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EXECUTIVE COMMITTEE OF  
THE MULTILATERAL FUND FOR THE  
IMPLEMENTATION OF THE MONTREAL PROTOCOL  
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**STRATEGY PLAN OF ODS PHASE-OUT FROM PRODUCTION OF EXTRUDED  
POLYETHYLENE AND POLYSTYRENE FOAMS SUB-SECTOR IN CHINA**  
(Submitted by UNIDO on behalf of the Government of China)

## PART I

### SECRETARIAT'S COMMENTS AND RECOMMENDATIONS

1. In Decision 28/46 the Executive Committee considered a strategy plan of ODS phase-out from production of extruded polyethylene and polystyrene foam sub-sectors of China. The Committee requested UNIDO to refine the strategy. In the revised strategy the total capacity of the enterprises for which funding for conversion would be sought would correspond to the existing level of production in the sub sector indicated in the strategy, including those projects already approved.
2. The Executive Committee considered the strategy again at its 29<sup>th</sup> Meeting and requested UNIDO to carry out further work in conjunction with the Secretariat in order to demonstrate that the strategy complies with Decision 28/46 and to refine the project to eliminate references to Decision 25/50 which was not applicable, and to report back to the 30<sup>th</sup> Meeting (Decision 29/64).
3. UNIDO undertook work on the strategy plan and the Secretariat provided comments and input prior to the 30<sup>th</sup> and 32<sup>nd</sup> meetings. The level of rationalisation undertaken in the sub-sector, as indicated in the tables provided in the Executive Summary, would appear to meet the requirements of Decision 28/46. The strategy now makes no reference to Decision 25/50.
4. Subject to its deliberation as appropriate, the Executive Committee may wish to take note of the strategy plan of ODS phase-out from production of extruded polyethylene and polystyrene foam sub-sectors of China, with the understanding that:
  - (a) this does not denote approval of the projects and associated costs identified in the strategy plan and;
  - (b) the identified projects may be submitted to the Executive Committee for consideration, consistent with the rules and policies of the Fund extant at the time.

## **PART II**

### **STRATEGY PLAN OF ODS PHASE-OUT FROM PRODUCTION OF EXTRUDED POLYETHYLENE AND POLYSTYRENE FOAMS SUB-SECTOR IN CHINA**

(Submitted by UNIDO on behalf of the Government of China)

(EXECUTIVE SUMMARY)

**State Environmental Protection Administration  
The People's Republic of China**

**Strategy Plan of ODS Phase-Out from Production of  
Extruded Polyethylene and Polystyrene Foams  
Sub-sector of China**

**Executive Summary**

**32nd meeting of the Executive Committee of the Multilateral Fund for the  
Implementation of the Montreal Protocol**

**Beijing 2000**

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## Executive Summary

The Strategy Plan of ODS phase-out from production of extruded polyethylene (EPE) and extruded polystyrene (EPS) foams sub-sectors of China is designed to facilitate planning, formulation and implementation of investment projects for replacement of CFC-12 by butane for this sub-sector in a timely and cost-effective manner.

1. The **sectoral background information** reflected in the Strategy Plan was provided by SEPA based on the latest data collected by the national bodies concerned as an integral part of the relevant information and data collected for the preparation of the updated 1999 Country Programme, which is currently under consideration of the Executive Committee.
2. Implementation of the Montreal Protocol by the country is considering as an integrated part of the national industrial development programme related in particular to the rationalization of SME industrial sectors. As a part of this programme realization the sub-sectors of EPE packaging nets and EPS products manufacturing using CFC-12 have already been significantly restructured during 1998-2000.

The summary table below shows that the number of enterprises as well as the number of CFC-12 based production lines has been reduced through closure or consolidation of selected factories and destruction or conversion of extrusion lines.

**In the EPE production sub-sector** 45 mostly ineffective enterprises with 69 production lines (out of total 75 remaining enterprises with 130 lines) during 1999-2000 have been requested to stop production without any financial support. However the production level by the remaining rationalized 30 factories with 61 lines increased from 1640 Mt in 1998 to 3240 Mt in order to meet to the growing market demands by the agriculture sector. Further reduction of the number of enterprises (at least for 4 factories) as well as the reduction the number of extrusion lines (min. for 5 units) is foreseen by the proposed terminal EPE project.

**In the EPS production sub-sector** during this period of time 35 factories with 53 production lines (out of 55 remaining factories with total 82 extrusion lines) have also been requested to stop production without any financial support. As result the production level of the sub-sector has dropped for almost 50% in comparison to 1998. Further reduction of the number of enterprises (at least for 3 factories) as well as the reduction the number of extrusion lines (min. for 3 units) is foreseen by the proposed two EPS projects.

In view of the above described developments only remaining enterprises of both restructured sub-sectors have been selected for the conversion under the respective group and terminal umbrella projects, using financing of the Multilateral fund.

Taking into consideration that both sub-sectors have already been significantly restructured and rationalized recently without any external financial support, only minor additional industrial rationalization of the enterprises included in the proposed projects described in the Strategy Plan is expected.

The **background information and baseline data** required for preparation of the Strategy Plan for individual group projects formulation were provided by SEPA based on the technical inspection and general audits of each factory in accordance with the methodology described in the Strategy Plan, verified by UNIDO consultants and a specialized working group of SEPA and then officially endorsed by SEPA before submission to the Multilateral Fund Secretariat.

3. The main based line data and parameters used for elaboration of the proposed individual group and terminal projects are as follows:
  - a. average annual CFC-12 consumption during 1997-1999 by individual enterprises (established based on the purchase orders and invoices provided by the end-users and verified by the consultants and SEPA experts);
  - b. number of extrusion lines in operation at the selected enterprises and actual total production capacity (established based on the technical inspections of the enterprises before taking decision on the actual number of extrusion lines subject for conversion);
  - c. actual annual level of foams production by the selected enterprises (as average during 1997-1999);
  - d. current operation practice of enterprises of each group project (number of working days per year, number of shifts per day, total number of working hours per year).

