozen of which are most important and widely used ones, e.g. furandan, Bassa and Isoprocarb. In China, Hu-nan Haili Chemical Corporation Limited firstly patented the production technology for MIC series pesticides. This technology was transferred to 4 pesticide factories. MIC series pesticides have a good domestic and international consumption market, and the remaining life of the production facilities is about 20 years. It should be noted that the pesticide furandan can be produced with two different technical processes, i.e. phosgene and non-phosgene routes, and only the former uses CTC as chemical process agent. In China 5 enterprises use the phosgene route and 2 factories use the non-phosgene route to produce furandan. For the non-phosgene route, the raw reactive materials and the process itself are all different from the phosgene route. Although CTC is not used here, the production cost is about 15% higher.

14. In producing MIC series pesticides, MIC is the most important intermediate. More importantly, it is very toxic and strongly explosive, hence it is not suitable for storage or transportation at all, and it must be used immediately after it is produced. CTC as the process agent is used only in producing MIC intermediate (rather than the final products of MIC series pesticides), and its consumption ratio is 0.2-0.3t/t (CTC/MIC). Obviously, it is not possible to reduce the emission ratio through centralized production of MIC due to the above mentioned safety reasons.

15. The key problems for the utilization of solvent substitute technologies are the costs for establishing an anti-fire and anti-explosion production line and the daily maintenance. As the National Technical Research Center for pesticides and the technical origin of the MIC series pesticides, Hu-nan Haili Chemical Corporation Limited claims to be able to develop a solvent substitute technology, and promises to transfer the new substitute technology to other 4 enterprises when the new technology is available.

The flow sheet for the production of MIC intermediate is as follows.



16. CTC is chosen as CPA to function as a nonflammable and non-explosive diluent, further the decomposition temperature of MIC's precursor is close to the boiling point of CTC.

ANNEX 24 PROCESS AGENTS APPLICATIONS NOT USING ODS IN CHINA

1. Among the 25 applications listed in Decision X/14, many applications are produced in China using non-ODS-using process technologies.

Cases 1 and 2

2. Chloro-Alkali industry of China has phased out ODS-using applications both in elimination of NCl_3 in the production of chlorine and caustic (case 1) and in recovering chlorine in the tail gas from the production of chlorine (case 2) since the early 1990's. In order to prevent the accumulation of explosive NCl_3, it is purged after a definite period of time during liquefaction of chlorine, while the residue containing liquefied chlorine is treated with caustic solution before it is discharged. The chlorine contained in the tail gas is not scrubbed with CTC liquid solvent, but is reacted with hydrogen to form hydrogen chloride or treated with caustic solution to produce bleaching powder.

Case 4

3. There are two enterprises registered for producing the insecticide endosulfan, Kunshan Ruize Pesticide Factory (No. 106 in Annex 6) and Jiangsu Rudong Pesticide Factory (No.107).The former failed in trial production in 1995 due to technical problems and the equipment has been dismantled. The latter confirmed that their production does not use CTC.

Case 5

4. In China, many enterprises just produce ibuprofen dose, e.g. ibuprofen troche or injection, rather than ibuprofen itself. In fact, only two enterprises, Shandong Xinhua Pharmacy Factory and Hubei Zhongtian Pharmacy Corporation Ltd, are found to be producers of ibuprofen. Aryl-reformation reaction route has been used to produce ibuprofen since 1994, when CTC process agents were phased out. All the reacting materials and solvent involved in the production include neopentadiol, trichlorophosphorus, isobutylbenzene, petroleum ether, ethanol and dichloroethane.

Case 6

5. Dicofol is a widely used pesticide in China, and is produced by dozens of enterprises with large output. Hydrolysis process has been used to produce Dicofol raw pesticide since 1980's, where DDT is firstly chlorinated, then hydrolyzed, and finally emulsified with benzene or petroleum ethers to form 20% emulsion dose of dicofol. In the whole process, no CTC process agent is needed.

Case 8

6. 1,4-dichloroformyl benzene, as a monomer of polymer poly-phenylene-terephtal-amide, is generally produced by chlorinating p-phthalic acid with chlorine. In this process, CTC may be used as a possible process agent. Four producers for the intermediate have been found, Shanghai Celluloid Factory, Jiangxi Nanchang Pesticide Factory, Shanghai Qunli Chem Co Ltd and Beijing Chem Factory. However none have claimed any use of CTC as a process agent in their production of 1,4-dichloroformyl benzene.

