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Report by the Executive Committee on Process Agent Uses in Article 5 Parties and their related emission levels

Introduction

1. In decision X/14, the Parties requested the Technology and Economic Assessment Panel (TEAP) and the Executive Committee to report to the Meeting of the Parties in 2001 on the progress made in reducing emissions of controlled substances from process-agent uses and on the implementation and development of emissions-reduction techniques and alternative processes not using ozone-depleting substances and to review Tables A and B of the present decision and make recommendations for any necessary changes. In response to this request the Executive Committee prepared and submitted document UNEP/OzL.Pro.13/8 to the 13th Meeting of the Parties in October 2001.

2. Decision X/14 also indicated, *inter alia*, that the Executive Committee may consider a range of options for Article 5 Parties to reduce the emissions of controlled substances from process-agent use to levels agreed by the Executive Committee to be reasonably achievable in a cost-effective manner without undue abandonment of infrastructure. Incremental costs for a range of cost-effective measures including, for example, process conversions, plant closures, emissions control technologies and industrial rationalisation, to reduce emissions of controlled substances to these levels should be eligible for funding in accordance with the rules and guidelines of the Executive Committee of the Multilateral Fund.

3. In decision XV/7, the Parties requested the Technology and Economic Assessment Panel and the Executive Committee to report to the 25th meeting of the Open-ended Working Group on the progress made in reducing emissions of controlled substances from process agent uses and on the implementation and development of emissions reductions techniques and alternative processes not using ozone depleting substances. The present document has

been prepared in response to that request in regard to Parties operating under Article 5(1) of the Montreal Protocol.

Background

4. In order to prepare this report, the Executive Committee authorised the Fund Secretariat, at its 44th meeting to hire an expert consultant to catalogue process agent uses in Article 5 countries and their related emission levels, with the proviso that options for addressing emissions reductions would not be analysed (decision 44/65). The results are contained in a technical study entitled "A study to catalogue process agent uses and emissions levels involving substances controlled under the Montreal Protocol in countries operating under Article 5.1 of the Protocol". The study is reproduced in full as Annex I to the present document.

5. The methodology employed in the study included a survey of process agent uses in Article 5 countries conducted via questionnaires to countries with potential process agent consumption; analysis of the survey responses; an analysis of information provided in all process agent project documents submitted to the Executive Committee, and; analysis of consumption data officially reported to the Fund and Ozone Secretariats. The principal findings have been incorporated in the present report.

6. The country survey was conducted by means of a questionnaire, distributed to 26 Article 5 countries. The 26 countries were selected because they had either explicitly reported consumption in the process agent sector or had reported consumption greater than 1 ODP tonne of one or more of the three ODS identified as process agents in previous reports (namely, CTC, CFC-113, and bromochloromethane (BCM)). This action was taken to ensure that process agent uses were not inadvertently overlooked through being previously misreported as solvent use. A full description of the methodology including the questionnaires, is contained in the technical study.

Levels of consumption of ODS as process agents in Article-5 countries

7. On the basis of information on process agent uses reported in the survey conducted as part of the study and details of consumption at the enterprise level provided in project documents, the total identified annual process agent use in Article 5 countries is 13,623 ODP tonnes. The data provided in the survey was for 2003. Data in project documentation covered the years 2000 to 2002.

8. Of the total identified use of some 13,600 ODP tonnes, about 13,500 ODP tonnes is CTC. Out of the remainder, 40 ODP tonnes of CFC-113 was identified in one Article 5 country, and 12 ODP tonnes of BCM was identified in a single use in one other Article 5 country.

9. Ninety-seven per cent of the total identified use was reported in three countries, China (10,538 ODP tonnes), India (2,268 ODP tonnes) and D.P.R. Korea (432 ODP tonnes).

10. Some 94 per cent of the identified use, amounting to 12,800 ODP tonnes, takes place in applications that have been approved as process agent uses in decisions XV/6 and XV/7 of the Parties. The remaining 6 per cent or 817 ODP tonnes are used in 18 applications that are not included in these decisions. Six of the 18 applications were recommended as process agents in the 2004 TEAP report arising from submissions by D.P.R. Korea (four applications)

and Romania (two applications), but were not decided on by the Parties at their sixteenth meeting. One of the 18 applications was included in the original list in decision X/14 but de-listed through decision XV/6. The remaining 11 applications appear not to have been submitted to the TEAP at this stage. It is indicated in the technical study that one of these eleven applications, namely the use of BCM in Turkey may be a feedstock use rather than a process agent application.

11. Article 5 countries have also provided information on national consumption in the process agent sector in annual reports to the Fund Secretariat on progress with implementation of country programmes and to the Ozone Secretariat as required under Article 7 of the Protocol. The sum of the latest process agent consumption reported to the Fund Secretariat in country programme data is 21,185 ODP tonnes. Details of the reported national process agent consumption can be found in the table provided in Annex II to this report.

12. There is a major discrepancy between total process agent use derived from project level information (13,598 ODP tonnes) and from consumption officially reported to the Fund Secretariat in country programmes in the process agent sector (21,194 ODP tonnes in 2003). However the officially reported consumption itself varies widely from year to year (11,282 ODP tonnes in 2001 and 5,914 ODP tonnes in 2002). A full comparison of identified process agent use and officially reported process agent consumption also appears in the table in Annex II. The discrepancies may arise as a result of one or more of the following factors:

- uncertainties arising from a "top down" calculation of process agent consumption commencing with annual production, plus imports, minus exports, less the quantities used for feedstock and other purposes, without making allowances for annual stock changes;
- uncertainties arising from varying interpretations of the definition of controlled use, taking into account approved process agent applications, other potential process agent applications and feedstock use, and;
- uncertainties in "bottom up" assessments that rely on identification of all uses at the enterprise level in a country.

13. In regard to the final point, one Party, Iran, commented explicitly in its response to the survey that further work would be needed to identify potential additional process agent uses in the country.

<u>Activities under the Multilateral Fund to phase-out process agent consumption</u>

14. Further to decision X/14, the Executive Committee adopted, at its 27th Meeting in decision 27/78, a set of framework guidelines/broad principles for consideration of process agent proposals. The text of decision 27/78 is appended to this report (Annex III). The guidelines noted that as additional projects were considered and approved, a body of information on cost-effectiveness, emissions limits and other requirements concerning eligibility and the determination of incremental costs would emerge.

15. On the basis of these guidelines and within the lists of approved process agent uses promulgated via decision X/14 and later, decisions XV/6 and XV/7 of the Parties, the Executive Committee has approved 13 individual projects to phase out the consumption of 1,214 ODP tonnes of CTC used as a process agent at a total cost of US $5,192,304 (Annex IV). The most recent individual projects were approved in December 2001. All have

employed process conversion to eliminate the use of CTC entirely, thus bypassing the requirement to specify acceptable levels of residual emissions.

16. Three multi-year, national CTC phase-out plans have also been approved in principle (China, D.P.R. Korea and India) at a total cost of US $122,684,044 (including CTC production phase-out in China and India). Funding of these by means of annual tranches is in progress.

17. The projects for China and D.P.R. Korea contain provisos that the countries may apply for additional assistance from the Multilateral Fund to complete the phase-out of a specified level of consumption in identified process agent applications that were not included in decision X/14 as approved process agent uses at the time the projects were considered by the Executive Committee. China's additional uses have subsequently been approved *vide* decision XV/6. D.P.R. Korea still has four applications that are not included in the list approved under decision XV/6. The four applications were among those recommended by TEAP in its 2004 report. India has identified eight uses that are not included in decision XV/6, however India has agreed with the Executive Committee to phase-out all CTC consumption without further assistance from the Fund and has flexibility under the agreement to re-allocate funding to best facilitate the phase-out.

18. Since the three major consumers, accounting for 97 per cent of total consumption, all have national CTC phase-out plans in place or in prospect for the new uses, consumption for process agent uses as defined under the Montreal Protocol will cease in these countries when Multilateral Fund projects are completed, irrespective of current data discrepancies.

19. With the inclusion of Pakistan, the only other country in which a process agent project has been funded by the Multilateral Fund, the phase-out of some 98 per cent of the total currently identified use of ODS as process agents in Article 5 countries has either already been addressed or has been quantified and recognised by the Executive Committee as potentially eligible for future funding requests. It is pointed out in the technical study that all but 0.2 per cent of currently identified uses have been described in project documentation.

20. Subsequent to the survey carried out as part of the technical study, China advised the Executive Committee at its 45th Meeting that a number of additional process agent uses with a significant level of CTC consumption (some 3000 ODP tonnes) have now been identified in China. The newly identified uses are not included in the applications listed in decisions X/14 or XV/6. As it stands, the Agreement between China and the Executive Committee for phase-out of the production and consumption of CTC provides that any CTC consumption additional to the uses identified in the sector plan would be phased out by China at no additional cost to the Multilateral Fund.

Emissions controls versus process change

21. Decisions X/14 and XV/7 envisaged a body of information emerging on, *inter alia*, the implementation and development of emissions-reduction techniques. To this end, and consistent with the guidelines for process agent projects established by the Executive Committee in decision 27/78, all individual projects considered by the Executive Committee contained an examination of the technological and financial implications of emissions controls compared to the alternative of eliminating the use of the relevant ODS (usually CTC) by changing the process. Emissions controls were found in each case to be substantially more costly and/or technologically unfeasible. The three national CTC phase-out plans also

contained proposals to change the process and eliminate the relevant ODS use for every process agent application where a technological alternative had been identified.

22. Overall, some 91% of the phase-out of ODS process agent use funded or identified in individual project or national phase-out plans will be accomplished by changes in technology to a substance that is not controlled or by shutting down the plant. Only 9% of the phase-out is expected to be achieved by emission controls to minimise, capture and destroy controlled substances vented to atmosphere and this percentage could decrease if technological alternatives for process change in the relevant applications are identified prior to the proposed implementation dates of the sub-projects addressing these applications.

23. The 9% proposed to be addressed by emission controls relates to three processes in China for which the implementing agency has not so far been able to find an alternative process. One of the three applications, involving the use of CTC, accounts for 8.6% of this amount. A similar, but not identical, application in D.P.R. Korea is to be addressed by changing the process to eliminate the use of CTC. This indicates that there may be an opportunity for the application in China also to utilise process change. The Executive Committee has invited the relevant implementing agency to investigate the issue.