<b>EPE Subsector</b>	<b>Before rationalization/ conversion</b>	<b>After rationalization/ conversion</b>
No. of enterprises	134	85
No. of production lines	245	164
Average annual CFC-12 consumption 1997-1999, Mt	3,156	not applicable
Average annual level of production 1997-1999 (tonnes of foam products )	12,268	11,770 (based on current production practice) <i>Note : market demands approx. 13,400 t incl. 7-10% increase)</i>
Production Capacity (tonnes per year)	12,700	12,200
Production practice	3 shifts/day June – October 2 shifts/day April – May; Nov 1 shift/day Feb - March; Dec No production Jan (approx. 40% of production lines)	To be changed to enable production requirements to be met with lower level of capacity

<b>EPS Subsector</b>	<b>Before rationalization/ conversion</b>	<b>After rationalization/ conversion</b>
No. of enterprises	73	35
No. of production lines	118	62
Average annual CFC-12 consumption 1997-1999, Mt	4,180	not applicable
Average annual level of production 1997-1999 (tonnes of foam products )	20,300	10,930 (based on current production practice) <i>Note : market demands 21300 t incl. 5-7% increase)</i>
Production Capacity (tonnes per year)	20,850	11,300
Production practice	3 shifts/day not applicable 2 shifts/day May - October 1 shift/day Jan – April; Nov – Dec No production not applicable	To be changed and rationalized to enable production requirements to be met with lower level of capacity

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The above considerations are consistent with the requirements of the Decisions 28/46 and 29/64

4. The **cost of the individual projects** included in the Strategy Plan have been estimated based on the technical and commercial data of similar projects approved for China recently.

The incremental capital cost of the group projects was estimated based on the incremental capital cost of conversion of individual enterprises.

The incremental operating savings have been calculated based on the differences in consumption and prices between CFC-11 and butane and then deducted from the estimated incremental capital cost.

*Note:*

*a. The lists and base line data for each group of factories to be included in the group or terminal projects will also be updated before the projects' formulation and submission.*

*b. The projects' budgets included in the document will be re-estimated on a project by project basis in light of the relevant developments, decisions and guidance documents to be available before submission*

5. **Cost-effectiveness of EPE/EPS projects.** The replacement of CFC-12 by butane results in incremental operating savings, which are deducted from the estimated projects' budgets. Since the factories involved in the proposed group projects have relatively low CFC-12 consumption, the incremental operating savings are also lower in comparison with the larger CFC-12 consuming enterprises in this sector. Consequently, the cost-effectiveness of these projects is in the range of 3.9 – 8.2 US\$/kg ODP.

6. The proposed Strategy Plan includes the following **investment projects**:

6.1. 1<sup>st</sup> EPE group project to phase out of 1,146 MT of CFC-12 from 25 enterprises with 46 extrusion lines approved by 25<sup>th</sup> ExCom

- planned completion time - end year 2000
- approved project budget - US\$ 4,488,516
- cost-effectiveness – 3.92 US\$/kg

6.2. 2<sup>nd</sup> EPE group project to phase out of 825,7 MT of CFC-12 from 27 enterprises with 47 extrusion lines approved by 28<sup>th</sup> ExCom

- planned completion time - end year 2001
- approved project budget - US\$5,289,441
- cost-effectiveness – 6.43 US\$/kg



6.3. Terminal umbrella EPE project to phase 810 MT of CFC-12 from 30 factories with 61 extrusion lines.

- planned submission time - mid year 2001
- planned completion time - mid year 2003
- estimated project budget - US\$ 5.9 million
- estimated cost-effectiveness – 7.38 US\$/kg

6.4. 1<sup>st</sup> EPS group project to phase out 686 MT of CFC-12 from 12 enterprises with 19 extrusion lines.

- planned submission time - end year 2001
- planned completion time - mid year 2003
- estimated project budget: US\$ 2.9 million
- estimated cost-effectiveness: 4.22 US\$/kg

6.5. Terminal EPS umbrella project to phase out 332 MT of CFC-12 from 8 enterprises with 10 extrusion lines.

- planned submission time - mid year 2002
- planned completion time - mid year 2004
- estimated project budget - US\$ 1.6 million
- estimated cost-effectiveness – 4.77 US\$/kg

7. In light of the Decision 28/46 and Decision 29/64, the following measures are foreseen by the Strategy Plan:

- a. Reduction of the total number of the enterprises within the group through closure of selected enterprises and relocation of their extrusion lines (without reduction of the total number) to the selected more technically and financially strong and better managed enterprises and to maintain the previous total production capacity of the group by the enlarged enterprises;
- b. Reduction of the total number of the enterprises or/and the total number of extrusion lines of the group through closure of the selected enterprises, reduction of the number of extruders to optimise and balance the production capacity of the individual factories and enlargement of the selected enterprises through relocation of extruders from the factories to be closed.

It is obvious that practical implementation of the above described concepts of industrial rationalization (especially the procedure of closure of enterprises) should be done in accordance with the local environmental regulatory system and legislation. Such legislation should consist of not only the environmental restrictions but also the measures and possibilities of financial and social compensation and assistance from the Government to motivate the public and private sectors to introduce advanced environment friendly technologies.

At the same time the actual market demands for CFC-free extruded PE/PS foam products as it is indicated in the table above have also to be satisfied.

In view of the above mentioned considerations, SEPA in cooperation with the relevant national agencies and organizations concerned will as well as with the project beneficiaries will elaborate a fund mobilization system to cover the above mentioned additional costs associated with the industrial rationalization and not included in the group project budgets.

8. Taking into consideration that all the ongoing and proposed pipeline projects of the EPE/EPs sector will be completed by the end year 2004 resulting phasing out of 3,200 Mt ODP, it will greatly assist the country to achieve the 2005 reduction target.

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The People's Republic of China**

**Strategy Plan of ODS phase-out from Production of  
Extruded Polyethylene and Polystyrene Foams  
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## Introduction

The Strategy Plan is prepared by the State Environmental Protection Administration of China in co-operation with the State Light Industry Bureau and other national agencies concerned as well as with the relevant implementing agencies in accordance with the Decisions 25/3, 28/46 and 29/64 of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol.