Case 9

7. In China, all fluoropolymer resins are produced by using the aqueous emulsion method, rather than homogeneous solution polymerization technology. Hence no CFC-113 CPA is used. However a small amount of CFC-113 application has been found in production of tetrafluoroethene (TFE) monomer of fluoropolymer resins. TFE mixture is produced by HCFC-22 pyrolysis, and pure TFE is obtained with distillation technology. At the end of the distillation, CFC-113 is used as a scrubbing solvent to reduce the loss of TFE from the tail gas. The consumption ratio of CFC-113 here is about 1kg/tTFE.

Case 11

8. The domestic production of SBR is quite large. However, all of the products are produced with non-ODS-using technical processes, such as the melt blending process. The principal producers of SBR in China include Beijing Yanshan Petrochemical Corporation Ltd, Sinochem Qilu Petroleum Chemical Co. Ltd and Jilin Chem Co Ltd.

Case 19

9. It is reported that three processes are available for the production of bromohexine hydrochloride, of which only the India technology needs CTC, while the other two do not use any ODS as a process agent. In China, there are only three enterprises for this product, Changsu City Pharmacy Factory, Shanghai 17th Pharmacy Factory and Zhejiang Wenling Pharmacy Factory, and they all adopt the non-CTC-using process.

Case 20

10. Non-cyclohexanone process was used by some enterprises to produce diclofenac sodium before 1996, where the reactant 2-6-dichloroaniline and CTC were used, and the CTC consumption ratio was reported to be 0.1-0.2t/t. This process is complicated and the production cost is high. Since 1997, the non-cyclohexanone process has been completely replaced with a new technology i.e. the cyclohexanone process, where the CTC is phased out completely. Moreover, the production cost has decreased some 20 times.

Case 21

11. Cloxaciline is a new variant of penicillin, its producers include Shanghai 4th Pharmacy Factory and Taiyuan Pharmacy Factory. However, no CTC CPA is used in production, and the major reactants are 1-chloro-benzaldehyde, hydroxyamine hydrochloride, ethyl acetoacetate, and 6APA, the main skeleton of penicillin, while the solvents used are acetone and isopropanol.

Case 23

12. The production process of isosorbide mononitrate (Iso SDN) is very simple, and in the whole process there is no ODS process agent is needed. The production can be outlined as follows. At first, sorbitol is partly oxidized by nitric acid to form raw product, isosorbide mononitrate, and then the product is purified with double crystallization processes in water and ethanol solvents.

OORG TECHNICAL REVIEW REQUEST

China

Sector Plan for Phaseout of ODS in Chemical Process Agent Applications in China

(OORG Reviewer: W. G. Kenyon)

OORG TECHNICAL REVIEW REQUEST

China

Sector Plan for Phaseout of ODS in Chemical Process Agent Applications in China

(OORG Reviewer: W. G. Kenyon)

The following review of the "Sector Plan for Phaseout of ODS in Chemical Process Agent Applications in China" (received 16 April 1999) was conducted at the request of Ms Helen Chan, World Bank. In this case ODS means mostly Carbon Tetra Chloride (CTC) plus some CFC-113.

1. Country of Origin: China

2. Project Title: " Sector Plan for Phaseout of ODS in Chemical Process Agent Applications in China"

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, the project is required to meet the 1999 CFC-113 freeze and is thus consistent with the country's action plan.

5. Technology:

a) The ODS (primarily CTC with a minor amount of CFC-113) in use in the Process Agents subsector are generally used as solvents 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.

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

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 phaseout 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 cleaning formulations may not be regulated in all provinces in China.

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.

[However, in many cases the facts presented are imprecise at best, leaving many questions to puzzle the reader. For example, in the case of chlorinated rubber (CR) manufacture, six enterprises are included that do not make CR. Why? Similarly, two enterprises are mentioned that are experimenting with aqueous technology. Did these enterprises use ODS in the past? When did they implement the aqueous process? Since the CR is claimed to be inferior to the present process CR and more costly by 15%, what is done with it?]

c) Feasibility of transfer to the country of concern:

   i) Technology transfer and training are claimed to have been included as line items in the investment costs. The reader should note that “technology transfer” can have a number of interpretations, ranging from transfer with proper respect for intellectual property rights to ‘technology recruited from abroad’.

   ii) In the case of proprietary processes, there is often great reluctance to grant any licensing agreements required since the technology is seldom well understood and may not commercially available from local sources.

   iii) Other technology systems utilizing ozone safe chemistries may have been investigated but discarded when product quality was inferior to the current ODS process. 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 various aqueous cleaning agents and processes chosen. However, there is usually an increase in the electrical power requirements, resulting in a modest indirect GWP increase.

b) While the ODP of the alternative process may currently be zero, it is not always feasible to gather the impact on GWP of proprietary process operational demands and hence, incremental costs or saving.