24. No details of the technologies proposed to achieve the reductions in emissions in the three applications are yet available, since the activities are programmed for future years of the national phase-out plan for which details are not currently available.

25. When decision X/14 and subsequent decisions by the Executive Committee were taken, there was a presumption that emissions control might play an important role in the phase-out of ODS in process agent uses. This has not been the case. Should emissions control techniques still be proposed in the future for one or more of the three applications in China, or in any other as yet unidentified uses, the Executive Committee will consider identifying levels of emissions that can reasonably be achieved in a cost effective manner without undue abandonment of infrastructure, as requested in decision X/14, on a case-by-case basis.

<u>Level of emissions compared to consumption</u>

26. The information in project documents and in responses to the survey did not indicate that any Article 5 Parties are currently collecting and destroying ODS emissions from process agent applications. On this basis, in all cases, the quantity that is lost to the environment “the emissions” is equal to the total quantity used to replenish material in the process, that is, the "makeup quantity" which is reported at the project level as consumption. This can be compared with the definition of “insignificant” level of emissions indicated in Table B of decision X/14 which applies to non-Article 5 Parties, in which the average level of emissions is less than 5 per cent of the make-up quantity.

<u>Conclusions</u>

27. From the survey and from an analysis of consumption information in projects submitted to the Executive Committee, the total identified consumption of ODS in process agent applications by Article 5 countries is about 13,600 ODP tonnes, almost all of which is CTC.

28. Some 98 per cent of the total will either be phased-out through implementation of individual projects and the three national CTC phase-out plans already funded or approved in principle by the Executive Committee, or has been quantified in the relevant national plans and recognised by the Executive Committee as potentially eligible for future funding requests.

29. ODS phase-out, comprising of about 91% of the total phase-out in approved or foreshadowed projects, is proposed to be accomplished by changes in the process technology to enable use of a process agent that is not a controlled substance or by shutting down the plant. Process change with zero residual emissions has therefore become established as the predominant modality for achieving phase-out in the process agent sector in Article 5 countries.

30. No information has been received to indicate that any Article 5 countries are currently collecting and destroying emissions from process agent applications. Therefore the quantities of ODS that are reported at the project level as consumption are emitted to the environment.

Annex I

A Study to Catalogue Process Agent Uses and Emissions Levels Involving Substances Controlled under the Montreal Protocol in Countries Operating under Article 5.1 of the Protocol

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Executive Summary

The aim of this study is to catalogue process agent uses and related emission levels in countries operating under Article 5.1 of the Montreal Protocol (developing countries). Analysis of options for emissions reductions was specifically excluded.

The survey involved a desk study of annual ODS consumption data, provided by the Parties, to the Ozone Secretariat under Article 7 of the Protocol and to the Fund Secretariat under annual reports on the progress of implementation of country programmes. These, together with the project plans and phase-out plans provided most of the information. The study was followed up by a questionnaire to relevant Article 5.1 countries to ascertain their current usage of controlled substances for process agent applications and the levels of emissions from the processes. Use of controlled substances as chemical feedstocks for fluorocarbons manufacture in the People's Republic of China and in India and for the production of the intermediate chemical DV acid chloride in India were not included in this study.

Some 26 countries were surveyed; the criterion for inclusion being process agent or solvent use of a controlled substance comprising more than 1 ODP tonne per year. To date, 12 responses have been received. The principal findings from the information in the projects and phase-out plans already held by the Secretariats and the responses to questionnaires are:

- In most cases, the process agent is used as a process solvent. This is particularly so for carbon tetrachloride (CTC) which constitutes all but 0.4% of the emissions[1].
- With two exceptions, some form of recycle of the process solvent is carried out. The exceptions are the production of Ketotifen in the People's Republic of China and l-Ascorbic acid in the Democratic People's Republic of Korea.
- The most informative measure of the effectiveness of containment of the solvent in the whole process is the use factor (or *usage*); this is the annual quantity of process agent consumed (also known as the "makeup quantity") relative to the annual quantity of product made.
- The closer the use factor is to zero, the more effective is the recycle of process agent and values range from 0.006 to 13.4 for all uses. Even in the six applications using more than 1,000 ODP tonnes per year of process agent, use factors from 0.12 to 1.6 were reported. Thus the effectiveness of recycling is highly variable. Nevertheless, in any particular process, improved recycling would be as effective in reducing process agent emissions as the capture and destruction of the emissions.
- No Party provided evidence for current destruction of process agents and so the quantities that are lost into the environment are equal to the quantities used to replenish material in the process - the "makeup quantities". All of the process agents under consideration will tend to migrate into the atmospheric compartment of the environment (as against water, soil or biota).

[1] The rest of the emissions are CFC-113 and bromochloromethane (BCM).

- The year to year variation in the consumption reported by Parties can be misleading and high. This is particularly the case where process agent uses are calculated as the remainder after accounting for imports, exports, domestic production and feedstock use, without allowing for changes in stock holding (inventory).
- Calculated from the best available data in national plans and the reports to the Protocol Secretariats, total process agent use in Article 5.1 countries was in the region of 13,600 ODP tonnes per year in 2003. However, for the reasons given above, the uncertainty of this number is large. For example, the simple sum of all reported data in 2003 is 23,300 ODP tonnes; a value that is almost certainly in error since it would have required a doubling in process agent use by one Party in direct contravention of its national plan for phase-out.
- The applications of all but 0.2% of the 13,600 ODP tonnes used are described in national plans or in individually approved projects but 7,350 ODP tonnes of this, while already identified in phase-out plans, may be the subject of additional requests for support from the Multilateral Fund.
- Some 94% of the identified consumption is in applications that are now listed as process agents under decisions XV/6 and XV/7 taken at the Fifteenth Meeting of the Parties.
- About 91% of the reduction in process agent use is proposed to be accomplished by changes in technology (including change in the process agent to a substance that is not controlled) or by shutting down the plant. The other 9% is expected to be achieved by emission controls to minimise, capture and destroy controlled substances vented to atmosphere. However, no evidence was presented to indicate that such procedures are happening now.

Introduction

At their fifteenth meeting the Parties to the Montreal Protocol requested the Executive Committee to report to the twenty fifth session of the Open-ended Working Group (in July 2005) on the progress made in reducing emissions of controlled substances from process-agent uses and on the implementation and development of emissions-reduction techniques and alternative processes not using ozone-depleting substances. Subsequently at its 44th Meeting, the Executive Committee of the Multilateral Fund authorised the study in this form to catalogue process agent uses and related emission levels (excluding the analysis of options for emissions reductions) in countries operating under Article 5.1 of the Montreal Protocol (developing countries).

The survey involved a desk study of annual ODS consumption data provided to the Ozone Secretariat under Article 7 of the Protocol and to the Fund Secretariat under annual reports on progress with implementation of country programmes, followed up by a questionnaire to relevant Article 5 countries to ascertain their usage of controlled substances for process agent applications and the levels of emissions from the processes.
31.

The Nature of Process Agents

A Process Agent is defined in the Process Agent Task Force Report of 1997 [*1*] as a controlled substance that because of its unique chemical or physical properties facilitates an intended chemical reaction or inhibits an unintended (undesired) chemical reaction. Thus a solvent that facilitates a chemical reaction simply by dissolving the reagents and does not react itself with those reagents meets the criteria for a process agent. Many of the process agent applications described in this report fall into that category.

In a broader context, the chemical and physical properties that make a controlled substance suitable for use as a process agent in a chemical process include:

chemical inertness in the chemical reaction process,

appropriate physical properties, e.g.

- Boiling point
- Vapour pressure
- Specific solvency,

non-flammability and the ability to suppress explosion.

They are used:

to facilitate reactions, including entering into the reaction acting as chain transfer agents,

to control the desired physical properties of a process, e.g.,

- Molecular weight
- Viscosity,

to increase plant yield and

to minimise undesirable by-product formation.

The complete definition is given in Appendix A.

Where the controlled substance is a major component of the reaction mixture and becomes transformed during the reaction and is incorporated chemically into the product, it should be treated as a chemical feedstock.

The process agents considered in this report comprise only those that were listed in the responses from Article 5.1 Parties:

Carbon tetrachloride (CTC, CCl_4),
Fluorotrichloromethane (CFC-12, CCl_2F_2),
Trichlorotrifluoroethane (CFC-113, CCl_2FCClF_2) and
Bromochloromethane (BCM, CH_2ClBr)

and, throughout the report, the materials will be referred to by their short names - CTC, CFC-12, CFC-113 and BCM.

Approved uses covered by Decisions XV/6 and XV/7, taken at the Fifteenth Meeting of the Parties are listed in Appendix B, Table 1, plus brief descriptions of the reasons for using the agent and ways that emissions can be reduced. Appendix B, Table 2 carries a similar list for applications not yet approved. In both cases, only the applications that have been identified by Article 5.1 Parties are listed.

Reductions in emissions may be accomplished in a number of ways through optimisation of the process. On the other hand, elimination of emissions requires more radical approaches. These involve changes to the process to avoid use of controlled substances, shut-down of the process (and cessation of manufacture) or treatment of the process streams that are released into the environment to destroy the controlled substances they contain. The extent of emission of the controlled substance is different for each process agent application.

In the general case where controlled substances are used as process agents, the supply is utilized to replenish process inventory lost as the result of transformation, destruction and emissions to the atmosphere from the process and/or trace quantities slowly emitted from the product. Therefore the supply required for replenishment of lost inventory is referred to as "makeup" and defined as follows:

Make up quantity: The quantity of controlled substance per year, needed to continue the manufacture of products in a plant, due to transformation, destruction and inadvertent losses (i.e. emissions and residual amounts in final product) [*2*].

Feedstock Uses

Carbon tetrachloride is used in India and China as a chemical feedstock in the manufacture of CFCs 11 and 12 (fluorotrichloromethane and dichlorodifluoromethane), in the course of which all of the quantity used is either chemically converted or lost into the environment from process leaks [*3, 4*]. It is not a process agent in this application.

Carbon tetrachloride is also used in India as a chemical feedstock to make "DV acid chloride", 3-(2,2-dichloroethenyl)-2,2-dimethyl cyclopropane carbonyl chloride or *cypermethric acid chloride*. This is an intermediate in the manufacture of insecticides. No details of the process were made available but the consumption is significant, at several thousand tonnes per year, and increasing rapidly. Emissions of CTC from the process were stated to be much less than 7% of the make-up quantities and this use is not treated as process agent in this report [*3*].