### 1. Background

The Chinese government has approved the "China Country Programme for Phase out of Ozone Depleting Substances (ODS)" in 1993, which marked the beginning of the government's actions on phasing out of ODS by using the grants from the Multilateral Fund. In order to reflect the main tendencies and to provide the actual information and data on the production, application and phase-out of the ODSs by the different industrial sectors of the country within the period of 1993-1999 and to highlight the future strategy plan of action for the complete ODSs phase-out, the Country Programme was updated in 1999, which is presently under the consideration by the Executive Committee. As for the sector of the expanded polymer foams is concerned, the ODS Project Management Office of SEPA and the China Plastics Industry Association have established a specialized working group (SWG) with the task to carry out an in depth inventory of the sector and its sub-sectors and to assist SEPA and the implementing agencies to elaborate a PE/PS sub sectoral strategy plan and a work programme for the ODSs phase-out.

The Chinese foam industry consumed 23,853 tons of CFCs in 1997 (China Country Programme, 1999). CFC-11 was the dominant substance (17,192t), followed by CFC-12 (6,661t). Production is divided between larger state-owned enterprises and smaller township or private enterprises. Production and process information from state enterprises is well documented. However, information on the rest of the industry is less reliable. More detailed information about the sector is provided in the following table:

Table 1. Production of Foam and Consumption of ODS in 1997

<b>CATEGORIES</b>	<b>ODS (T)</b>	<b>PRODUCTION (T)</b>
Extruded PS/PE	6,661	50,000
Flexible Polyurethane	6,340	140,000
Rigid Polyurethane	10,852	70,000
<b>TOTAL</b>	<b>23,853</b>	<b>260,000</b>

The State Environmental Protection Administration and the State Light Industry Bureau are agencies coordinating ODS phase out in foam industry. They plan to phase out the use of ODS in extruded PS/PE by 2004 and phase out the use of ODS in polyurethane by 2010.

Table 2, 3 and 4 show total amount of ODS phase out target of approved MLF projects and net ODS consumption left in the foam sector. China's Ozone Leading Group provided the following information, which was presented in the County Programme Update (prepared end-1999)

Table 2. ODS Phases-out Target of Approved Projects  
(including approvals by the 28<sup>th</sup> Excom, July 1999)

Sub-sector	ODS type	Number of Enterprises	Phase-out target, MT	Funds approved US\$
PE	CFC-12	59	2,661	12,936,067
PS		18	2,310	7,680,667

Table 3. Net ODS Consumption left in the EPE/PS Foam Sector  
(Including approvals by the 28<sup>th</sup> ExCom, July 1999)

CFCs	Consumption <sup>1</sup> Mt			Phase out Target of Approved Project <sup>2</sup> Mt	Project Impact by the end of 1999 <sup>3</sup> Mt	Net ODS consumption Left in the foam sector <sup>4</sup> Mt
	1997	1998	1999			
CFC-12	6,661	6,663	3,981	4,972	2,819	1,828

1. Date collected from County Program Update (3,981 has already included project impact of 2,819 tons);
2. Date collected from projects up to 28<sup>th</sup> ExCom ;
3. Date collected from projects claimed completed by government;
4. Net consumption of ODS for new MLF project =3.981- (4,972-2,819)

Table 4. Breakdown of ODS consumption by remaining enterprises

Sub-sector	ODS type	Remaining enterprises	Remaining ODS consumption, MT
PE	CFC-12	29	810
PS		20	1,018

## 2. Description of the PE/PS foams sub-sectors

Although in the Decision 25/34 the polystyrene/polyethylene sub-sectors are defined as one sub-sector, on practice the sub-sector is operating as two different sub-sectors: extruded polyethylene (EPE) and extruded polystyrene (EPS) foams due to the following reasons:

- different design of extruders, (different design of screws and extrusion dies) and therefore different cost of retrofitting;
- different outputs (capacities) of extruders and CFC-12 consumption (much higher at the EPS foams factories);
- different products, applications and market:
  - EPS insulation boards for construction and sheets for food packaging;
  - EPE packaging nets for the agricultural products;

- different government policy and regulations for agro-related and other sectors of economy.

Therefore, at the actual conditions of China, the Government strategy has been prepared with the concept to address the sub-sectors separately by the Separate groups and terminal umbrella projects as it was recommended by the 28<sup>th</sup> meeting of the ExCom.

## **2.1. Sub-sector of the EPE foam production**

Originally, the sub-sector was mainly dealing with manufacture of the PE packaging nets for the agricultural products as well as for fragile industrial products. Now EPE foam sheet production is increasing fast because of changes of market demands. The nets producing factories are located in the countryside in different provinces in order to be closer to the customers.

The total number of enterprises operating in this sub-sector is 204, including 70 factories established after July 1995 are not covered by the Strategy Plan for the financial assistance of the Multilateral Fund. These new factories are equipped with the extruders operating with butane and only 3 extrusion lines originally at some of new factories (out of 70) were operating with CFC-12 during 1996-1998 using in total average 50 Mt of CFC-12. Recently, these 3 lines have been converted to the butane blowing technology also. All other 67 new factories were originally based on the butane blowing process.

There are 7 factories which have been converted before 1998 under the MLF projects; 52 factories are being converted under two approved group project (see table 2); 45 factories with 69 extrusion lines have been requested to stop manufacture because of their low efficiency, market problem or other reasons; 30 factories with 61 extrusion lines are subject for conversion under a proposed terminal EPE umbrella project (see Annex 1). The EPE factories are mainly equipped with three types of the single screw extruders with the foam output of 25 kg/h, 14 kg/h and 10-12kg/h respectively.

The factories of the sub-sector are operating in three-, two- or in one shift depending upon the market demands. In peak season most of the factories operating in three shifts, in the spring and autumn season – in two or one shift. During January only approx. 60% factories are in production to meet the marked demands for packaging of agriculture products at storage places.