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 conversions. The proposed equipment should provide up to date, efficient, zero-ODP processes incorporating proper management of waste streams consistent with capacity levels similar to current throughput levels. (Avoid violation of capacity increase rule.)

Note that the costs will vary with the selection of the ‘best’ alternative process for each of the product sub sub-sectors in this programme. Thus, the non-ODS process for chlorinated rubber might be quite different from one of the agricultural herbicides, etc.

b) Existing equipment similar to the proposed new equipment would not have been expected to be found in the existing facilities, since the present ODS processes may not be replaced with in kind alternative processes. Thus, the existing equipment would generally require replacement.

c) Cost of equipment

i) The base line costs seem to be addressed. The suggested equipment costs appear consistent with current industry pricing practices but the source of said pricing has not been provided.

ii) The proposed equipment and technology listed is not often readily available from local suppliers. In general, the requested equipment is consistent with the project plan; however justification for the individual pieces of equipment is rarely provided.

iii) It appears that the various pieces of equipment requested should meet the conversion requirements for replacing ODS PAs with various alternative processes. There is a possibility that water pre-treatment systems for treating and upgrading the incoming water may be required in some installations. If this is the case, the costs shall be borne by the enterprises and not the MLF, since no quantification of same has been provided.

iv) Certain processes will require stringent new emission control and abatement equipment. The existing baseline solvent equipment in these enterprises cannot be modified/converted to aqueous or other in kind alternative processes.

v) Since dismantling of baseline equipment is not noted as a line item in the budgets, a detailed plan for the scrapping out and disposition of the current baseline ODS equipment to prevent re-deployment must be provided.

vi) Projected salvage value of scrapped equipment was not provided; however, value of equipment scrapped from such lines is typically low and may not cover removal/disposal costs. This point needs further assessment.

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

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

Certain individual sub-project budgets contain line items for training with the new equipment, as well as commissioning (see for example, Table 6.4 C). Since each enterprise will generally be converting from an ODS to an entirely different process type, these costs are warranted. Even when the ODS process is left in place and emission abatement is fitted, the abatement equipment will require proper training to meet the goal of ozone layer protection.

e) Operating Costs

i) The Incremental Operating Costs (IOC) projected after the conversion could be significantly higher than the existing costs. The increased costs appear to be associated with the replacement processes. Increased electrical energy consumption is to be expected with the utilization of aqueous processes to cope with the greater power burdens associated with pumping and drying. However, the IOC associated with emission abatement, plant closures and production rationalization are much more difficult to calculate.

The reviewer and The World Bank personnel are very concerned over the apparent lack of any real foundation for the Incremental Operating Costs claimed in the document. Apparently this issue was raised with the document generation task group without a satisfactory response.

ii) The new process and equipment, while minimizing environmental, health and safety impacts associated with the new processes are claimed to result in increased operating costs [see 7.e) i)]. In addition, the costs are all quoted on the basis of a 2 year period, instead of the agreed upon 1 year period. This discrepancy needs to be corrected, followed by re-calculation of all the Incremental Operating Costs/Savings; followed by re-calculation of the overall costs & total requested grant.

iii) The operating costs given and their relation to the technology chosen are not supported with experience in similar CTC (& CFC-113) PA applications [See 7.e) I)].
Without information on the tank sizes of the new equipment, projected dilutions for each application and related process parameters in each case, it is most difficult to precisely calculate a reliable IOC/S estimate.

8. Implementation Time Frame: The implementation time frame proposed
appears feasible if the technology is readily

available and in commercial operation. Otherwise, it is too aggressive.

9. Recommendation:

a) **Approval only after Correction of All the deficiencies cited above.**

OORG Technical Reviewer: ______________________________
W. G. Kenyon

Date Review Completed: 21 April 2002 .

WB response: The general issues raised by the OORG reviewer have been addressed. However, due to the nature of the project and the market in China, it has not been possible to obtain firm quotations from foreign technology providers and without having detailed specification from the technology providers. There for, the present costs is based on information available to the Chinese process agent experts who have been working on the proposal.

The issue regarding IOC has also been discussed. While the present IOC used for the different applications are based on the limited experiences available on the matter. Especially in the area of emission control. The technical experts are trying to obtain more information from foreign producers and technology providers. This information will be made available as soon as obtained.