Emissions

CTC

This is the most significant process agent in terms of both its range of applications and the quantities involved. In a large number of the processes, CTC is used as a solvent (*see Appendix B, Tables 1 and 2*) to facilitate the chemical reaction. It is recovered and recycled within the process by a variety of means: distillation and decantation being the more common. The recovery and recycle regime can be highly effective; for example in the average chlorinated rubber process in China the instantaneous inventory is in the region of 10 tonnes but some 160 tonnes/year of CTC passes through each processes [*4*]. It can also be non-existent; in the same country the production of Ketotifen is accompanied by total loss of the 13.4 tonnes of CTC used to make each tonne of product [*4*]. The data in Appendix B contain values, as reported in the reference documents, for:

> The use ratio (also reported as usage). This is the quantity of process agent consumed per unit of product and is a measure of the overall efficiencies of use, recovery and recycle. With total recovery and recycle, the use ratio would be zero but, in practical situations, some makeup quantities are required and some material is destroyed within the process. The use ratio combines all of these influences and so is reported here. Furthermore, most of the reference documents provide enough information to calculate use ratios.
>
> The emission ratio (instantaneous quantity of process agent not recovered relative to the quantity in use). There are many fewer data for this and the number itself is less informative than the use ratio. A low emission ratio simply indicates that only a small proportion of the mass in circulation in the process is lost each time it passes through. That could still mean that the use ratio is significant. For example, if the emission ratio were 4% and 30 tonnes of process agent were circulated for each tonne of product, then 1.2 tonnes of process agent would be lost for each tonne of product, giving a use ratio of 1.2.

None of the processes is completely sealed and losses occur by leakage of CTC directly into the atmosphere (from storage and processing vessels) and also indirectly, after being released into surface water. It has been demonstrated that chlorinated solvent (such as CTC) in a contaminated surface water course rapidly migrates into the atmosphere, rather that remaining in the water [*5, 6*]

Emission ratios vary from 100% (total loss of the material as it is used) to a few percent (effective recycle procedures) but, in an established process unless specific procedures have been put in place to collect and destroy the potential emissions ("emission control technology"), the quantity required each year for process agent use is equal to the quantity lost into the environment. Although the possibility of emission control technology was discussed in some national plans [*3, 4*], no party claimed that emission control is currently being operated (or indeed that it has been installed). Consequently, the quantity of material emitted was set equal to the quantity used.

With very few exceptions, the process agents are recycled to some extent through the processes, with varying degrees of success in their recovery and containment. However, for most, if not all, of the CTC uses reported by Article 5.1 Parties, there is no transformation within the process and no deliberate destruction and so make-up quantities are equal to the quantities emitted.

CFC-12

Consumption of this controlled substance as a process agent was reported historically by one Party (see Table 5). While it was thought to be used as a purifying agent in primary aluminium production, the exact nature of the process agent application was not made available and, although the material and this application were included in the survey, no details could be given in Appendix B. No CFC-12 is now used in this application.

CFC-113

The single process agent application for CFC-113 considered here is in the production of fluoropolymer resins. In this case, emissions may be reduced by capture and treatment of the process streams that are released into the atmosphere [*4*].

BCM

Two uses for this material are included in Appendix B. In the first, the manufacture of the pharmaceutical Losartan Potassium (Losartan K), use of BCM as a process agent was approved under Decisions XV/6 and XV/7 of the Fifteenth Meeting of Parties. In the second, BCM is a reagent and solvent in the chloromethylation of Sulbactam to make chloromethylpenicillinate-S,S-dioxide. In the course of this reaction it is a chemical reagent that is completely incorporated into the product molecule and gives rise to sodium bromide as a co-product. Although this use is still included in those subsequently listed in this report as process agents, it would appear that it is more accurately characterised as a feedstock.

Box 1.
Article 5.1 Parties reporting consumption under Article 7 of the Montreal Protocol

Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Bahamas, Bahrain, Bangladesh, Barbados, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Burkina Faso, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chad, Chile, China, Colombia, Comoros, Congo, Democratic Republic of Congo, Cook Islands, Costa Rica, Côte d'Ivoire, Croatia, Cuba, Cyprus, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Federated States of Micronesia, Fiji, Gabon, Gambia, Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea Bissau, Guyana, Haiti, Honduras, India, Indonesia, Islamic Republic of Iran, Jamaica, Jordan, Kenya, Kiribati, Democratic People's Republic of Korea, Republic of Korea, Kuwait, Kyrgyzstan, Lao People's Democratic Republic, Lebanon, Lesotho, Liberia, Libyan Arab Jamahiriya, Madagascar, Malawi, Malaysia, Maldives, Mali, Marshall Islands, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nauru, Nepal, Nicaragua, Niger, Nigeria, Niue, Oman, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Qatar, Romania, Rwanda, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Serbia and Montenegro, Seychelles, Sierra Leone, Singapore, Solomon Islands, Somalia, South Africa, Sri Lanka, Sudan, Suriname, Swaziland, Syrian Arab Republic, United Republic of Tanzania, Thailand, The Former Yugoslav Republic of Macedonia, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Tuvalu, Uganda, United Arab Emirates, Uruguay, Vanuatu, Venezuela, Viet Nam, Yemen, Zambia, Zimbabwe.
Source, reference [*7*]

Table 1. Summary of Country Studies

Country	Not examined - use less than 1 ODP tonne	Individual Process Agent Application(s)	Process Agent(s) approved as part of National Plan	Potential Process Agent use	Responded to question-naire	Included in further study
Algeria				✓		
Argentina		✓			✓	✓
Bahamas				✓		
Bahrain	✓					
Bangladesh				✓		
Barbados	✓					
Bolivia	✓					
Brazil		✓				
China, PR			✓			✓
Colombia		✓			✓	✓
Congo, DR				✓		
Cuba	✓					
Egypt		✓			✓	
Ghana	✓					
India			✓			✓
Indonesia				✓		
Iran *				✓	✓	
Jordan				✓	✓	
Korea, DPR			✓			✓
Lebanon	✓					
Mauritius	✓					
Mexico		✓			✓	
Morocco	✓					
Myanmar	✓					
Nepal	✓					
Nigeria				✓		
Oman	✓					
Pakistan		✓				✓
Paraguay				✓		
Peru	✓					
Romania		✓			✓	✓
Sri Lanka		✓			✓	✓
Sudan		✓				
Syria				✓	✓	
Tanzania	✓					
Tunisia	✓					
Turkey		✓			✓	✓
Uganda	✓					
Uruguay	✓					
Venezuela				✓		
Yemen **				✓	✓	
Zimbabwe				✓	✓	

* The response from Iran indicated that a further survey would be required to ascertain applications and quantities of process agents

** In the period of writing this report, consumption of Process Agent reported by Yemen was amended to below the 1 ODP tonne threshold.

Methodology-
Survey by Questionnaire

Based on submissions of the Parties to the Ozone Secretariat (as required by Article 7 of the Montreal Protocol) and submissions to the Fund Secretariat, a list of candidate Parties was compiled. The criteria for inclusion in this initial screen of the 143 Article 5.1 Parties, that report under Article 7 (see Box 1), was that they should have either declared a process agent consumption or the consumption of a compound of interest in the "solvent" application category. Throughout this study, it has been assumed that submissions by parties are accurate and exact numerically but this is not always consistent with the actual results.

The list of Parties surveyed is shown in Table 1 and comprises 42 of the 143 eligible Parties. At this stage, 16 countries were deselected because, although they had reported individual consumption as either a process agent or solvent, the value was less than 1 ODP tonne. Although this is a rather arbitrary cut-point, it represents only 1/100th of 1 percent of the total process agent use by Article 5.1 Parties and is a defensible *de minimis* level.

The remaining 26 Parties received questionnaires individually designed to elicit their latest data for the quantities, nature and applications of process agent use. For the 10 Parties with process agent uses declared in individually approved projects and the three Parties whose process agent declarations were part of National Plans, the questionnaire sought to update the information previously provided. In addition, the questionnaire provided the opportunity for the Party to list any other applications of the controlled substances as process agents that had not been submitted as approved projects or in applications that have not yet been approved (as process agents by Parties), although they could meet the criteria.

The general form of this questionnaire is shown in Appendix C. In the particular case cited, one of the process agent applications that was part of the National Plan is no longer approved by the Parties (the manufacture of Ketotifen). However, when the National Plan was drawn up, Ketotifen was on the approved list and it appears to remain, technically, a process agent application of CTC, so was cited in this part of the form for this country.

The thirteen parties remaining had submitted data that showed solvent applications for one of the controlled substances of interest. In these cases a questionnaire of the form shown in Appendix D was employed with the aim of eliciting whether or not any part of that use could have been as a process agent and, if so, in what application.

In total twelve responses were received. In the absence of a response from countries receiving a general questionnaire, it was assumed that their solvent applications had been correctly reported and that they could be excluded from further study. The responses from three Parties also enabled them to be eliminated:

> *Argentina,* where BCM is no longer used in the manufacture of Losartan K and the 13.86 tonnes of CTC used in petroleum reforming catalyst treatment has been reclassified by the party as feedstock because it is destroyed;
>
> *Egypt*, where 51 ODP tonnes of CFC-12 had been declared as a process agent apparently to purify primary production aluminium, reported that controlled substances were no longer used for this application and

Mexico, where a 26.4 ODP tonne use of CFC-113 had actually been miscategorised.

Process agent applications in Colombia, Romania, Sri Lanka, Sudan and Turkey were examined on the basis of their responses to the questionnaires and information supplied to the Ozone and Fund Secretariats. Similar applications in China, India, D.P.R. of Korea and Pakistan were studied using the National Plans or individual process agent approvals.

Results

There are three classes of Application:

1. Those that are approved under Decisions XV/6 and XV/7 from the Fifteenth meeting of Parties. The method of use of the process agent is well described and the essentials are listed in Appendix B, Table B.1.
2. Those that are not approved under a decision of the Parties but which are also well documented and are listed in Appendix B, Table B.2. In some cases, although the method of use of the controlled substance is documented, no actual use is reported by any of the Parties.
3. Those for which quantities are claimed by some Parties but which are not well documented. These are listed without further comment at the end of Table B.2.