## **2.2. Sub-sector of the EPS sheets and insulation boards manufacture**

The sub-sector is mainly dealing with manufacture of the PS sheets for subsequent thermofoaming for application of fresh and fast food packaging as well as with production of PS insulation boards for application in construction as well as for other industrial and domestic insulation applications. The total number of the enterprises operating in this sub-sector is 73 and all of them have been established in the period 1992 - 1994; there are no new factories established after July 1995. Among them, 16 factories have been converted before 1999 under the MLF projects, 2 factories are being converted (see table 2), 35 factories with 53 extrusion lines have been requested to stop manufacture because of their low efficiency, market problem or other reasons. 20 factories with 29 extrusion lines are proposed for conversion under group project and a terminal umbrella project (see Annex 2).

The factories are located in the industrial zones of the country and are equipped with two series connected single screw extrusion lines (imported and locally made) with output of 50 kg/h.

These factories are in operation in two shifts from May to November; the rest of the year – in one shift.

The updated CFC-12 consumption data by the EPE/EPS sub-sector are summarized in Table 5.

*Note: Consumption of CFC-12 by the sub-sector did not grow after year 1997. Therefore the baseline data used for the Strategy Plan is 6.661 Mt ODP for 1997.*

Table 5. Consumption of CFC-12 by the EPE/EPS section

Sub-sector	Actual consumption Mt		Phaseout target approved by the end of 1999 Mt		Remaining consumption for submission after 1999
	1997	1999	Total	Impact	
1	2	3	4	5	6
EPE	2,621	2,782	2,662	690	810
EPS	4,040	1,199	2,310	2,129	1,018
Total	6,661	3,981	4,972	2,819	1,828

1. CFC-12 consumption allocation by sub-sectors based on the Country Programme up-date (1999);
2. Actual CFC-12 consumption of the sub-sector based on enterprise investigation (1999);
3. Total approved tonnage by July 2000 (including 28<sup>th</sup> meeting of the Excom);
4. Data collected from projects claimed completed by government
5. Actual CFC-12 consumption by the sub-sector based on enterprise investigation (1999);
6. The consumption increase in EPE sub-sector (column3-column2=161) from 1997 to 1999 is caused by the natural increase of EPE foam production.
7. The consumption decrease in EPS sub-sector (column3-column2) from 1997 to 1999 is caused by self-conversion or production suspension.

### 3. Methodology and criteria for selection of enterprises

- 3.1. On the request and guidance of SEPA, the China Plastic Industry Association had carried out an in-depth inventory exercise of the EPE and EPS sub-sectors in 1997-1999 and the complete list of the enterprises operating in these sub-sector was prepared.
- 3.2. Under the overall coordination of SEPA, the inventory list of EPE/EPS enterprises was reviewed by the implementing agencies in cooperation with SEPA consultants and the priority lists of factories as candidates for the projects were established.



- 3.3. The pre-selected factories are requested to fill in a relevant questionnaire to be submitted to SEPA for the evaluation. Pre-selected factories should, inter alia, to provide the following information:
- date of establishment;
  - ownership status;
  - breakdown of CFC-12 and other chemicals consumption for the last three years;
  - describe the baseline equipment, names of the original manufacturers and year of purchase;
  - describe the current production programme and the market opportunities;
  - made statements about stability and financial capacity and readiness for the eventual cost-sharing of the conversion etc.
- 3.4. Based on the submitted questionnaire, a tentative list of the enterprises - candidates for the individual or group projects is being established and SEPA, on behalf of the Government, is taking decision regarding the projects distribution among the implementing agencies.
- 3.5. The project(s) formulation starts from a visit of the national or international consultant(s) to the selected enterprises in order to verify the main data and information of the questionnaire and to collect the additional information required for the project(s) formulation. The enterprises have to present the evidence documents to confirm (prove) the information provided in their questionnaire. In case the presented documents are not sufficient or incomplete, an enterprise - candidate might be tentatively excluded from the short list.
- 3.6. The consultants are obliged to brief the selected enterprises about the advantages and disadvantages of the available alternative technology options, basic rules and regulations of the Multilateral Fund as well as the relevant implementation procedures and the national environmental policies and legislation.
- 3.7. The project documents, prepared by the implementing agencies in line with the respective format, criteria, rules and regulations as well as the relevant Decisions of the Excom are subject for SEPA endorsement prior submission to the MLF Secretariat.

#### **4. Selection of alternative blowing technology**

There are several options to replace CFC-12 in the production of EPE/EPS foam, such as:

- Atmospheric gases and their blends
- Hydrocarbons, including LPG
- HCFCs
- HFCs
- CO<sub>2</sub>/butane blend

##### **Atmospheric gases and their blends**

**Nitrogen** gas is inert, non-toxic and non-combustible, but asphyxiate. The use is becomes difficult because of its low solubility in the polymer and the increase in mix viscosity which may be too high from any extrudes. The final products have a relatively high density. New polymer developments may make the use of nitrogen a more viable option in the future.

**Berstorff Technology** is based on a mixture of nitrogen and alcohol. This technology exhibits undefined risks in toxicity and fire. The resulting product has also a high density.

**Carbon dioxide** gas is an asphyxiate, high energy consuming and moderately toxic gas. Carbon dioxide as con-agent is a proven technology. The process using CO<sub>2</sub> alone in EPE foam net production is patented and therefore require licensing. Further, carbon dioxide diffusion rates are also too fast to avoid massive shrinkage. It is viable for higher density foams and therefore is not suitable for the current application.

### **Hydrocarbons including LPG**

**N-pentane, butane, isopentane, isobutane and their mixtures** are proven replacements to CFCs. The technology is cost effective and results in a product of acceptable quality. However, the flammability of hydrocarbons can cause a problem both in the manufacturing processes. Stringent safety precautions in the manufacturing processes are required.

**Liquefied petroleum gas (LPG)** has also been proposed as replacement for CFC-12 in polyethylene (PE), polypropylene (PP) and polystyrene (PS) foam industry. LPG is however toxic, flammable and not generally accepted for food packaging. If LPG is to be used, it should be purified/deodorized by using molecular sieves and a buffer agent for boiling point stabilization should be added.

### **Hydro chlorofluorocarbons (HCFCs)**

**HCFC-22** is non-flammable, low in toxicity, thermally and chemically stable, and has been proven effective. This substance has however an ozone depleting potential (ODP), and only qualifies as an interim replacement **HCFC-142b** can be used alone or in combination with HCFC-22 to reduce the flammability. The price penalty is however considerable and equipment has to be modified to cope with the moderately flammable substance and the modified diffusivity of the compound.