The quantities used in each application are listed in Table 2 which also shows the source of information and the countries reporting use. In total, some 13,621 ODP tonnes of process agents have been reported as being used by Article 5.1 Parties, comprising 13,569 ODP tonnes of CTC, 40 of CFC-113 and 12 of BCM. The last figure is material used in Turkey for the manufacture of Sultamicillin antibiotic that, in fact, may be feedstock.

The values were taken from the latest information that gave consumption in individual applications; either the responses to the questionnaires or data submitted to the Fund Secretariat and Ozone Secretariat. This has resulted in total values that are significantly less than the total value for the year 2003 published by the Ozone Secretariat. This is almost wholly due to the values reported by the People's Republic of China and will be discussed later.

Emissions were assumed to equal consumption. Firstly, no Party reported that emissions were any different from consumption in their responses to the questionnaire, and secondly, the technical data summarised in Appendix B suggests that, in most cases, emission reductions would result only from changes in process agent use. The exceptions are the uses of CFC-113 for fluoropolymer resins, CTC for Ketotifen and CTC for the manufacture of chlorosulphonated polyolefin in the People's Republic of China, where vents treatment systems that will reduce emissions by destroying the controlled substance component are planned [*4*]. These applications account for 9% of the emissions that potentially can be abated. Alternative technology has been proposed to stop emissions of CTC from the manufacture of chlorosulphonated polyolefin in the DPR of Korea by changing to a new, solvent free fluidised bed process [*10*].

In the region of 94% of the quoted consumption is in applications that have been approved under Decisions XV/6 and XV/7 by the Fifteenth Meeting of the Parties and are shown on the first page of Table 2. The remainder, shown on the second page of Table 2 have yet to be considered by the Parties for approval, or were dropped from the approved list for procedural reasons. For example, the manufacture of Ketotifen was in the list approved initially [*1*] but is not on the current list although it is included in a national plan that was approved in the meantime [*4*].

Table 2. Process Agent Use and Emission by Article 5.1 Parties

Process Agent	Application (approved under decisions XV/6 and XV/7)	References	Emission, equal to Use ODP tonnes	Countries
CTC	Elimination of nitrogen trichloride in the production of chlorine	*1, 8, 9*	2.75	Colombia
CTC	Manufacture of chlorinated rubber	*3,4,10,11*	1908	China, India, DPR Korea
CTC	Manufacture of Endosulphan insecticide	*1,3,12,13*	290	India
CTC	Manufacture of isobutyl acetophenone (Ibuprofen analgesic)	*3, 14, 15, 16, 17, 18, 19*	274	India, Pakistan
CTC	Manufacture of 1,1-bis (4-chlorophenyl) 2,2,2-trichloroethanol (Dicofol insecticide)	*1, 3, 20*	76	India
CTC	Manufacture of chlorosulphonated polyolefin (CSM)	*1,4, 10, 21*	1375	China, DPR Korea
CFC-113	Manufacture of fluoropolymer resins	*4, 22*	40	China
CTC	Manufacture of chlorinated paraffin	*1, 3, 4, 23*	1442	China, India
CTC	Manufacture of bromohexine hydrochloride	*3, 24, 25, 26, 27, 28*	234	India
CTC	Manufacture of Diclofenac sodium	*3, 29, 30*	561	India
CTC	Manufacture of phenyl glycine	*3, 31, 32, 33*	15	India
CTC	Manufacture of chlorinated polypropylene Manufacture of chlorinated EVA	*4*	1942	China
CTC	Manufacture of methyl isocyanate derivatives	*4*	1440	China
CTC	Manufacture of 3-phenoxybenzaldehyde	*4*	520	China
CTC	Manufacture of 2-chloro-5-methylpyridine	*4*	282	China
CTC	Manufacture of Imidacloprid	*4*	1230	China
CTC	Manufacture of Buprofenzin	*4*	964	China
CTC	Manufacture of Oxadiazon	*4*	17	China
CTC	Manufacture of chloridized N-methylaniline	*4*	103	China
CTC	Manufacture of Mefenacet	*4*	23	China
CTC	Manufacture of 1,3-dichlorobenzothiazole	*4*	28	China
BCM	Manufacture of Losartan potassium	*2,34*	2.4	Argentina

Process Agent	Application (not yet approved)	References	Emission, equal to Use ODP tonnes	Countries
BCM	Manufacture of Sultamicillin	*35*	12	Turkey
CFC-11	Purification of aluminium	no data	0	Egypt
CTC	Manufacture of Ampicillin	*3, 31, 32, 33*	*Included in phenyl glycine above*	
CTC	Manufacture of ascorbic acid	*2, 10, 36*	79.2	DPR Korea
CTC	Manufacture of betamethazone phosphate	*33*		
CTC	Manufacture of Cefaclor®	*33*		
CTC	Manufacture of Ceftriaxone®	*33*		
CTC	Manufacture of Chlorophenesin	*33*	44	India
CTC	Manufacture of Ciprofloxacin	*2, 10, 33, 36*	82.5	DPR Korea
CTC	Manufacture of Clotrimazole	*33*		
CTC	Manufacture of Cloxacillin	*33*		
CTC	Manufacture of dexamethazone phosphate	*33*	55	India
CTC	Manufacture of estramustine phosphate	*33*		
CTC	Manufacture of the herbicide 2,4-D	*2, 37*	22	Romania
CTC	Manufacture of the herbicide DHEPC	*2, 37*	135.3	Romania
CTC	Manufacture of isosorbide mononitrate	*33*	6	India
CTC	Manufacture of Ketotifen	*4*	13	China
CTC	Manufacture of Naproxen	*33*		
CTC	Manufacture of Norfloxacin	*2, 10, 33, 36*	*Included in Ciprofloxacin above*	DPR Korea
CTC	Manufacture of Omeprazol	*33*		
CTC	Manufacture of trityl chloride	*33*	130	India
CTC	Production of the disinfectant sodium dichloroisocyanurate	*2, 10, 33, 36*	68.2	DPR Korea
CTC	Conditioning of Petroleum Reforming Catalyst	*34, 38*	13.86	Argentina
CTC	Production of Vinyl Chloride Monomer	*39*	0	Brazil
CTC	Manufacture of Carbimazole	*3*	8	India
CTC	Production of p-nitrobenzyl bromide	*3*	103	India
CTC	Production of benzophenone	3	45	India
CTC	Production of ethyl-4-chloroacetoacetate	*3*	11	India
CTC	Absorption quality testing of activated carbon	no data	16.65	Sri Lanka

Tables 3 and 4 carry information similar to Table 2, grouped into applications approved under decisions XV/6 and XV/7 and those not so approved. Furthermore, within each table, the results are grouped by Party. The year to which the results actually correspond is also given. However, in most cases, values in the plan and more recent information are similar.

The data in the column describing the use factor for each application in each Party were extracted from the national data reported in the quoted reference. In almost all cases where carbon tetrachloride is used as a process solvent it is recycled. The exceptions are Ketotifen production in the People's Republic of China and ascorbic acid production in the Democratic People's Republic of Korea. The effectiveness of recycling is variable and this is partly responsible for the wide variation in the use factors, which are also impacted by process technology considerations. For some applications, the national data did not give enough information to calculate a usage factor; generally because the process agent use was quoted without giving a value for the production. Nevertheless, in any one process, improved recycling would be as effective in reducing process agent emissions as the capture and destruction of the emissions.

Table 3. Process Agent Usage and Emissions in Activities Approved under Decisions XV/6 and XV/7.

Party	Activity	ODS used	Year	Emission, equal to Use ODP tonnes	Use factor metric tonnes per tonne of product	Ref.
Argentina	Manufacture of Losartan potassium	BCM	2000	2.4	id	34
China (PR)	Manufacture of chlorinated rubber	CTC	2000	1494	0.55	4
	Manufacture of chlorosulphonated polyolefin (CSM)	CTC	2000	1202	0.44	4
	Manufacture of fluoropolymer resins	CFC-113	2000	40	0.006	4
	Manufacture of chlorinated paraffin	CTC	2000	1243	0.20	4
	Manufacture of chlorinated polypropylene	CTC	2000	1942	0.73	4
	Manufacture of chlorinated EVA	CTC				
	Manufacture of methyl isocyanate derivatives	CTC	2000	1440	0.12	4
	Manufacture of 3-phenoxybenzaldehyde	CTC	2000	520	0.40	4
	Manufacture of 2-chloro-5-methylpyridine	CTC	2000	282	4.07	4
	Manufacture of Imidacloprid	CTC	2000	1230	1.60	4
	Manufacture of Buprofenzin	CTC	2000	964	0.29	4
	Manufacture of Oxadiazon	CTC	2000	17	0.28	4
	Manufacture of chloridized N-methylaniline	CTC	2000	103	0.18	4
	Manufacture of Mefenacet	CTC	2000	23	0.70	4
	Manufacture of 1,3-dichlorobenzothiazole	CTC	2000	28	0.35	4
Colombia	Elimination of nitrogen trichloride in the production of chlorine	CTC	2000*	2.75	na	8
India	Manufacture of chlorinated rubber	CTC	2000	305	id	3
	Manufacture of Endosulphan insecticide	CTC	2000	290	0.067	12
	Manufacture of isobutyl acetophenone (Ibuprofen analgesic)	CTC	2000	186	0.68	14
	Manufacture of 1,1-bis (4-chlorophenyl) 2,2,2-trichloroethanol (Dicofol insecticide)	CTC	2000	76	id	3
	Manufacture of chlorinated paraffin	CTC	2000	199	id	3
	Manufacture of bromohexine hydrochloride	CTC	2000	234	0.92	24
	Manufacture of Diclofenac sodium	CTC	2000	561	1.14	29
	Manufacture of phenyl glycine	CTC	2000	15	0.083	31
Korea (DPR of)	Manufacture of chlorinated rubber	CTC	2002	109	id	10
	Manufacture of chlorosulphonated polyolefin (CSM)	CTC	2002	173	id	10
Pakistan	Manufacture of isobutyl acetophenone (Ibuprofen analgesic)	CTC	2003	88	0.78	14

Notes:
- id insufficient data in references to complete calculation
- na not applicable
- * average over the period 1997-2001

Table 4. Process Agent Usage and Emissions in Activities not Approved under Decisions XV/6 and XV/7.