### **Hydro fluorocarbons (HFCs)**

**HFC-134a** is non-flammable, low in toxicity and has zero ODP. The current pricing will prevent utilization in the very cost sensitive food serving and packaging applications. The utilization of HFC-134a in foam competes with the utilization as a refrigerant in appliances and automotive air conditioners. **HFC-152a** is low in toxicity, moderately flammable and possesses zero ODP. It has rather high cost and its flammable nature requires modification of production equipment.

All the enterprises of the EPE and EPS sub-sectors to be covered by this document have selected to use butane to replace CFC-12 in the conversion.

Reasons for the selection are:

- Proven technology in processing and product performance
- Environmentally acceptable
- Acceptable toxicity
- Adaptable to the existing equipment

- Cost-effective
- Available in China in bulk delivery.

A draw back of butane is its high flammability, requiring very stringent safety precautions.

### **Safety Concept**

In accordance with the common practice and standard for conversion and operation at the EPE /EPS plants using a hydrocarbon blowing technology, the following safety related issues should be taken into consideration:

- approximately 60% of the blowing agent (butane) is emitted into the atmosphere during the extrusion process at the crossover section;
- one of the most hazardous zone is around at the die head due to the high emission of butane at this unit;
- due to the high probability of the polymer blocking inside the extruder (solidification in case of electricity cut off, cooling problem of the extruder mechanical defects, etc.) butane can be detected in the PE feeding section of the extruder;
- approximately 40% of butane will be emitted into the atmosphere during storage of the final products;
- a safety certification of the plants converted to a hydrocarbon blowing technology is required by the national rules and regulation.

In addition to the industrial safety arrangements a human health related precautions should also be taken into account as follows:

- the national and international standard for food products packaging require application of high purity (food grade) of the packaging materials. Therefore the butane supplying system has to have a purification unit (molecular sieves based) to ensure separation of impurities (e.g. mercaptans and other sulphur containing impurities).

## **5. Strategy of ODS phase-out from the EPE/EPS sub-sector**

In view of the above-described specific features of both sub-sectors, the Government has decided to address the sub-sector for conversion using a group project approach as follows:

### **5.1 Phaseout of CFC-12 from the EPE sub-sector**

#### **5.1.1. Summary of the 1<sup>st</sup> group project covering 25 enterprises with 46 extrusion lines and total CFC-12 consumption of 1,146 Mt.**

The project was approved by the 25<sup>th</sup> meeting of the Excom for a total grant of US\$ 4,488,516 with the cost-effectiveness of US\$ 3.92 per kg.

The average annual level of production of the extrusion lines of this group of factories is 4,240 t using 36 extruders of 25 kg/h output and 10 extruders of 14 kg/h output, which are in operation under three or two shifts. The blend of PE resin with additives/CFC-12 consists of 20% CC-12 by weight.

The project is expected to be completed by the end of 2000.

5.1.2. Summary of the 2<sup>nd</sup> group project covering 27 enterprises with 47 extrusion lines with the total CFC-12 consumption of 825.7 Mt of ODP

The project was approved by the 28<sup>th</sup> meeting of the Excom for the total US\$ 5,289,441 with the cost-effectiveness of 6.43 US\$/kg.

The average annual level of production of this group of factories is 3,288 t of PE nets, using 11 extruders of 25 kg/h output and 36 extruders of 14 kg/h output which are in operation under three and two shifts depending on the market requirements.

The structure of the 2<sup>nd</sup> group project and its implementation strategy is similar to the 1<sup>st</sup> group project for the EPE sub-sector.

The project is expected to be completed by the end of 2001.

5.1.3. Summary of the terminal umbrella project for the EPE sub-sector:

The remaining enterprises (see Annex 1) of the EPE sub-sector (30 factories with total of 61 extrusion lines) will be converted under the terminal project in accordance with the requirements, recommendations and decisions related to the terminal umbrella projects:

- a) In comparison to the EPE factories covered by two above mentioned approved projects, the remaining enterprises are smaller, equipped with 1 to 5 extruders with output of 10~12 kg/h of nets while the Yichun plastics Plant (see Annex I, 30) with output of 25 kg/h of sheet and operate mainly in two or one shifts. The total average of CFC-12 consumption in 1997-1999 by this group was 810 Mt that is equivalent to 3,240 t of EPE products. The blend of PE resins with additives plus CFC-12 consist of 20% of CFC-12 by weight.  
It is planning that the number of converted factories will be reduced by 4 enterprises and at least 5 extrusions lines will be destroyed.
- b) The conversion cost of 56 extrusion lines is estimated using data and parameters of the approved the EPE projects as following:
  - averaged conversion cost of one extrusion line including cost of retrofitting of extruder, pumping system, storage tank, safety instrumentation, fire fighting equipment, engineering service, training etc. - US\$ 130,000 per line;
  - incremental operating savings -1.6 \$/kg of CFC-12;

- total estimated conversion cost:  
(US\$ 130,000x56 extr.)-(810,000 kg CFC-12x1.6 \$/kg)=US\$ 5,984,000
- Planned submission time – mid 2001
- Planned completion time – mid 2003
- Estimated project budget – US\$ 5,984,000
- Cost-effectiveness – 7.38 US\$/kg

*Note: The actual project budget will be re-estimated in light of the new relevant developments, decisions and guidance which might be available before submission.*

- c) It is the responsibility of the Government and SEPA in cooperation with a selected implementing agency to elaborate an optimal implementation concept of the terminal project in the frame of the project budget with minimum possible negative economic and social impacts which might be caused by restructuring and rationalization of this group of factories.
- It is also expected that SEPA in cooperation with the respective national agencies concerned and in accordance with the national legislation will prepare a compensation programme to be financed by the Government or from other sources of funds to support the factories which have to be eventually closed.

## **5.2. Phase-out CFC-12 from the EPS sub-sector**

The sub-sector is represented in total by 73 enterprises all established before 1995 with the total average CFC-12 consumption of 2,620 Mt during 1997-1999. There are 18 factories with total CFC-12 consumption of 2,440 Mt covered by the approved projects; 16 of them have been converted in 1999; 35 factories have been converted to butane themselves or stopped production.

The remaining 20 EPS factories (see Annex 2) with total 29 extrusion lines and total annual CFC-12 consumption of 1,018 Mt will be addressed for the conversion to the butane blowing technology under two group projects.

It is foreseen that the total number of converted enterprises will be reduced to 17 with 26 converted extrusion lines.

The projects' budgets were estimated based on data and parameters of similar projects are being implemented in China. Two major parameters have been used for the calculations:

- Average conversion cost (ICC) of individual EPS line (50kg/h output) including cost of retrofitting of extruder, storage tank and pumping systems, safety instrumentation, fire fighting equipment, engineering, training etc.– US\$235,000 per unit.
- Incremental operating savings (IOS) are deducted from the total conversion cost US\$1.6/kg of CFC-12.

### **5.2.1. Summary of the 1st EPS umbrella project to phase-out of 686 Mt of ODP from 10 enterprises with 17 extrusion lines**

The following factories are selected for this group: 1 factory equipped with 3 extrusion lines, 5 factories with 2 extrusion lines and 6 factories with 1 extrusion line with foam output of 50 kg/h. Currently

the factories of the first sub-group (with three or two extruders) are operating in most cases in two shifts some of them in one shift during winter time. The factories of the second sub-group (with one extrusion line) are usually operating in one shift. The total averaged annual foam production by these factories is 3,350 Mt of foam (with 17% of CFC-12 by weight in the blend PS resin with additives/CFC-12).

Cost estimation of the 1<sup>st</sup> group EPS umbrella project :

$(US\$235,000 \times 17 \text{ extr.}) - (686,000 \text{ kg CFC-12} \times 1.6 \text{ \$ /kg}) = \text{US\$ } 2,897,400$

- planned submission time - end year 2001;
- planned completion time - mid year 2003;
- estimated project budget - US\$ 2.9 mio.;
- estimated cost-effectiveness – 4.22 US\$/kg.

#### 5.2.2. Summary of the EPS terminal umbrella project to phase-out of 332 Mt of ODP from 7 enterprises with 9 extrusion lines.

The following factories are selected for this project: 2 factories equipped with 2 extrusion lines and 6 factories with 1 extrusion line with foam output of 50 kg/h. Currently the factories of the first sub-group (with two extruders) are operating in most cases in two shifts some of them in one shift during winter time. The factories of the second sub-group (with one extrusion line) are usually operating in one shift. The total average foam production of these factories is 1,620 Mt of foam with 17% of CFC-12 by weight in the blend PS resins with additives /CFC-12).

Cost estimation of the EPS terminal umbrella project:

$(US\$235,000 \times 9 \text{ extr.}) - (332,000 \text{ kg CFC-12} \times 1.6 \text{ \$ /kg}) = \text{US\$ } 1,583,800$

- planned submission time - mid year 2002;
- planned completion time - end year 2003;
- estimated project budget - US\$ 1.6 mio.;
- estimated cost-effectiveness – 4.77 US\$/kg.

It is the Government and SEPA responsibility to decide about the final list of 20 EPS enterprises only to be selected for the projects.

*Note: The actual project budgets will be re-estimated in light of the new relevant developments, decisions and guidance that might be available before submission.*

### 5.3. Cost-effectiveness of the EPE/EPS projects

The projects for these sub-sectors approved by the Executive Committee for China before 1998 are dealing with the individual enterprises with relatively high CFC-12 consumption: average 100 Mt for the EPE and 135 Mt for the EPS per year per factory. Due to the expecting savings from the replacement of CFC-12 by butane, the calculated savings (also relatively high) are deducted from the total estimated project

budgets. As a result, the average cost-effectiveness of the previously approved individual projects is 4.6 US\$/kg for EPE and 3.5 US\$/kg for EPS factories respectively.

In the case of the group projects, the ICC and savings should also be calculated for the individual enterprises in accordance with the relevant rules and guidance of the Multilateral Fund. Due to the low CFC-12 consumption by the factories of the group projects (average 30 Mt for the EPE and 50 Mt for the EPS per factory per year), a level of possible savings is also lower in comparison to the bigger CFC-12 consumers. As a result, these projects are less cost-effective (average 5.2 US\$/kg for the EPE sub-sector, as approved, (see para 5). and 4.5 US\$/kg for the EPS sub-sector as estimated (see para 5.2):

#### **5.4. Strategy of industrial rationalization of the EPE/EPS sub-sector**

The 25<sup>th</sup> Excom recommended to SEPA and the implementing agencies to apply a concept of industrial rationalization when formulating and implementing the umbrella projects for the SME sub-sectors. The subject was thoroughly investigated in light of possible technical, commercial and social impact of such process as well as based on the initial experience in implementation of the first EP umbrella project for china.

Theoretically, there are numbers of measures, aimed at the technical, commercial and management optimisation of the conversion process applicable for the industrial rationalization concept for the group umbrella projects. In general terms, the rationalization task for the EPE/EPS group and terminal umbrella projects can be achieved through implementation of the following concepts:

- a. Reduction of the total number of the enterprises within the group through closure of selected enterprises and relocation of their extrusion lines (without reduction of the total number) to the selected more technically and financially strong and better managed enterprises and to maintain the previous total production capacity of the group by the enlarged enterprises;
- b. Reduction of the total number of the enterprises or/and the total number of extrusion lines of the group through closure of the selected enterprises, reduction of the number of extruders to optimise and balance the production capacity of the individual factories and enlargement of the selected enterprises through relocation of extruders from the factories to be closed.

Implementation of the above described concepts of the industrial rationalization will lead to the following unavoidable additional conversion costs which are not foreseen by the existing financial rules of the Multilateral Fund:

##### **1. Relocation of production facilities and enlargement of selected enterprises**

- costs of disassembling of equipment and utility systems, transportation to a new place etc.;
- costs of civil/electrical/mechanical works, required for accommodation of the relocated equipment;
- costs of installation and commissioning of the relocated equipment, associated with the process of retrofitting;
- training costs of operational and managerial personnel.