Party	Activity	ODS used	Year	Emission, equal to Use ODP tonnes	Use factor metric tonnes per tonne of product	Ref.
Argentina	Conditioning of Petroleum Reforming Catalyst	CTC	2002	13.86	na	*38*
Brazil	Production of Vinyl Chloride Monomer	CTC	2003	68.38	na	*39*
China (PR)	Manufacture of Ketotifen	CTC	2000	12	13.4	*4*
Egypt	Purification of aluminium	CFC-12	2003	0	na	
India	Manufacture of Chlorophenesin	CTC	2000	44	id	*3*
	Manufacture of dexamethazone phosphate	CTC	2000	55	id	*3*
	Manufacture of isosorbide mononitrate	CTC	2000	6	id	*3*
	Manufacture of trityl chloride	CTC	2000	130	id	*3*
	Manufacture of Carbimazole	CTC	2000	8	id	*3*
	Production of p-nitrobenzyl bromide	CTC	2000	103	id	*3*
	Production of benzophenone	CTC	2000	45	id	*3*
	Production of ethyl-4-chloroacetoacetate	CTC	2000	11	id	*3*
Korea (DPR of)	Manufacture of ascorbic acid	CTC	2002	79.2	0.92	*36*
	Manufacture of Ciprofloxacin	CTC	2002	82.5	4.6	*36*
	Manufacture of Norfloxacin	CTC			4	*36*
	Production of the disinfectant sodium dichloroisocyanurate	CTC	2002	68.2	0.24	*36*
Romania	Manufacture of the herbicide 2,4-D	CTC	2003	22	0.56	*37*
	Manufacture of DEHPC	CTC	2003	135.3	1.38	*37*
SriLanka	Absorption quality testing of activated carbon	CTC	2003	16.65	na	
Turkey	Manufacture of Sultamicillin *	BCM	2003	12	7.3	*35*

Notes:
- * This may not be a process agent application
- id insufficient data in references to complete calculation
- na not applicable

Table 5 summarises the total consumptions listed for each party in Tables 3 and 4 and also the latest reported total data from the Ozone Secretariat [*40*]. The report from Argentina to the Ozone Secretariat under Article 7 of the Protocol did not contain information on either of the process agent uses mentioned in reference [*34*]. In the cases of Brazil, Egypt and Mexico, use has been discontinued, so that the most recent (2004) reported consumptions are all zero.

In Pakistan, Romania, Sri Lanka and Turkey, there is no significant change in use and the reduction in Colombia is more apparent than real because of the effect of sporadic imports on the accounting for process agent use (without allowing for stockholding).

There would seem to be a similar problem, on a much larger scale, with the data from the People's Republic of China. It is apparent that the usage rate for CTC as a process agent is calculated from its annual production, plus imports, minus exports, less the quantity used as feedstock. The remainder is given as the quantity used as process agent *without allowing for stock changes*. In the year 2001, the process agent use was reported as 10,637 ODP tonnes [*41*] so that the apparent 88% growth rate in process agent use over two years between 2001 and 2003 is almost certainly the result of such stock changes not being properly accounted.

Because neither Party responded to the questionnaire, there are no data to substantiate the reasons for the fall in use of CTC in India by 9% between 2000 and 2002, nor the rise in use of CTC in the Democratic People's Republic of Korea by 69% between 2002 and 2003. As with the data from China, these could be artefacts of the accounting and reporting procedures.

Table 5 Summary of Uses of Process Agents by the Parties

Party	ODS used	Sum of latest individually denominated uses				Latest reported total [*40, 42*]	
		Activities not approved by the Parties		Activities approved under Decisions XV/6 and XV/7			
		Year	Use ODP tonnes	Year	Use ODP tonnes	Year	Use ODP tonnes
Argentina	BCM			2004	0	2003	2.4
	CTC	2004	0			2003	0
Brazil	CTC	2003	68.38			2003	68.38
PR of China	CFC-113			2000	40	2003	17.11
	CTC	2000	13	2000	10485	2003	20014.36
Colombia	CTC			2000	2.75	2004	1.38
Egypt	CFC-12	2004	0			2003	51
India	CFC-113					2002	23.58
	CTC	2000	402	2000	1866	2002	2065.8
DPR of Korea	CTC	2002	229.9	2002	202	2003	731.5
Pakistan	CTC	2001	88			2003	88
Romania	CTC	2002	173			2004	157.3
Sri Lanka	CTC	2003	16.65			2003	16.65
Sudan	CTC					2003	1.1
Turkey	BCM	2003	12			2003	12

Viewed as uncertainties, these discrepancies would suggest that country data could be in error by an average of about 30 to 50% in any one year but the remedy is to account for the use as actual quantities used in the process operations ("bottom-up accounting") rather than attempting to asses the usage from overall production and use in other major outlets without allowing for stock changes.

Conclusions

Some 143 Parties to the Montreal Protocol operating under Article 5.1 report data on their consumption of controlled substances to the Protocol Secretariats. From these data, only 26 Parties were determined to use (or could potentially be using) controlled substances as process agents. Each was sent a questionnaire individually designed to elicit their latest values for the quantities of process agent used and to ascertain the applications in which they were employed, together with estimates of the emissions from these applications.

The results showed that, in total, some 13,599 ODP tonnes per year of process agents were used by Article 5.1 Parties, comprising 13,562 ODP tonnes of CTC, 40 of CFC-113 and 12 ODP tonnes of BCM. The estimate relates to years in the period 2000 to 2003 but the year to year variation in the values quoted by Parties can be misleading and high. This is particularly the case where process agent uses are calculated as the remainder after accounting for imports, exports, domestic production and feedstock use, without allowing for changes in stock holding (inventory). For example, the simple sum of all reported data in 2003 is 23,300 ODP tonnes; a value that is almost certainly in error since it would have required a doubling in process agent use by one Party in direct contravention of its national plan for phase-out.

Applications of all but 0.2% of the 13,600 ODP tonnes used are described in national plans or in individually approved projects but 7,350 ODP tonnes of this, while already identified in phase-out plans, may be the subject of additional requests for support from the Multilateral Fund.

Some 94% of the consumption is in applications that are now listed as process agents under decisions XV/6 and XV/7 taken at the Fifteenth Meeting of the Parties. In most cases, the process agent is used as a process solvent. This is particularly so for carbon tetrachloride (CTC) which constitutes all but 0.4% of the emissions.

With two exceptions, some form of recycle of the process solvent is carried out. The exceptions are the production of Ketotifen in the People's Republic of China and l-Ascorbic acid in the Democratic People's Republic of Korea. The effectiveness of recycling is variable and this is partly responsible for the wide variation in the use factors, which are also impacted by process technology considerations. Nevertheless, in any particular process, improved recycling would be as effective in reducing process agent emissions as the capture and destruction of the emissions.

About 91% of the reduction in process agent use is proposed to be accomplished by changes in technology (including change in the process agent to a substance that is not controlled) or by shutting down the plant. The other 9% is expected to be achieved by emission controls to minimise, capture and destroy controlled substances vented to atmosphere.

However, no Party provided evidence for current destruction of process agents and so all of the material lost must be emitted into the environment. All of the process agents under consideration will tend to migrate into the atmospheric compartment of the environment (as against water, soil or biota). The quantities that are lost are equal to the quantities used to replenish material in the process - the "make-up quantities".

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[*15*] Conversion of Carbon tetrachloride (CTC) as process solvent to Ethylene dichloride at Doctors Organic Chemicals Ltd., information to 32nd Meeting of the Executive Committee of the Multilateral Fund of the Montreal Protocol, from the government of India, September 22, 2000.

[*16*] Conversion of Carbon tetrachloride (CTC) as process solvent to Ethylene dichloride at Satya Deeptha Pharmaceuticals Ltd., information to 32nd Meeting of the Executive Committee of the Multilateral Fund of the Montreal Protocol, from the government of India, April 11, 2000.

[*17*] Conversion of Carbon tetrachloride (CTC) as process solvent to Ethylene dichloride at Svis Labs Ltd., information to 32nd Meeting of the Executive Committee of the Multilateral Fund of the Montreal Protocol, from the government of India, April 14, 2000.

[*18*] Conversion of Carbon Tetrachloride (CTC) as process solvent to ethylene dichloride at Chiplun Fine Chemicals Ltd. (CFC) information to 29th Meeting of the Executive Committee of the Multilateral Fund of the Montreal Protocol, from the government of India, September 12, 1999.

[*19*] Process Agents Task Force, Case Study #5, Use and consumption of CTC in Ibuprofen production, UNEP, Technology and Economic Assessment Panel, May 2001.

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Appendix A - Definitions from the 1997 PATF Report

"**Feedstock**: A controlled substance that undergoes transformation in a process in which it is converted from its original composition except for insignificant trace emissions as allowed by Decision IV/12."

"**Process Agent**: A controlled substance that because of its unique chemical and/or physical properties facilitates an intended chemical reaction and/or inhibits an unintended (undesired) chemical reaction.

Controlled substances are typically used in chemical processes as process agents for at least two of the following unique chemical and/or physical properties:

1. Chemically inert during a chemical reaction
2. Physical properties, e.g.
- Boiling point
- Vapour pressure
- Specific solvency
3. To act as a chain transfer agent
4. To control the desired physical properties of a process, e.g.,
- Molecular weight
- Viscosity
5. To increase plant yield
6. Non-flammable/non explosive
7. To minimise undesirable by-product formation

Note 1: Refrigeration, solvent cleaning, sterilisation, aerosol propellants and firefighting are not process agents according to this definition

Note 2: Parties need not consider use of ODS for foam blowing, tobacco puffing, caffeine extraction, or fumigation because these uses are already covered in other Decisions and/or by Technical Option Committee Reports." [*1*]

APPENDIX B Summary of Process Agent Applications featured in this Report

Table B.1 Activities Approved under Decisions XV/6 and XV/7

Activity	ODS used	Details of use of process agent	Fate of Process agent		Source of information
			Internal Recycle	Emission	
Elimination of nitrogen trichloride in the production of chlorine	CTC	Solvent for nitrogen trichloride used in the destruction process	Yes, ratio variable	Make-up quantities are transferred into the atmosphere unless captured and destroyed.	*9*
Manufacture of chlorinated rubber	CTC	Solvent for the chlorination of rubber using chlorine. No process details	No process details.	Make-up quantities are transferred into the atmosphere unless destroyed. Usage 0.55t/t	*4*
Manufacture of Endosulphan insecticide	CTC	Solvent for reaction of HET diol with thionyl chloride.	Recovery by distillation.	Make-up quantities are transferred into the atmosphere unless destroyed.	*13*
Manufacture of isobutyl acetophenone (Ibuprofen analgesic)	CTC	Solvent for reaction of isobutyl benzene with acetyl chloride and aluminium chloride. Recovery by distillation.	Yes. No information on ratio	Make-up quantities are transferred into the atmosphere unless destroyed.	*18, 19*
Manufacture of 1,1-bis (4-chlorophenyl) 2,2,2-trichloroethanol (Dicofol insecticide)	CTC	Solvent in chlorination of technical DDE, whence it is recovered by distillation. And solvent to purify technical dicofol, whence it is removed by distillation.	Yes. No information on ratio	Make-up quantities are transferred into the atmosphere unless destroyed. Emission ratio = 5%	*20*

Table B.1 continued

Activity	ODS used	Details of use of process agent	Fate of Process agent		Source of information
			Internal Recycle	Emission	
Manufacture of chlorosulphonated polyolefin (CSM)	CTC	Solvent for the reaction of polyethylene with chlorine and sulphur dioxide. The released CTC from the reactor and rear operations is recovered, purified and recycled by condensation and absorption.	Yes. No information on ratio	Make-up quantities are transferred into the atmosphere unless destroyed. Emission ratio = 3%	*21*
Manufacture of fluoropolymer resins	CFC-113	Resins, process agents (solvents), and other reactants are batch charged into reaction vessels followed by product isolation, product purification, and solvent recovery.	Vent collection and recovery systems capture and recycle 99% of CFC-113 in the primary vents.	Make-up quantities are transferred into the atmosphere unless destroyed separately by thermal oxidation. Emission ratio = 1%	*4, 22*
Manufacture of chlorinated paraffin	CTC	Solvent for reaction of paraffin wax with chlorine	During paraffin dissolution and chlorination, the evaporated CTC is recovered by condensation and recycled upstream for the process.	Make-up quantities are transferred into the atmosphere unless destroyed. Emission ratio = 3%	*23*
Manufacture of bromohexine hydrochloride	CTC	Solvent for bromination of o-nitrotoluene to o-nitrobenzylbromide, whence it passes through several other process steps and is recovered by distillation from the crude product	Yes	Make-up quantities are transferred into the atmosphere unless destroyed.	*27, 28*

Table B.1 continued

Activity	ODS used	Details of use of process agent	Fate of Process agent		Source of information
			Internal Recycle	Emission	
Manufacture of Diclofenac sodium	CTC	Solvent for chlorination of phenol to 2,6-dichlorophenol	No data	Make-up quantities are transferred into the atmosphere unless destroyed.	*30*
Manufacture of phenyl glycine, intermediate in manufacture of Ampicillin and Cefaclor.	CTC	Solvent for hydrochlorination of D(-) alpha phenyl glycine and for product purification.	Separation by filtration, solvent recycled to reaction stage.	Make-up quantities are transferred into the atmosphere unless destroyed.	*32, 33*
Manufacture of chlorinated polypropylene	CTC	Solvent for direct chlorination of polypropylene but no process details	Tail gas treatment by active carbon adsorption	Make-up quantities are transferred into the atmosphere unless destroyed. Usage from 0.68t/t to 0.62t/t.	*4*
Manufacture of chlorinated EVA	CTC	Solvent for direct chlorination of ethyl vinyl acetate but no process details	Tail gas treatment by active carbon adsorption	Make-up quantities are transferred into the atmosphere unless destroyed. Usage from 0.68t/t to 0.62t/t.	*4*
Manufacture of methyl isocyanate derivatives	CTC	Used as a nonflammable and non-explosive diluent in producing methyl isocyanate intermediate (rather than the final products of MIC series pesticides).	Recycled by distillation	Make-up quantities are transferred into the atmosphere unless destroyed. Usage in range 0.2-0.3t/t (CTC/MIC)	*4*
Manufacture of 3-phenoxybenzaldehyde	CTC	No data		Usage 0.4t/t	*4*

Table B.1 continued

Activity	ODS used	Details of use of process agent	Fate of Process agent		Source of information
			Internal Recycle	Emission	
Manufacture of Imidacloprid	CTC	Solvent in the chlorination of 2-chloro-5-methyl-pyridine to 2-chloro-5-chloromethyl pyridine with chlorine.	Captured from the tail gas by condensation and then recycled.	Make-up quantities are transferred into the atmosphere unless destroyed. Usage from 1 to 2 t/t	*4*
Manufacture of Buprofenzin	CTC	Solvent for chlorination of N-methylaniline (to *chloridized N-methylaniline*) with chlorine.	Partial recycle	"CTC consumption ratio 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."	*4*
Manufacture of Oxadiazon	CTC	Diluent agent and inert solvent for the chlorination reaction but no details of the production process.	Sixty percent of the CTC consumption results from tail gas emissions, and 30% more is contained in wastewater.	"CTC consumption ratios are about 0.3t/t"	*4*
Manufacture of chloridized N-methylaniline	CTC	See *Manufacture of Buprofenzin* above			*4*
Manufacture of Mefenacet	CTC	Solvent in production of intermediate 1,3-dichloro-benzothiozole; process details not available.	Recycle with two-stage brine condensers.	Make-up quantities are transferred into the atmosphere unless destroyed. Consumption ratio of 0.4~0.7t/t (intermediate)	*4*
Manufacture of 1,3-dichlorobenzothiazole	CTC	See *Manufacture of Mefenacet* above			*4*
Manufacture of Losartan potassium	BCM	Reaction solvent for bromination of mBTT and for subsequent product purification.	Yes, by distillation	Make-up quantities are transferred into the atmosphere unless destroyed. Emission ratio 25%.	*2, 34*

Table B. 2 Activities not Approved under Decisions XV/6 and XV/7

Activity	ODS used	Details of use of process agent	Fate of Process agent		Source of information
			Internal Recycle	Emission	
Manufacture of Sultamicillin	BCM	BCM is a reagent and solvent for the chloromethylation of sulbactam into chloromethylpenicillinate-S,S-dioxide	Excess BCM recovered and recycled by distillation.	BCM appears to be a chemical feedstock in this process, not a process agent.	*35*
Manufacture of Ampicillin	CTC	See *Manufacture of*			*33*
Manufacture of ascorbic acid	CTC	Conversion of L-gulonic acid diketal to L-gulonic acid ethyl ester is performed with hydrogen chloride (HCl) in a mixture of ethanol and CTC		Total usage sent to drain (hence to atmosphere)	*2, 10*
Manufacture of betamethazone phosphate	CTC	Solvent in the production of pyrophosphoryl chloride	Solvent removed and recycled.	Make-up quantities are transferred into the atmosphere unless destroyed.	*33*
Manufacture of Cefaclor®	CTC	See *Manufacture of phenyl glycine* above			*33*
Manufacture of Ceftriaxone®	CTC	Solvent for production of 2-(2-chloroacetamido-4-thiazolyt)-2-	Solvent removed from oily product and recycled (no technical data)	Make-up quantities are transferred into the atmosphere unless destroyed.	*33*

Table B. 2 continued

Activity	ODS used	Details of use of process agent	Fate of Process agent		Source of information
			Internal Recycle	Emission	
Manufacture of Chlorophenesin	CTC	Solvent for chlorination of phenol (intermediate)	Solvent removed and returned to chlorination step.	Make-up quantities are transferred into the atmosphere unless destroyed.	*33*
Manufacture of Ciprofloxacin	CTC	Solvent for the reaction of 1-chloro-4-nitrobenzene with chlorine in the presence of $FeCl_3$ (Korea) or Solvent in the	Recovered, purified and recycled by distillation	In DPR Korea - the mother liquor, a solution of $FeCl_3$ and some chloronitrobenzenes, 'is disposed of'. Otherwise, make-up quantities are transferred into the atmosphere unless destroyed.	*2, 10, 33*
Manufacture of Clotrimazole	CTC	Solvent in chlorination of 2-chlorotoluene	Solvent removed and returned to chlorination step.	Make-up quantities are transferred into the atmosphere unless destroyed.	*33*
Manufacture of Cloxacillin	CTC	Solvent in chlorination of 2-chlorobenzaldehyde oxime (intermediate)	Unspecified solvent recovery	Make-up quantities are transferred into the atmosphere unless destroyed.	*33*
Manufacture of dexamethazone phosphate	CTC	See *Manufacture of betamethazone phosphate* above			*33*
Manufacture of estramustine phosphate	CTC	See *Manufacture of betamethazone phosphate* above			*33*
Manufacture of the herbicide 2,4-D	CTC	Solvent in two chlorination stages and in product purification.	The CTC is recovered and recycled.	Emissions of CTC to the environment take place in each of the process stages.	*2, 37*
Manufacture of the "herbicide" DEHPC. *Actually, the product (diethylhexylperoxycarbonate) is an unstable polymerisation initiator used to make PVC.*	CTC	Solvent in two stages of the process.	Reaction product contains DEHPC dissolved in CTC and this solution is used directly to polymerise PVC. Also emissions of CTC during intermediate stages of the process.	The CTC remains unchanged in the polymer and is released into the environment through the plastic lifetime.	*2, 37*