## 2. Closure of enterprises

- reimbursement or compensation of the owners (shareholders) of the enterprises;
- compensation of the operational and managerial personnel;
- retraining of the personnel for the new jobs.

It is obvious that practical implementation of the above described concepts of industrial rationalization (especially the procedure of closure of enterprises) should be done in accordance with the local environmental regulatory system and legislation. Such legislation should consist of not only environmental restrictions but also the measures and possibilities of financial and social compensation and assistance from the Government to motivate the public and private sectors to introduce advanced environment friendly technologies.

At the actual conditions of industrial and economic development of China, the following issues should be taken into consideration for practical implementation:

- the factories combined under the projects are, in fact, completely independent and at the conditions of the open market oriented economy are even competitors; Therefore for this and other technical and logistic reasons, they should be approached for conversion separately ;
- the current operating practice of the factories in terms of total working hours per extruder per year is directly linked with the level of employment and the market demands and therefore has very limited flexibility to be changed.

In view of the above mentioned considerations, SEPA in cooperation with the relevant national agencies and organizations concerned will as well as with the project beneficiaries will elaborate a fund mobilization system to cover the above mentioned additional costs associated with the industrial rationalization and not included in the group project budgets.

However due to the extreme complexity of the issue it will also be needed in the future to adjust the described concept of industrial rationalization in light of possible new recommendations and decisions of the Executive Committee related to the SME sub-sectors.

## 6. **Institutional support**

6.1. China Ozone Layer Protection Leading Group, established in 1992 , is a governmental trans-department coordination institution with responsibility of organization and coordination work during implementation of the "Vienna Convention" and the "Montreal Protocol".

The composition of the leading group is as follows:

Deputy Group Leader Unit:           The Ministry of Foreign Affairs  
  State Development and Planning Commission  
  State Economy and Trade Commission  
  The Ministry of Science and Technology  
  The Ministry of Finance



Group Member Unit:

- The Ministry of Public Security
- The Ministry of Information Industry
- State Machinery Administration
- State Taxation Bureau
- State Petrol-chemical Industry Administration
- State Internal Trade Administration
- Ministry of Agriculture
- The General Administration of Customs
- State Light Industry Bureau
- State Tobacco Monopoly Bureau
- State Medicine Supervision and Administration Bureau

6.2. The Ozone Layer Protection Working Group was set up under the Leading Group, whose members were designated by each group leader units. The Working Group's Office located at SEPA deals with the daily work of the Leading Group . The Ozone Layer Protection Working Group is responsible for :

- Implementation of the "Convention" and the "Montreal Protocol"
  - Coordination of ODS production, importation, exportation and consumption
  - Local and overseas fund mobilization for implementation of the Country Programme
  - Submission of various programmes and proposals to the Ozone Layer of Protection
- Leading Group

6.3. The Ozone Layer Protection MLF Project Management Office with responsibility of organising the execution of the Country Programme was set up at SEPA. It is fully responsible for project selection, preparation and application with MLF financing and also for unified co-ordination, management and supervision during project implementation.

The Specialised Foam Working Group of SEPA has elaborated two guidance documents for formulation and implementation of the programme for ODS phase-out from the foam sector of China:

- Foam Umbrella Project Preparation and Implementation Mechanizm:
- Implementation Guidance for Foam Umbrella projects.

## 7. **Establishment of Technical Service Center for Foam Sector**

In order to support quality control of the substitute products as well as to follow-up and monitor the function of substitute products, to conduct overall CFCs conversion programme and speed up promotion and utilization of CFCs substitutes, a technical monitoring and evaluation centre for CFCs conversion under China foam plastic sector is proposed to be set up at the Plastic Processing Application Institute under China Light Industry Bureau and State Plastic Product Monitoring & Inspection Centre. The Centre will provide the main services for the industry as following:

- Perfect raw material analysis system of foam plastic sector;
- Perfect product performance test system of foam plastic sector;

- Establish technical demonstration workshop of CFCs conversion in order to promote ODS free production in foam plastic sector, including staff training, technical assistance, training of equipment conversion and maintenance;
- Organize training in safety operating of hydrocarbon substances for production enterprises;
- Organize training in monitoring and information obtaining;
- Establish quality standard for ODS substitutes, including draft out, revise, release and implement:
  - Establish Quality standard on PS Foam Product Using ODS Substitute as Foaming Agent
  - Establish Quality standard on PE Foam Product Using ODS Substitute as Foaming Agent

The above-mentioned standard will be established on the basis of sector survey and final conformation of data so as to guarantee accuracy, reliability, effectiveness and feasibility of the standard;

- Establish Safety Production Code on PS/PE Foam Production Using Flammable and Explosive Foaming Agent\

Before the formulation of the above-mentioned code, a test report, sector survey report, and the report on technicality, economy and safety of the new code should be presented. During the implementation process, training courses on the content of the code and technology related issues for concerned departments should be organized. Conduct policy readjustment from central to local department, purchase necessary hardware and software needed by the code and recruit working staff (such as supervisor)

- Formulate Safety Production Manual in EPS/EPE sub-sector and detailed training courses. The Information Unit on ODS Substitute Technology in Plastic Sector will be established at the Centre in order to strengthen information communication and network management during ODS phase-out process:
  - Establish well-designed database
  - Organize systematic personnel training
  - Organize specialist team providing technical consultancy and assistance for enterprises
  - Set-up homepage in Internet
  - Introduce the importance of ODS conversion programme by media and enhance public awareness of environmental protection. Establish a Newsletter dedicated to CFCs conversion activities in foam plastic sector and strengthen technical communication. Report regularly on the status of ODS phase-out. Introduce ODS free products to the public.

## **8. ODS related Policy Measures and Bans**

### **8.1 Policy on Product quality Management**

- Standard on PE Foam Product Using ODS Substitute as Foaming Agent will be formulated at during period of 1999 and 2001;
- Standard on PE Foam Product Using ODS Substitute as Foaming Agent will be formulated during period of 1999 and 2001;
- Standard on Rigid PU Foam Series Product Using ODS Substitute as Foaming Agent will be formulated during the period of 2000 and 2002;
- Standard on flexible PU Foam Series Product Using ODS Substitute as Foaming Agent will be

formulated during the period of 2001 and 2002.