Table B.2 continued

Activity	ODS used	Details of use of process agent	Fate of Process agent		Source of information
			Internal Recycle	Emission	
Manufacture of isosorbide mononitrate	CTC	Solvent (together with pyridine) in the condensation of	CTC recovered for recycle by distillation.	Make-up quantities are transferred into the atmosphere unless destroyed.	*33*
Manufacture of Ketotifen	CTC	Used as a process solvent in one step of the 18 stage process	No data	Usage between 13 and 21 tons of CTC per ton of ketotifen	*33*
Manufacture of Naproxen	CTC	Solvent in condensation of acetyl chloride with 2-methoxynaphthalene and in subsequent product	Recovered, purified and recycled by distillation	Make-up quantities are transferred into the atmosphere unless destroyed separately by thermal oxidation.	*33*
Manufacture of Norfloxacin	CTC	Solvent for the reaction of 1-chloro-4-nitrobenzene with chlorine in the presence of FeCl3 (Korea) or Solvent in the chlorination of benzoic acid to trichlorobenzoic acid intermediate (more generally used).	Recovered, purified and recycled by distillation	In DPR Korea - the mother liquor, a solution of FeCl3 and some chloronitrobenzenes, 'is disposed of'. Otherwise, make-up quantities are transferred into the atmosphere unless destroyed.	*2, 10, 33*
Manufacture of Omeprazol	CTC	Suspending agent in chlorination of 2-hydroxymethyl-3,5,dimethyl-4-methoxy pyridine (intermediate) using thionyl chloride.	Solid product is removed and solution of thionyl chloride is recycled	Solvent carried on solid product to next stage of process.	*33*
Manufacture of trityl chloride	CTC	Solvent (and reagent) in condensation of benzene with carbon tetrachloride	No data	Make-up quantities are transferred into the atmosphere unless destroyed.	*33*

Table B.2 continued

Activity	ODS used	Details of use of process agent	Fate of Process agent		Source of information
			Internal Recycle	Emission	
Production of the disinfectant sodium dichloroisocyanurate	CTC	Removal of NCl3 from product of chlorination of isocyanuric acid.	The aqueous layer containing the desired product and the CTC layer containing the NCl3 are separated, and the NCl3 is chemically destroyed by reaction with aqueous sodium thiosulfate. The now-clean CTC is returned to the process.	Make-up quantities are transferred into the atmosphere unless destroyed.	*2, 10*
Production of Vinyl Chloride Monomer	CTC	Carbon Tetrachloride (CTC) is added to EDC feed in order to increase the productivity of the cracking furnaces. CTC acts as a free radical chain initiator.	CTC is lost from the process in a light ends stream containing non saturated hydrocarbons	Part of the quantity used can be transferred into the atmosphere unless destroyed.	*39*
Catalyst conditioning and regeneration	CTC	Regeneration of petroleum reforming catalyst	No data	Part of the quantity used can be transferred into the atmosphere unless destroyed.	*38*
Adsorption quality testing of activated carbon	CTC	Measurement of the quantity of CTC adsorbed onto samples	No data	No data	*Response to Questionnaire by Sri Lanka*
Manufacture of carbimazole	CTC	No data	No data	No data	*3*
Manufacture of p-nitrobenzyl bromide	CTC	No data	No data	No data	*3*
Manufacture of benzophenone	CTC	No data	No data	No data	*3*
Manufacture of ethyl-4-chloroacetoacetate	CTC	No data	No data	No data	*3*

Appendix C - Example of Specific Questionnaire for a Country with a National Emissions Reduction Plan

QUESTIONNAIRE TO ASSIST THE FUND SECRETARIAT TO OBTAIN INFORMATION ON THE LEVEL OF EMISSION OF OZONE DEPLETING SUBSTANCES USED AS PROCESS AGENTS

Please return to: A. McCulloch, c/o Secretariat of the Multilateral Fund for the Implementation of the Montreal Protocol

FAX No +1 514 282 0068

by: **28 February 2005**

In the information supplied by **Country** to the Fund Secretariat for the year 2002, consumption of 100 ODP tonnes of CFC-113 and 1000 ODP tonnes of carbon tetrachloride (CTC) was reported as Process Agents.

There are two Tables. The first table covers applications for which process agent use in your country was reported in *Plan for Phaseout of ODS in Chemical Process Agent Applications in Country*. The second table contains other process agent applications adopted by Decisions XV/6 and XV/7 of the Fifteenth Meeting of Parties, plus additional applications not so far approved but known to exist in some countries. Table 2 also has space for reporting other applications.

1. Please update the information for applications reported in project documentation

Table 1

Application	ODS used	Number of approved enterprises in year 2000	Total Quantity of Process Agent		Numbers of enterprises in 2003			
			Consumed in 2003 ODP tonnes	Emitted in 2003 ODP tonnes	Using ODS	Using ODS with emission control technology	Manufacturing but not using ODS	Not manufacturing / closed
Chlorinated Rubber (CR)	CTC	7						
Chlorinated Paraffin (CP70)	CTC	9						
Chlorosulphonated polyolefin (CSM)	CTC	3						
PTFE	CFC-113	5						
Ketotifen	CTC	1						

2. Please indicate how much Process Agent, if any, was used in Country in the following activities:

Table 2

Activity	ODS used	Yes	No	No information	If YES, how much ODS was used in 2003? (ODP tonnes)	If YES, how much ODS was emitted in 2003? (ODP tonnes)
Applications approved by Parties (Decisions XV/6 & XV/7)						
Elimination of nitrogen trichloride in the production of chlorine	CTC					
Recovery of chlorine in tail gas from production of chlorine	CTC					
Manufacture of Endosulphan insecticide	CTC					
Manufacture of isobutyl acetophenone (Ibuprofen analgesic)	CTC					
Manufacture of 1,1-bis (4-chlorophenyl) 2,2,2-trichloroethanol (Dicofol insecticide)	CTC					
Manufacture of polyphenylene terephthalamide (PPTA)	CTC					
Manufacture of fine synthetic polyolefin fibre sheet	CFC-11					
Manufacture of styrene butadiene rubber (SBR)	CTC					
Photochemical synthesis of perfluoropolyether polyperoxide precursors of Z-perfluoropolyethers and difunctional derivatives	CFC-12					
Reduction of perfluoropolyether polyperoxide intermediate for production of perfluoropolyether diesters	CFC-113					
Preparation of perfluoropolyether diols with high functionality	CFC-113					
Manufacture of bromohexine hydrochloride	CTC					
Manufacture of Diclofenac sodium	CTC					
Manufacture of phenyl glycine	CTC					
Manufacture of Cyclodime	CTC					
Manufacture of chlorinated polypropylene	CTC					
Manufacture of chlorinated EVA	CTC					
Manufacture of methyl isocyanate derivatives	CTC					
Manufacture of 3-phenoxybenzaldehyde	CTC					
Manufacture of 2-chloro-5-methylpyridine	CTC					
Manufacture of Imidacloprid	CTC					
Manufacture of Buprofenzin	CTC					
Manufacture of Oxadiazon	CTC					
Manufacture of chloridized N-methylaniline	CTC					
Manufacture of Mefenacet	CTC					
Manufacture of 1,3-dichlorobenzothiazole	CTC					
Bromination of a styrenic polymer	BCM					
Manufacture of Losartan potassium	BCM					

3. Table 2 **Country** continued....

Activity	ODS used	Yes	No	No information	If YES, how much ODS was used in 2003? (ODP tonnes)	If YES, how much ODS was emitted? (ODP tonnes)
Other Process Agent uses (not approved by Parties)						
Manufacture of Sultamicillin	BCM					
Purification of aluminium	CFC-11					
Manufacture of Ampicillin	CTC					
Manufacture of Anticol	CTC					
Manufacture of ascorbic acid	CTC					
Manufacture of betamethazone phosphate	CTC					
Manufacture of Cefaclo®	CTC					
Manufacture of Ceftriaxone®	CTC					
Manufacture of Chlorophenesin	CTC					
Manufacture of Ciprofloxacin	CTC					
Manufacture of Clotrimazole	CTC					
Manufacture of Cloxacillin	CTC					
Manufacture of dexamethazone phosphate	CTC					
Manufacture of Disulfiram	CTC					
Manufacture of estramustine phosphate	CTC					
Manufacture of the herbicide 2,4-D	CTC					
Manufacture of the herbicide DHEPC	CTC					
Manufacture of isosorbide mononitrate	CTC					
Manufacture of Naproxen	CTC					
Manufacture of Norfloxacin	CTC					
Manufacture of Omeprazol	CTC					
Manufacture of Tralomethrine	CTC					
Manufacture of trityl chloride	CTC					
Production of the disinfectant sodium dichloroisocyanurate	CTC					
Other uses, please specify:						

Appendix D - Form of General Questionnaire

QUESTIONNAIRE TO ASSIST THE FUND SECRETARIAT TO OBTAIN INFORMATION ON THE LEVEL OF EMISSION OF OZONE DEPLETING SUBSTANCES USED AS PROCESS AGENTS

Please return to: A. McCulloch, c/o Secretariat of the Multilateral Fund for the Implementation of the Montreal Protocol
FAX No +1 514 282 0068
by: **28 February 2005**

In the information supplied by **Country** to the Multilateral Fund Secretariat and/or to the Ozone Secretariat for the year 2003, consumption of 1000 ODP tonnes of carbon tetrachloride (CTC) was reported in the solvent sector.

1. Please confirm that the above consumption of controlled substance was in the solvent sector and not as process agent.

	YES
	NO

2. Please confirm that NO additional amounts of controlled substances were used as process agents.

	YES, no additional amounts were used as process agents.
	NO, there are additional amounts used as process agents.

3. If your answers to questions 1 and 2 are both YES, you do not need to continue the questionnaire and you should return it now. Otherwise, please continue with questions 4 and 5 below.
4. If controlled substances were used in **Country** as process agents please indicate whether any of the following activities took place (List of uses of controlled substances as process agents adopted by Decisions XV/6 and XV/7 of the Fifteenth Meeting of Parties).

Table 1

Activity	ODS used	Yes	No	No information	If YES, how much ODS was used in 2003? (ODP tonnes)	If YES, how much ODS was emitted in 2003? (ODP tonnes)
Elimination of nitrogen trichloride in the production of chlorine	CTC					
Recovery of chlorine in tail gas from production of chlorine	CTC					
Manufacture of chlorinated rubber	CTC					
Manufacture of Endosulphan insecticide	CTC					
Manufacture of isobutyl acetophenone (Ibuprofen analgesic)	CTC					
Manufacture of 1,1-bis (4-chlorophenyl) 2,2,2-trichloroethanol (Dicofol insecticide)	CTC					
Manufacture of chlorosulphonated polyolefin (CSM)	CTC					
Manufacture of polyphenylene terephthalamide (PPTA)	CTC					
Manufacture of fluoropolymer resins	CFC-113					
Manufacture of fine synthetic polyolefin fibre sheet	CFC-11					
Manufacture of styrene butadiene rubber (SBR)	CTC					
Manufacture of chlorinated paraffin	CTC					
Photochemical synthesis of perfluoropolyether polyperoxide precursors of Z-perfluoropolyethers and difunctional derivatives	CFC-12					
Reduction of perfluoropolyether polyperoxide intermediate for production of perfluoropolyether diesters	CFC-113					
Preparation of perfluoropolyether diols with high functionality	CFC-113					
Manufacture of bromohexine hydrochloride	CTC					
Manufacture of Diclofenac sodium	CTC					
Manufacture of phenyl glycine	CTC					
Manufacture of Cyclodime	CTC					
Manufacture of chlorinated polypropylene	CTC					
Manufacture of chlorinated EVA	CTC					
Manufacture of methyl isocyanate derivatives	CTC					
Manufacture of 3-phenoxybenzaldehyde	CTC					
Manufacture of 2-chloro-5-methylpyridine	CTC					
Manufacture of Imidacloprid	CTC					
Manufacture of Buprofenzin	CTC					
Manufacture of Oxadiazon	CTC					
Manufacture of chloridized N-methylaniline	CTC					
Manufacture of Mefenacet	CTC					
Manufacture of 1,3-dichlorobenzothiazole	CTC					
Bromination of a styrenic polymer	BCM					
Manufacture of Losartan potassium	BCM					

5. Please indicate whether <u>any other</u> processes involving controlled substances as process agents not included in Table 1 above take place in **Country**.

Table 2

Activity	ODS used	Yes	No	No information	If YES, how much ODS was used in 2003? (ODP tonnes)	If YES, how much ODS was emitted? (ODP tonnes)
Manufacture of Sultamicillin	BCM					
Purification of aluminium	CFC-11					
Manufacture of Ampicillin	CTC					
Manufacture of Anticol	CTC					
Manufacture of ascorbic acid	CTC					
Manufacture of betamethazone phosphate	CTC					
Manufacture of Cefaclo®	CTC					
Manufacture of Ceftriaxone®	CTC					
Manufacture of Chlorophenesin	CTC					
Manufacture of Ciprofloxacin	CTC					
Manufacture of Clotrimazole	CTC					
Manufacture of Cloxacillin	CTC					
Manufacture of dexamethazone phosphate	CTC					
Manufacture of Disulfiram	CTC					
Manufacture of estramustine phosphate	CTC					
Manufacture of the herbicide 2,4-D	CTC					
Manufacture of the herbicide DHEPC	CTC					
Manufacture of isosorbide mononitrate	CTC					
Manufacture of Ketotifen	CTC					
Manufacture of Naproxen	CTC					
Manufacture of Norfloxacin	CTC					
Manufacture of Omeprazol	CTC					
Manufacture of Tralomethrine	CTC					
Manufacture of trityl chloride	CTC					
Production of the disinfectant sodium dichloroisocyanurate	CTC					
Other uses, please specify:						

Annex II

Table 1: Consumption in process agent applications

	Total of individually denominated process agent uses (in ODP tonnes)		Process agent consumption officially reported to the Fund Secretariat in country programme data (in ODP tonnes)		
	Applications approved by the Parties	Other potential process agent applications	2001	2002	2003
CTC					
Brazil		68.4		35.2	68.4
China	10,485.0	13.0	3,434.8	2,744.4	20,014.4
Colombia	2.8		-	0.9	-
India	1,866.0	402.0	6,912.4	2,065.8	
Korea, DPR	202.0	229.9	753.5	753.5	731.5
Pakistan		88.0	88.0	88.0	88.0
Romania		173.0	71.9	196.9	157.3
Sri Lanka		16.7	21.5	29.1	16.7
Sudan			-	-	1.1
Total CTC	**12,555.8**	**990.9**	**11,282.1**	**5,913.9**	**21,077.3**
CFC-11					
Egypt			65.0	60.0	51.0
Total CFC-11			**65.0**	**60.0**	**51.0**
CFC-113					
China	40.0		-	95.5	21.4
India			-	29.5	
Mexico			-	57.0	33.0
Total CFC-13	**40.0**	**-**	**-**	**182.0**	**54.4**
BCM					
Argentina					2.4
Turkey		12.0	-	-	8.8
Total BCM	**-**	**12.0**	**-**	**-**	**11.2**
TOTAL ODS	**12,595.8**	**1,002.9**	**11,347.1**	**6,155.8**	**21,193.9**
Notes:					
Argentina	In its reply to the questionnaires Argentina advised that BCM is not longer used for the production of losartan potassium.				
Egypt	In a communication by the Ozone Officer of 23 February 2005, it is stated that the company has stopped using CFC-12 as a process agent.				
Mexico	The reported consumption of CFC-113 was mis-assigned to the process agent sector instead of the solvent sector.				

Annex III

Decision 27/78: Process agents: implementation of decision X/14 (paragraphs 3, 5, and 6) of the Tenth Meeting of the Parties

"Having taken note of the comments and recommendations of the Sub-Committee on Project Review (UNEP/OzL.Pro/ExCom/27/13, paras. 122-126), including the draft Framework Guidelines/Broad Principles for Process Agent Projects proposed by the Sub-Committee for adoption by the Executive Committee (UNEP/OzL.Pro/ExCom/27/13, para. 124), the Executive Committee decided:

(a) That initial implementation of decision X/14 could proceed using the parallel approach outlined in document UNEP/OzL.Pro/ExCom/27/40;

(b) To adopt the draft Framework Guidelines/Broad Principles for Process Agent Projects proposed by the Sub-Committee on Project Review, as contained in Annex III to the present report; *(reproduced below)*

(c) That, on the basis of the broad principles that have been agreed, Implementing Agencies could submit a limited number of projects conforming to the agreed broad principles, for consideration at the Twenty-eighth Meeting;

(d) To note, as additional projects were considered and approved, a body of information on cost-effectiveness, emissions limits, and other requirements concerning eligibility and the determination of incremental costs would emerge. This information could form the basis for the Executive Committee to report to the Parties on emissions limits (for the purposes of administering Decision X/14) and for the possible development at a later stage of more detailed guidelines for each of the process agent applications listed in the decision."

Framework guidelines/broad principles for process agent projects

General principles

1. In conjunction with their first project, countries must provide a thorough sector overview containing all enterprises, stating all consumption and emissions figures and indicating those enterprises for which the country intends to seek compensation from the Multilateral Fund. The country should indicate whether the relevant consumption information has been submitted as part of its Article 7 consumption reports, and if not, its intentions and progress in this regard.

2. For the purpose of project submissions, consumption at the enterprise level is the quantity of process agent in ODP tonnes used annually by the enterprise as 'make-up' in the relevant process. Information on the amount of ODS contained in the process equipment should be included with the project submission.

3. To permit adequate consideration of the industrial rationalisation option, a project proposal should cover all the production facilities in the country for the particular application under consideration.

4. Project proposals should be prepared consistent with all existing policies and guidelines of the Executive Committee. In particular, new-for-old plant replacement and technological upgrade need to be taken into account in accordance with decisions 18/25 and 26/37.

5. Initial projects will be considered for the applications listed in Table A of decision X/14 in order to provide information on reasonably achievable emissions reductions and associated costs.

6. The projects should indicate which applicable measures are proposed to control emissions (e.g. emissions control technologies, process conversion, plant rationalisation or closure) the cost-effectiveness and the emissions reductions which can be achieved.

7. Where either emissions controls or process changes are proposed, the project submission must include an evaluation of the incremental costs of achieving significant levels of emissions reductions by each technique.

8. The cost-effectiveness of process agent projects will initially be considered on a case-by-case basis to provide a body of information which can be a basis for the establishment of appropriate cost-effectiveness thresholds in due course.

Annex IV

Process agent phase-out projects approved by the Executive Committee

Country	Agency	Project Title	ODP To Be Phased Out	Date Approved	Total Funds Approved
Individual projectst					
India	IBRD	Phase-out of use of carbon tetrachloride as process agent in the production of endosulphan by Excel Industries Limited	375.0	Jul-99	366,000
India	UNIDO	Conversion of carbon tetrachloride as process solvent to ethylene dichloride at Satya Deeptha Pharmaceuticals Ltd., Humnabad	27.9	Dec-00	260,133
India	UNIDO	Conversion of carbon tetrachloride as process solvent to trichloromethane at M/S Alpha Drugs India Ltd., Patiala	69.7	Dec-00	145,505
India	UNIDO	Conversion of carbon tetrachloride as process solvent to ethylene dichloride at Svis Labs Ltd., Ranipet	54.2	Dec-00	249,463
India	UNIDO	Conversion of carbon tetrachloride as process solvent to ethylene dichloride at Doctors Organic Chemicals Ltd., Tanuku	94.6	Dec-00	288,180
India	UNIDO	Conversion of carbon tetrachloride as process agent to monochlorobenzene at M/S Benzo Chemical Industries, Tarapore	23.0	Jul-01	136,786
India	UNIDO	Conversion of carbon tetrachloride as process agent to monochlorobenzene at Pradeep Shetye Ltd., Alibagh	133.9	Jul-01	279,001
India	UNIDO	Conversion of carbon tetrachloride as process agent to ethylene dichloride at Chiplun Fine Chemicals Ltd., Ratnagiri	16.7	Jul-01	155,830
India	UNIDO	Conversion of carbon tetrachloride as process agent to monochlorobenzene at FDC Limited, Roha	34.1	Jul-01	238,371
India	UNIDO	Conversion of carbon tetrachloride as process agent to monochlorobenzene at GRD Chemicals Ltd., Indore, M.P.	17.9	Jul-01	127,667
India	IBRD	Conversion of chlorinated rubber manufacture from carbon tetrachloride to non-ODS process at Rishiroop Organics Pvt. Ltd.	248.8	Jul-01	2,074,300
India	UNIDO	Conversion of carbon tetrachloride as process agent to cyclohexane at Amoli Organics Limited, Mumbai	38.5	Dec-01	385,367
Pakistan	UNIDO	Conversion of carbon tetrachloride as process solvent to 1,2-dichloroethane at Himont Chemicals Ltd.	80.0	Dec-01	485,701
Sector plans					
China	IBRD	Phase out the production and consumption of CTC for process agent and other non-identified uses (phase I)		Nov 02	65,000,000
India	IBRD/France/ Germany/ Japan	CTC phase-out plan for the consumption and production sectors		Jul-03	52,000,000
Korea, D.P.R.	UNIDO	Plan for terminal phase-out of CTC		Dec-03	5,684,844