## **8.2 Production and Safety Management**

- Safety Production Code on PS/PE Foam Production Using Flammable and Explosive Foaming Agent (Proposed) will be formulated during period of 2000 and 2001;
- Safety Production Code on PU rigid Foam (Proposed) will be formulated during the period of 2001 and 2002.

## **8.3 Bans**

- Announcement about Prohibition of Newly Produced ODS Production Equipment and Newly Produced Equipment Using ODS was jointly released by NEPA, SDPC, SETC, State Industrial and Commercial Bureau in 1997.
- China has commenced closure process in chemical production industry including CFC-12 production. Gradual reduction of CFC-12 supply until zero will guarantee the overall CFC free production within PS/PE enterprises.
- Series Announcement on Prohibition of Using CFCs as Foam Agent in Production in PS/PE foam sector will be released jointly with relevant line ministries in 2005.

*Note: The EPS/EPE enterprises established after July 1995 are requested to convert by themselves or close down in order to realize overall phase-out within this sub-sector.*

- Other related policies and directives will be released by the government:
  1. Establish quota management system in ODS production, consumption and importation.
  2. Establish tax reduction and exemption system in ODS and substitutes production, consumption, import, recycle as well as R & D and import ODS substitute technology.

**Annex I List of enterprises currently remaining in the EPE sub-sector**

	<b>Enterprise (EPE)</b>	<b>Number of extruder line</b>	<b>CFC-12 Consumption, 1999, Mt</b>
1	<b>Shandong Xixia Plastics Foam Nets Plant</b>	1	14.2
2	<b>Shandong Sitong Packaging Nets Plant</b>	5	65.4
3	<b>Shandong Xixia Fruit Freshness-retaining Packing Plant</b>	1	13.6
4	<b>Shandong Tongda Packaging Nets Plant</b>	4	50.3
5	<b>Shandong Hefengqiao Packaging Nets Plant</b>	1	12.8
6	<b>Shandong Liyuan Packaging Nets Plant</b>	5	61.3
7	<b>PuchengBaofeng Packaging Nets Plant</b>	2	29.1
8	<b>Shandong Yongxing Packaging Nets Plant</b>	2	27.6
9	<b>Pucheng Xingshen Packaging Nets Plant</b>	2	25.4
10	<b>Pucheng Gongguo Packaging Nets Plant</b>	3	40.5
11	<b>Pucheng Xingquan Packaging Nets Plant</b>	1	12.1
12	<b>Pucheng Jinyao Packaging Nets Plant</b>	2	26.5
13	<b>Shanxi PuchengHongtupo Packaging Nets Plant</b>	1	12.7
14	<b>Shanxi Huacheng Packaging Nets Plant</b>	1	13.8
15	<b>Shanxi Rongchang Packaging Nets Plant</b>	2	25.9
16	<b>Shanxi Dahua Packaging Nets Plant</b>	3	40.2
17	<b>Shanxi Xingyuxing Packaging Nets Plant</b>	1	13.5
18	<b>Shanxi Sihai Packaging Nets Plant</b>	3	39.2
19	<b>Shanxi Wenming Packaging Nets Plant</b>	1	15.6
20	<b>Sichuan Chongqing Bishan Packaging Nets Plant</b>	1	11.4
21	<b>Shandong Qushi Fruit Packaging Nets Plant</b>	1	12.8
22	<b>Pucheng Laosong Packaging Nets Plant</b>	2	26.1
23	<b>Shandong Xinlong Packaging Nets Plant</b>	4	49.8
24	<b>Shandong Longkou Changlunzhuang Packaging Nets Plant</b>	2	23.7
25	<b>Shanxi Xuehua Packaging Nets Plant</b>	2	24.6
26	<b>Shanxi Poli Packaging Nets Plant</b>	2	27.8
27	<b>Shanxi Paper Packaging Plant*</b>	2	24.6
28	<b>Shanxi Qian County Packaging Nets Plant*</b>	2	26.9
29	<b>Shanxi Qianxing Packaging Nets Plant*</b>	1	12.6
30	<b>Yichun Plastics Plant*</b>	1	30.0
		61	810

\* Enterprises as candidates for further closure or restructuring

## Annex II List of enterprises currently remaining in the EPS sub-sector

	<b>Enterprise (EPS)</b>	<b>Number of extruder line</b>	<b>CFC-12 Consumption, 1999, Mt</b>
1	Guangdong Shenzhen Defengsheng Co., Ltd.	2	78
2	Guangdong Zhuhai Xinfuhua Fast Food Appliance Co., Ltd.	2	80
3	Guangdong Nanhai Plastics Production Plant	1	42
4	Guangdong Nanhai Songgang Fangyuan Plastics Co., Ltd.	2	88
5	Guangdong Fushan Wanda Plastic Products Industry Co.	1	28
6	Guangdong Fushan Meihua plastic tableware factory	1	28
7	Guangdong Dongguan Yufeng plastic package material plant	1	21
8	Guangdong Dongguan Yongsheng plastic package co., ltd.	1	30
9	Fujian Xiamen Anjin Houkeng PSP Sheet Products Plant	1	25
10	Hangzhou Jinying Plastic Products Co., Ltd.	2	67
11	Beijing Tonghao plastic production plant	2	81
12	Tianjin Yuxin Plastics Packaging Co., Ltd.	3	118
13	Jinan Hongli Food Containers Co., Ltd.	1	28
14	Shanghai Songyang Industry & Trade Co., Ltd.	2	88
15	Nanjing Yue'an Plastic Enterprise Co., Ltd.	2	70
16	Nanjing Fast Food Appliance Plant	1	34
17	Harbin Duona Plastics Industry Co., Ltd.	1	25
18	Daqing Lindian Food Containers Plant	1	28
19	Chengdu Plastics Packaging Factory	1	25
20	Cangzhou Yongxiang Foam Plastics Plant*	1	34
<b>Total</b>		<b>29</b>	<b>1018</b>

\* Enterprise as a candidate for closure or restructuring